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Flexible Quotas as a Device in Fisheries Management

A CONTROL SYSTEM BASED ON PROGRESSIVE TAXATION

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TITLE:

Flexible Quotas as a Device in Fisheries Management - A Control System based on Progressive Taxation

ABSTRACT:

This paper introduces a new fisheries' management scheme that might give substantial improvements in rational fishery's exploitation. The idea is to control individual catch with a "flexible quota" that is a combination of a fixed subsidy, a regulated price and an individual progressive taxation for each vessel. The assigning of quotas are based on each shipmaster's best available estimate of vessel costs. They are encouraged to tell the truth about this private information, and there will be no incentive to lie. The information is used to calculate the size of each individual "flexible quota" that combined will constitute the total allowable catch. Socially efficient deviation from the individual expected quota will occur when real costs appear, but deviation from the total catch will probably be limited.

A further development of the model is used to promote the development of a culture where cheating is improper and where fishermen are encouraged to work together. This might be possible if small groups of fishermen are made economically dependent on each other while being grouped according to geographical and social connections. Cooperation within each group and between different groups will be achieved through the development of informal institutions that will arise due to the economical dependency. The economical connection within each group is based on individuals' deviation from the quota, which will be a source for a cashflow in and out of the group's joint account. At the end of the regulation period, the balance of this cash register will be calculated for each vessel proportionally to their flexible quota. Groups and accounts are inclusive in a system organised in hierarchical levels where higher levels also have flexible quotas and cash registers. Upper levels control the levels beneath, each subject to the same principle as the lower levels.

Contents

3. The system of "flexible vesselquotas".

The principle of this model of individual flexible quotas is considered as a means both for regulating efforts and harvesting within the fishing fleet. This regulation system is primarily intended for use concerning harvesting, i.e. as a flexible quota on delivered catches from a vessel during a regulation period (for instance one year), and this chapter will be focused mainly on control for these purposes.

I presume that this system will be used parallel to a system of concession for the fishing fleet that will ensure a constant number of performers within a period of regulation.

3.1. Primary concept.

The basis for using the flexible quota system is the same as for all other regulatory systems. Following the advice of oceanographers the fisheries' authorities of several countries negotiate TAC (Total Allowable Catches) of the various species each year. In this instance we presume that a TAC for a singular fish type is given and that all vessels only catch this type of fish.

In a system of individual nontransferable quotas this TAC is divided between regions and then between the different groups of vessels and tools. Vessels owning a concession and having fulfilled certain other requirements are given an individual quota for a year. The size of each quota is set by dividing the vessels into groups determined by for instance maximum meter length. Each vessel within the group is given the same nontransferable quota. In order to explain the main idea behind the flexible quota system I will use one of these vessel groups as a basis, substituting the nontransferable quota for each vessel by an equal share flexible quota.

The quotas are made flexible by a combination of a fixed taxation, subsidised prices and a taxation increasing with the accumulated catches throughout the year (a progressive tax). Total catches are kept down by each participant limiting his catches since the progressive taxation will increase and reach a level eventually during the period where the economical point of view will make it unprofitable for the skipper to deliver more. The system for regulation thus utilizes market mechanisms to distribute the total effort in a more effective manner than if quotas had been fixed.

Subsidised prices, compared to market rates for fish, are needed to ensure a large enough income to make progressive taxation possible. Subsidies will vary so that they function as a buffer towards marketing prices in keeping regulated prices stable. Fixed taxation is necessary to avoid conspiracy that may occur when small amounts are harvested at largely subsidised prices with minimal progressive taxation.

Incorporated in the system is a "joint account" for all vessels where net balance is determined by total tax deposits minus price subsidies allotted. Net balance in this joint account will, for a profitable harvesting, be positive, but since profitable fishing in the long run will attract new performers to the scene the expected balance will be equal to *zero*.[1]. This balance is supposed to be debited or credited each vessel in the group respectively by giving equal shares within a system ensuring that the credit will not affect the quantum decision of each vessel[2].

A big difference between a system of transferable quotas and the model with individual flexible quotas is that the latter enhances efficiency for the fisheries by making it more profitable for vessels with the lowest variable costs to fish more than for those with higher costs. In a system of individual transferable quotas (ITQ) the units with lots of available capital will be able to buy quotas from units with lesser available capital. Efficiency is thereby promoted by the assumption that a financially stronger unit is due to the unit having earned more on fishing, therefore being the more efficient. There is a danger here that the financial strength of a unit may have other causes than this and that competent fishers in such a system are not taken sufficient advantage of. In a system of flexible quotas it is not necessarily the amount of available capital that matters the most, but it will still be necessary to have sufficient means to invest in appropriate fishing gear. Sound investments will invariably be reflected in low variable costs.

This model of flexible quotas resembles the system of nontransferable vessel quotas by the allotment of individual quotas. The difference is that the individual quotas are not fixed but are set according to expected catches per vessel within a larger fleet. The system resembles a "free-for-all" model in that each skipper fishes freely as much as he finds it financially sound.
The skipper makes his decisions within a framework of terms provided centrally - a framework that ensures that the sum of each vessel catches combines to the total quota. From this the system may be viewed as a compromise between extremes - the model of nontransferable quotas and the "free-for-all" system that evens out the benefits and disadvantages of both and brings forth new possibilities.

The terms for the flexible quota model are set by regulating the profits of the vessels with a subsidized regulatory price, fixed taxation and progressive taxation. Mathematically I suggest that the total profit π over the period of regulation, for a vessel within a group, is regulated as follows:

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[1]When several joint accounts are connected in the system this will suggest how the fisheries authorities, if efforts capacity of the fleet is considered too vast, may control the fleet's capacity by confiscating means from the joint account. This also hints at possibilities for constructing a public taxation system for the fishing fleet and its participants integral to control of resources in general.

[2]See chapter 3.3.

$$\pi = ph - c_f - cE - ah^S - k \quad (3.1)$$

where

p = Regulated price for the fish

h = Total catch

c_f = Fixed costs for the vessel

c = Costs for each unit of effort (active days at sea). (Variable costs.)

E = Total effort

a = Tax rate

s = Rate of progression

k = Fixed tax

The regulation parameters are set so that the total group quota is obeyed. The effect on vessels' yearly catches is dependent on the size of the three parameters p, a and s, as well as a number of external conditions. These external conditions will amongst others be the size of stocks and their influence on catches, the skipper and other vessels' reaction to taxation and the variable costs of the fishing.

The progression rate s and the regulation price p are parameters that must be set according to the desired division of effort between vessels of different variable costs. The rate of progression will in addition influence the dynamic qualities of the regulatory system. The level of taxation a is ideally set at a quantity to match the total quota (TAC). A good pre-estimate of the tax rate a is dependent on considerable information, and with a rate of progression larger than *one* a heretofore unknown knowledge of the fishermen's reaction to the progression rate is required - a knowledge that presumably can only be acquired through empirical means (trying it out). Setting the fixed taxation k will depend on the costs of the most expensive vessel one wishes to include under the scheme of regulation.

Equation 3.1 shows regulation of profits when expected catches (the flexible quotas) are equal for all vessels in the group. When a group consists of different types of vessels with different hauling capacity, profits for each vessel will of necessity have to be regulated individually. When creating a general function for regulation, it will be of interest to elucidate on the size of expected catches for each vessel through a year. This is solved by introducing a parameter to the regulation function that decides when progression starts; an "individual flexible quota" $\hat{h}_j$, where the j -index indicates disparate types. This is analogue to allotting disparate quotas to different vessels in a system of nontransferable quotas.

Disparate flexible quotas also mean different regulation prices and tax fixations. The regulation of profits for a vessel type j may then be expressed by

$$\text{(3.2)} \quad \pi = p_j h - c_f - cE - p_j b \left(\frac{h}{\hat{h}_j} \right)^s \hat{h}_j - k_j$$

where

b = Normalized rate of taxation

It may seem as if the parameters b and $\hat{h}_j$ are two independent parameters in this equation (3.2), but in reality they may - when s is chosen - be merged to the constant $a = a_j = p_j b \hat{h}_j^{1-s}$ as presented in equation 3.1. This means that a change in the b-value is equivalent to a similar change in the flexible quota. In this regulatory system the definition of a correct b -value is that in a fleetgroup where all vessels have been granted similar and/or different individual flexible quotas, a total quota (TAC) equal to the combined individual flexible quotas of the group may be attained. A smaller flexible quota $\hat{h}_j$ will generally mean a lower regulation price p_j and a lower fixed tax k_j.

Ignoring the uncertainty on stocks as a considerable problem by using fixed total quotas many of the problems surfacing in trying to create an optimal policy of fisheries regulation are caused by the fisheries authorities' lack of information. What hauling capacity and what costs does each vessel in reality have? Even if the skipper of each vessel is himself uncertain, he will definitely have a better overview concerning his own ship than the authorities.

The Principle of Exposure (Myerson & Baron, 1982) states that every optimal policy of regulation may be substituted by an equally good policy where the performers being controlled are encouraged to report truthfully on private information without sound reasons for lying. Within a system of individual flexible quotas one may possibly be able to set the parameters of the regulatory system as a function of hauling capacity and costs in such a way that the skippers will find it profitable to discern their private information.

3.2 Choosing the progression rate.

The skipper on a vessel will from his experience have an overview of average costs per working day so that if he is informed on the stock situation he will to a certain extent be able to estimate his catches through an average working day. In fisheries regulated through individual flexible quotas the skipper, when the regulatory factor in equation 3.2 is given, may make an approximate estimate of profitable catches through the year before taxation becomes too severe as well as envisioning how many working days are necessary for bringing in the catch. Since fishing will be free all year round he can plan his fishing for "good days" since he may choose what days to go out from practical as well as meteorological and seasonal circumstances. The fishing may in other words be planned in the same way as if he was relating to a fixed quota. Throughout the year he may of course adjust these estimates, but sooner or later towards the end of the year he will end up in a situation where taxation of the next haul is so severe that going out again will be unprofitable. If the skipper and his crew are unemployed by the end of the year he may of course reduce his demand on required minimum pay, but eventually this too will reach its limit. He will by then have made his catches and efforts through the year relative to the size of his variable costs per working day.

At the given regulatory price p the size of the normalized taxation rate b is inversely proportional to the rate of progression s, ($b \equiv \frac{1}{s}$) (Berglann, 1994). When the progression rate is high, taxation will be low as long as catches are lower than the flexible quota, whereas it will "take off" and become quite considerable when catches exceed the limit. Even when the skipper has low variable costs he cannot fish much above quota before taxation becomes so high that he must stop. If his costs are high he may make catches closely up towards quota limitations.

If the progression rate is low taxation will be relatively high all the time and will not change so much when the flexible quota is overstepped. If, however, costs for going out are low, the skipper may make considerable catches above quota before taxation becomes so severe he has to give in. When variable costs are low enough he will in many cases be able to fish up to maximum capacity. A high level of costs will in this situation mean that the skipper already during his first working day will have a small profit from fishing. Only small changes in costs will make it unprofitable to go out and he will end up with making a minimal effort through the year.

Strong competition will appear between fishermen in a system of individual flexible quotas with a low progression rate. This is due to the emergence of strong incentives for making investments to reduce costs and increase hauling capacity. (See also chapter 4.5)

A system of flexible quotas with a high rate of progression may work as a fixed individual quota given to each performer. This may reduce the competition factor within the fishing fleet. Each skipper can thereby plan making his quota at the lowest possible costs because he is less dependent of other fishermen's catches. Previous experience from regulation through a system of individual nontransferable quotas implies that a high progression rate may in the long run increase profitability within the industry.

If, however, the progression rate is very high those with large hauling capacity and/or low costs will lose the opportunity to make that extra profit they probably deserve and possibly need to pay for investments made. Moreover, from a social economic view it will be ineffective. Also, within the coastal fleet there will always be certain vessels that for some reason or other only make a limited or no effort at all. (Torskefiskets økonomi og regulering, 1991). With a very high progression rate it may, as in a system of untransferable quotas, be difficult to obtain the TAC.

Using linear taxation in regulation gives the most efficient division of effort (Clark,1980.). The most efficient vessels are thereby given the opportunity to utilize their capacity to the full at the expense of vessels of lesser efficiency. In a system of progressive taxation a rate of progression that is too high will hinder this efficient division of effort. That is, the closer the progression rate is to *one*, the more socially efficient is the system on a short-term basis regarding the division of effort.

This implies that it should be feasible to find an appropriate rate of progression with consideration to short-term and long-term efficiency and which may increase profitability for the fishing fleet within an intermediate time perspective. The progression rate must then be set high enough to ensure reduced competition and low enough to obtain an economically efficient division of effort.

In choosing the progression rate the dynamic qualities of the regulatory system must be ensured satisfactorily and the system must be robust concerning uncertainties in the calculation of the regulatory parameters. The dynamic analysis in Berglann (1994) as a simple one-species model and a profitmaximizing fleet show that fluctuations in the size of stocks will reduce the social economic gains of the fisheries. Both fluctuations in prices and variable costs of fishing will oppose this reduction.

At uncertainties concerning average values of these variables it turns out that when the progression rate exceeds a certain limit (in this case 1.7) the regulatory system will be more robust considering the realization of a certain TAC. An even higher rate of progression may increase stability even more, but only to a limited degree.

Furthermore the analysis shows that there are two areas concerning a favorable choice of progression rate. With linear taxation (i.e. a progression rate equal to *one*) or almost linear, too great variations in prices, variable costs and hauling capacity will increase the natural fluctuations of stock and cause a strong reduction in industrial profits or extinction of stock. A progression rate as in this model of 1.2 to 1.3 turns out as yielding large profits something that is connected with the fact that fluctuations are filtered away at the same time as the most profitable vessels get to fish the most. When the progression rate is in the area of 1.4 to 1.6 the hauling effort of the vessels will follow the natural fluctuations of stocks well. Since, however, fluctuations in costs and prices also occur the natural stock fluctuations may be enhanced and a situation of reduced profits and danger of extinction returns. When the progression rate exceeds 1.7, one returns to a situation where such fluctuations are filtered away. However, compared to when the progression rate is in the area of 1.2 to 1.3 the social economic advantage is less since hauling efforts of those with low and high levels of cost are more equalized.

In Berglann (1995) theoretical investigations have been made, concerning the creation of a similar regulation to the system of individual flexible quotas, of a monopoly for when preliminary information on costs is uncertain both for the regulator and the monopoly, but where the monopoly has an advantage on information by having a better estimate. Here was found that a system of regulation where the progression rate $s = 2$ and a regulation price that is double to market price would be an optimum regulatory system. Further investigations suggest that this may also be an optimal parameter format for a system of individual flexible quotas with many vessels. This under the condition that the vessels have the same hauling capacity and linear function of costs and that the market price of fish is independent of available amounts. Note that in this case the competition factor has not been taken into consideration. The sole and only factor in optimizing the division of effort with these parameters is the information advantage of the fishers.

3.3 An hierarchical multilevel system and multistock management

In chapters 3.1 and 3.2 I presumed that there is stock being controlled, that the flexible quota is equal for all vessels, that all dues are paid into and all subsidies cashed out from an account that is mutual for a group of vessels where the balance of the account is calculated equally.

To simplify things I will now at the outset still presume that there is a stock unit being regulated and I will call the sum of flexible quotas allotted to vessels within one group the flexible group quota of the vessel group.

The more vessels in a vessel group, it will for statistical reasons be easier to determine the normalized taxation rate so that the group quota is obtainable. One way of realizing the total quota for a stock unit may be to mix all the different vessel types fishing from this stock and establish a single large joint account. The normalized taxation rate will be equal for all vessel types whilst flexible quotas, regulation prices and fixed taxation will vary. In such a mix of vessel types within the same account each vessel's contribution to the joint account will be proportional to the individual flexible quota. The share of the balance being credited or debited each vessel should then also be proportional to the flexible quota.

The disadvantage of a very large joint account is that each vessel's contribution only amounts to a very small portion of the total account. If one of the actors refrains from contributing to the joint account, for example by distributing large shares of his catch on the black market, this will go unnoticed. The situation is similar to tax evasions where the attitude is one of non-reaction to known infringements since the individual do not see the connection between the lack of singular contributions and for example a shaky economy for common benefits. Even if everybody initially were honest, a large joint account would entail several omissions in contribution to the account and in time one would reach the same stable "balance of attitude" that prevails amongst fishers today; "everybody" swindles because "everybody else" does.

By making the joint accounts small simultaneously choosing the vessels connected to the account with consideration to geographical and thereby also social connections, swindling will mean cheating on your neighbours economically. Most likely a situation will then be created where all account contributors are honest and a better culture for cooperation amongst fishers than what is present today may emerge.

The conclusion of this argumentation, which will be more closely examined in chapter 3.4, is that the joint account should not be too large. A fleet fishing from the same stock unit should therefore be divided into several vessel groups. Concerning which types of vessels being organized within a vessel group, practicably it will not be necessary to allot the same flexible quota for each vessel and it should neither be necessary to place demands on what type of fishing gear each vessel should utilize.

A satisfactory group size may for example contain 2-20 vessels from the same locality fishing from the same type of stock. It is such a group of vessels that from hereon will be mentioned as a vessel group, and the sum of all individual flexible quotas within a vessel group will be denoted as the vessel's or the vessel group's flexible group quota.

The problem then arising is what should happen when the vessels' actual catches within a vessel group do not align with the vessel group's flexible group quota. I will in the following argue that in this instance the natural way of regulating the vessel groups will be as if they were individual vessels. A joint account for the vessel groups must be established wherein regulation for total profits for the vessel group is estimated according to the same regulation function (equation 3.2) as is used for individual vessels and where the balance of the vessel group's joint account is calculated on the same principles. By continuing this a hierarchical multilevel system may be construed at for instance four levels[3]

[3]The number of levels and the size of each level will suggest itself naturally in the demographic structure of the different fishing communities and will a.o. be dependent on how many vessels are occupied in fishing from each stock unit.

where each vessel in a vessel group constitutes the lowest level (level 1) and the vessel group may be denoted as the next level (level 2). In continuing the next level above the vessel group, (level 3) may consist of all the vessel groups of a certain district and furthermore another level (level 4) containing all the vessel groups fishing from the same stock unit. It is at this level that the TAC distributed in Norway operates.

This hierarchical organization on four levels, schematically rendered in figure 3.1 is a principle on which larger regions may be regulated. So, the lowest level is the individual vessel. The next level (level 2) contains a certain number of vessels joined economically through the joint account of their vessel group. One may consider all the vessels connected to the joint account as one unit or a "supervessel" (at level 2) consisting of 2-20 vessels. The aggregated costs of the vessels in this unit become the unit's (or the supervessel's) costs and the sum of catches made by the vessels becomes the unit's (or supervessel's) catch.

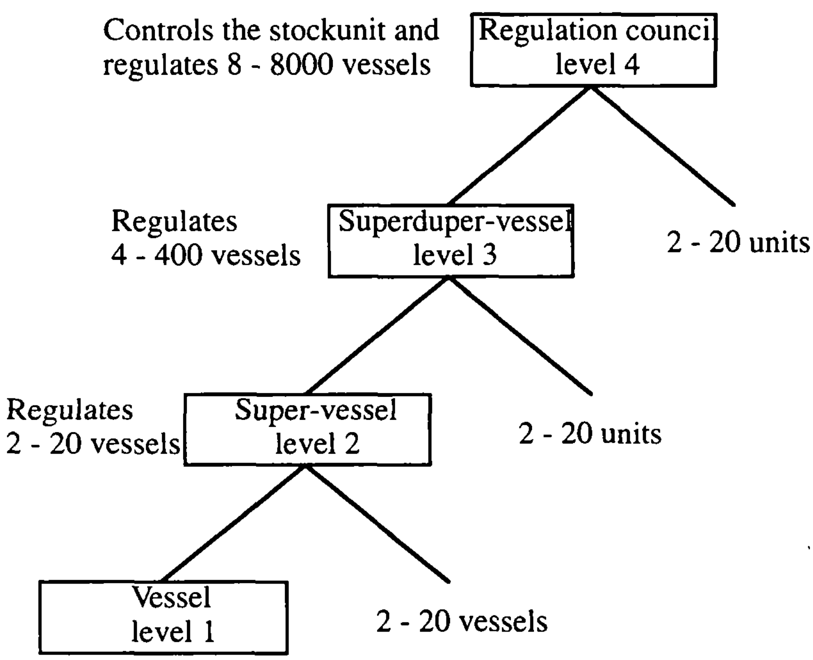

Figure 3.1. Schematic rendition of the organization of the hierarchical multilevel system to regulate a stock unit.

The next level (level 3) consists of a certain number of supervessels (2-20 units) that are linked economically through the joint account of the group of supervessels. By for instance joining all vessels operating within a district one will create a vessel group of supervessels, a "super-duper-vessel" (at level 3) consisting of 4-400 vessels. The aggregated costs for the vessels belonging to this unit become the unit's (or super-duper-vessel's) costs, and the sum of catches made by the vessels become the unit's (or super-duper-vessel's) catch.

All these units may then, when taxation parameters are determined, be regulated by the higher level based on the principle of individual flexible quotas with a joint account for the underlying units. The balance floats all the way up to the highest level before being redistributed. To make all this work the system of joint accounts must be created so that it seems as if the highest level (level 4) is being managed by an even higher level. If the total quota for the stock unit is exceeded this system must be made to function so that part of the joint account is confiscated, and if the result is that catches go under TAC, the lower levels should be given contributions. In this manner the TAC for the highest level will also be flexible.

Determination of the flexible quotas should be made by managing the highest level (level 4) through a Board of Regulation whose task it is to manage a TAC for the whole managerial region of a stock unit. Distribution of flexible quotas for underlying levels should be determined through negotiations. The Board of Regulation at the highest level may be identical the existing Board of Regulation in today's managerial system. Presently this Board of Regulation together with the fisheries organizations and the Director of Fisheries gives advice concerning the determination of TAC and suggests how this is to be distributed among the present-day system's different vessel- and tacklegroups. The final allotments are in some instances determined by the Government and in some instances by the Department of Fisheries.

TAC may in this hierarchical multilevel system be distributed all the way down to the individual vessel through negotiations so that the catches are made in the most cost-effective way possible. The units may adjust to a total catch of the species in an optimal way related to the aggregated variable costs of the units for catching the species simultaneously giving the units maximum profits being distributed to the individual vessels through the joint accounts.

Initially it is not necessary that these units, corresponding to an invisible skipper on the supervessel at level 2 and the super-duper-vessel at level 3, shall consist of formally established Boards of Regulation. However, within this system there may develop certain informal institutionalized arrangements between participants at different levels. At the higher level in this system contact between performers is already in existence through the fisheries organizations. At the lower levels daily contact amongst the fishers may bring forth excellent local solutions.

In reality fishing for a certain species will necessarily entail sidecatches of different varieties and for some vessels it will be desirable, as a main occupation, to participate in fishing on several species. If a vessel regulated under a system of individual flexible quotas for one species, during the regulation period for instance had the opportunity to engage in free fishing on another variety, this might disrupt the economical adjustment intended by the managerial regime during the regulation period. The skipper might also possibly "cheat" by going for sidecatches as the main occupation. Catches in the nature of what was intended as the main occupation might then pose as sidecatches.

This brings up three possibilities. The easiest option is to ignore the problem and go through with the managerial regime for one fish species. The economic adjustments will in this case not necessarily turn out that badly. Another solution is to pay attention to the problem by banning other types of fishing for vessels involved in the managerial scheme. We choose then to ignore the fact that cheating is possible whilst the greatest disadvantage is the lack of freedom prohibition will entail for the fishers involved.

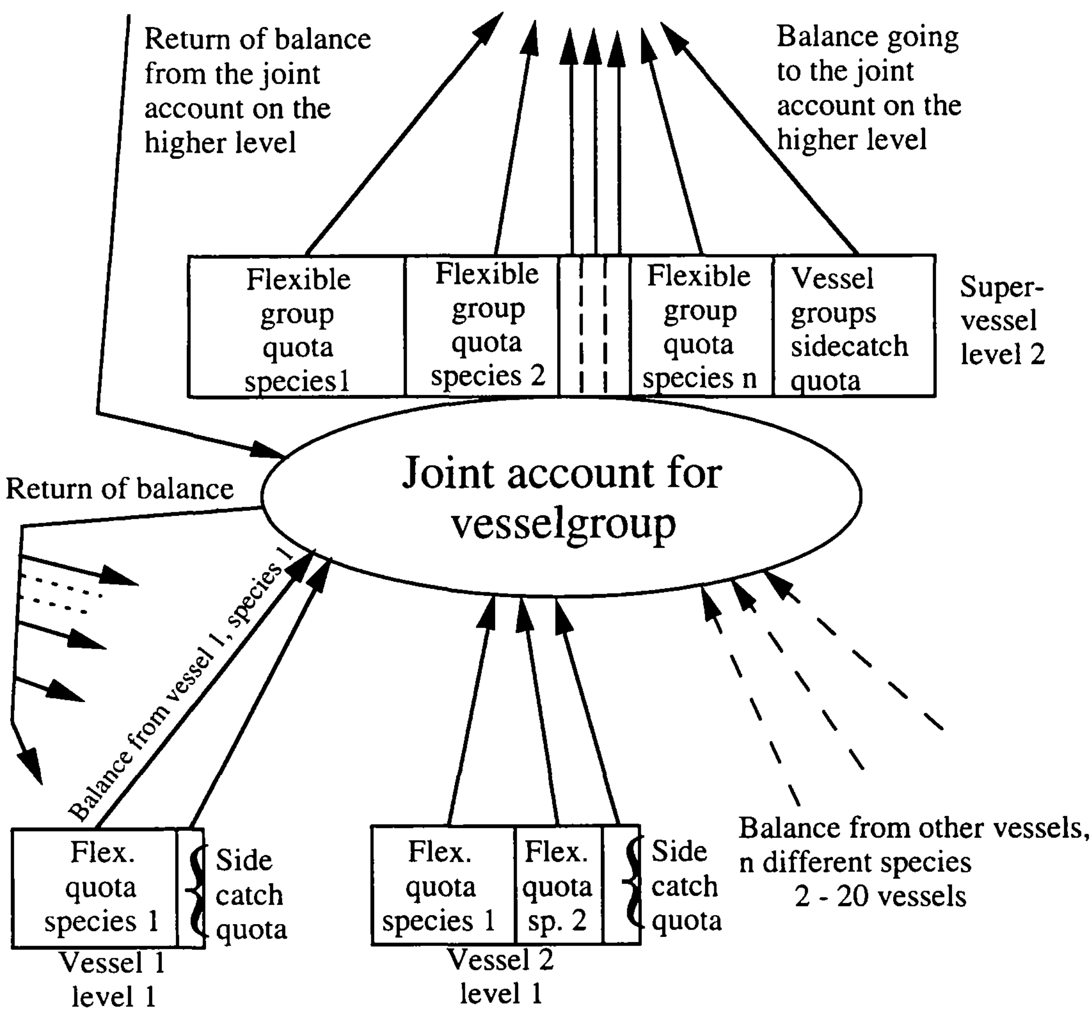

Figure 3.2. Schematic rendition of cash flow in and out of a joint account in a fully developed system of individual flexible quotas within a multistock management. There are *n* different types of stock (or stock units) that are economically exploitable where the skipper of vessel 1 has decided to go for fishing of type 1. The skipper on vessel to has decided to settle on mixed fishing of species 1 and 2, and as is illustrated here vessel 2 has larger hauling capacity than vessel 1. Arrows direction indicates the flow direction of a positive balance.

The better way would be to go through with the system in a multistock management by determining TAC for most of the economically exploitable fish species. The fishermen would then already at the outset of the regulation period have freedom to choose between quotas for several species. The join accounts for the variable species can then be connected so that the cash-flow in an out of an account is as illustrated in figure 3.2.

In such a fully developed system a condition for correct economical adjustment is the necessity for determining flexible TACs of species not ordinarily given such quotas as well as setting flexible TAC for sidecatches. Already in today's managerial system, quotas for sidecatches are given. The size of TACs not already determined today and the distribution thereof, must be discussed further, but quotas consistent with the catches normally presumed would be a natural choice. For both these instances - sidecatches and species that are not normally regulated through TAC - it may be sensible to use a lower progression rate in the regulation of profit (equation 3.2) than what is desirable for species where national obligations make targeting the TAC reasonably well mandatory. This will entail greater freedom for the participants in determining the total amount of realized catches.

The fully developed system of individual flexible quotas may be based on the present-day system of quota distribution for different stock units determined by the Board of Regulation (St.meld. 58, 1991-92). Where in today's system vessel quotas for individual vessels are given, equivalent flexible quotas are allotted. In those instances where vessels are given a competitive quota for sharing, this is divided according to the number of participants and added to the individual flexible quotas. In those cases where a vessel group (by today's group definition) is allotted a group quota or given individual maximum quotas, this is distributed according to the individual flexible quotas. Those shares of the total quotas that are allotted for sidecatches are given accordingly as flexible sidecatch quotas. The sum total of all the flexible individual and sidecatch quotas will then be equal to TAC for each stock unit. With the new type of group distribution in the hierarchical system where geographical and social connections are essential the individual flexible quotas may be summed up at their respective levels in the hierarchy thus forming the basis for the flexible group quotas incorporated in the regulative functions at each level. The totality of all the flexible group quotas and the groups' flexible sidecatch quotas at each level will then add up to being equal to the TAC for the stock units. Through the individual flexible quota system, two types of group divisioning of the fishing fleet is thus utilized; one grouping system based on the present-day system which determines the size of each vessel's flexible quota and another hierarchical group divisioning system where the actual regulation of the vessels is set.

Since the higher levels operate on a basis of aggregated hauling and costs functions there will be less insecurity in predicting the sum of the actual total catch of the vessel groups. According to Berglann (1994) better accuracy in predicting the variable costs will make a high progression rate more expedient in acquiring a predetermined TAC. Since the goal of the highest level is targeting the TAC as closely as possible it might be sensible to determine the penal function for the intermediate levels at a higher progression rate than for the lowest level. A lower progression rate for the intermediate levels will entail greater freedom in deviating from the flexible quota allotted and may be compared to the lower levels gaining local self-government to a higher degree. How the rates of progression are to be determined has to be discussed more intimately but will also in lieu of this be a question of policy that will have to be solved in cooperation with the parties involved.

Introducing this system should in principle enable the normalized taxation rate b in the regulation function for each fishing team to be set equal for all levels. Probably the development of the fleet's cost efficiency will be such that it will increase in the long run as a result of the regulatory system. If the criterion for desired distribution of effort within the fleet is economical efficiency the flexible quota between two units should at the next distributive round be adjusted so that actual catches and flexible quotas are equalized. In negotiating the distribution of TAC between units on different levels this will make a good bargaining position for those representing the most efficient units. Thus the development of the fleet structure may take the desired course.

What is intimated in the above about the distribution of flexible quotas based on economical efficiency is a simplification. Other political considerations, such as scattered settlements and securing employment both at sea and on land will have to be taken into account. By introducing a system of individual flexible quotas present-day divisioning of vessel groups must also be taken into consideration as well as the previous history of distribution of quotas between these groups. This suggests how present-day hauling capacity and investments are divided between vessels. Maintaining fisheries in different regions with permanent differences in profitability will also be desirable for instance when migrating stocks have to be considered. To maintain the notion of flexible quotas for the units, i.e. presupposed total catches for each variety of fish it will in effect also be necessary to differentiate the normalized taxation rate.

We know that interaction between stock units of different varieties affects stock sizes and thereby also the profitability of fishing. We know that the size of the normalized taxation rate indicates what type of fishing is the most profitable. If the system is introduced for several stock units the TAC may be adjusted so that the normalized taxation rates for the different fisheries are equalized. Simultaneously the flexible quotas for different types of stock units at the intermediate levels can be adjusted in order to resemble more closely the actual catches. If this is done judicially on all levels so that general tendencies rather than coincidental circumstances are monitored, we will eventually be able to instill the parameters in the hierarchical network to reflect the marine-ecological system. Since the economy of the fishing industry and the market plays an active part, a system will develop which pays attention to the bio-economical interaction. Since social connections are also taken care of through local and regional political interests surfacing via negotiations on distribution of quotas we will in reality end up with a system paying attention to both social, biological and economical relations.

Utilizing such a system would yield a multistock management where in principle there would be no need for mathematical models on interaction between species. However, the optimization acquired by adjusting regulation parameters will most probably result in a local economical maximum. That's when data models for determining initial quotas on various fish species may come in handy and they will also be useful in monitoring and predicting tendencies. Furthermore databased models can be used to try out strategies and to point at possible strategies to attain something close to a global optimum.

3.4 Incitements for cooperation and conspiracy.

In this chapter I will discuss more closely some arguments for why it might be sensible to construct the system of individual flexible quotas within a hierarchical framework of joint accounts on several levels where the lowest level consists of a limited number (2-20) of vessels with skippers that are socially related.

The Coase theorem (Coase, 1960) states that, when lacking transfer and negotiation costs, involved parties whose efforts interfere with each others profit will reach an agreement on allocation of resources that is both Pareto optimal[4] as well as independent of initial division of owners rights of resources. In the examples presented by Pareto in the original thesis two parties were involved, but Hoffman and Spitzer (1986) have presented experimental results showing that a Pareto optimal allocation may be attained by as many as 38 participants.

In the hierarchic system profits for each participant will be dependent on how much tax is deposited and how much subsidies are withdrawn from the joint account he participates in. A vessel with a high level of costs will deposit less dues in the account. Each participant will therefore have a subjective interest in influencing others towards a lowest possible level of costs. The system thereby encourages cooperation by for instance mutual acquirement of gear and lending each other implements. This may lower total costs of the vessel group. Others will also profit by such cooperation since part of the gains will spill over onto other vessel groups through the joint accounts of the higher levels. Those closest to that area of the hierarchical network in which profits are made gain the most from it whilst those further away get a lesser share.

The presumptions of the Coase theorem will be largely satisfied under the hierarchical system. When the number of participants is small, and they in addition are closely related both geographically and socially, negotiation costs are

[4]The definition of Pareto optimality is that nobody may better their conditions without somebody else worsening theirs.

negligible. Similar cooperation will also be possible between the higher levels of the hierarchical system. Granted this will be the case on a smaller scale since social and geographical relations is lesser and negotiation costs thereby higher. Cash-flow within the system is automatic without the influence of the participants. This means that transfers are implemented without expenses for participants on any level.

Imagine the hierarchical multilevel system described in figure 3.1 where cooperation between two of the vessels in the vessel group (at level 2) is implemented and where these two vessels make their catches separately but accounting of the catches are divided between the two in order to attain lesser total taxation dues into the joint account. Such redistribution of catches has no effect on total catch for the vessel group and likewise has no effect on expenses being debited the same account. If the vessel group consists of more than two parties, the other participants in the group will be cheated. With strong social relations between members the catches in this case will most likely be accounted for correctly so that distribution is managed through the joint account system, or the profits will be shared between participants in another way decided in common in a way that benefits everybody.

A different situation emerges when a vessel is better equipped, more secure, more comfortable and has lower costs than another vessel within the same vessel group. Both skippers will benefit from cooperating by using the better vessel for fishing whilst catches are divided between vessel in the accounting. In this case cooperation might lead to catches and thereby tax deposits becoming larger than if the two vessels had been fishing separately. Divisional accounting could probably be done with the blessing from the other fishers in the group since the additional deposits resulting from cooperation will be of benefit to the others of the vessel group.

My opinion is that there is no reason to prohibit redistribution of quotas between vessels within a group provided there are clear rules that such redistribution is for instance sanctioned by a qualified majority of the other participants in the vessel group involved (at level 2). The authorities will have no need for documentation of such an approval having taken place within the group. In this way a lot of paperwork may be avoided. Clear rules are only necessary to solve dissention between participants. The sanctioning of such redistribution works as if the two vessels were allowed to make up an individual vessel group where the rest of the group functions on a higher level. The situation is by the way equivalent to the vessel group jointly having the opportunity to distribute the flexible group quota themselves - in this case by allotting a larger flexible quota to the better vessel. The individual flexible quotas may in this way be considered legally negotiable but with local ties.

If a similar situation should occur where two vessels wishing to redistribute catches through book-keeping belong to different vessel groups connected to the same joint account at level 3, this will involve all vessel groups linked to this account. Here a rule of qualified majority will apply for a group of participants (or their representatives) of all vessel groups involved. This implies that the higher levels have the opportunity of adjusting the flexible group quotas. They are negotiable, but with strong ties since sanctioning of such redistribution may prove difficult in acquisition.

Other conflicts may occur when some group feels they have been treated unfairly when dividing the flexible quotas. Here trust in the informal institutions (regulation councils at the lower levels) and the composition of the Board of Regulation at the fourth level as well as the final decisions made by the Government are crucial. There is a certain danger that cooperation that in a given situation will be beneficial may be disrupted when groups are put up against each other. This may for instance happen when sectional interests gain the upper hand by certain districts or type of equipment being given priority. There is also the traditional conflict between the ocean-going and costal fleet. Some of these conflicts can be avoided by composing the vessel groups so that for instance several types of equipment (and possibly including ocean-going and coastal vessels) are represented and mixed. To what extent the composition of vessel groups is to be determined from above to put a damper on such conflicts or to what degree the wishes of the individual participants should be considered is a matter that has to be examined more closely.

The following is a game theoretical reflection where we assume a vessel group that is balanced and all participants are honest from the outset but where one dissembles from the group becoming a "black sheep". He cheats by joining the black market for fish distribution and is discovered by another member of the group. Since the participants are linked together economically through a joint account from which the size on reimbursements is strongly connected to the contributions of each vessel, the honest participant discovering the swindle might react either by directly reporting on the case to the group or by firstly giving the culprit a warning and with repetitious behavior, reporting on the case. The honest member will be incited to this since the joint account is so limited that he will lose economically in comparison to a situation where the black market fishing is reported and accounted for. The other participants in the group will then have opportunity to penalize the culprit through social sanctioning (not being welcome to join in a cup of coffee with the others) or in the worst case reporting the dishonest member to the fisheries authorities[5]. The authorities may then for the next quota allotments reduce[6] the vessel quota for the "black sheep" so much that all in all, considering the risk of discovery, cheating will no longer be profitable.

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[5]It is not my intention to introduce a culture of squealing. Normally social sanctions will suffice.

[6]Theoretically the penalty for the offender is to bring on the worst sanctioning possible, namely to seize his whole quota for all times. In reality limited measures are called for a.o. to legitimize the system and because the dishonest fisher will be able to continue his "black" fishing if his income becomes too limited.

This may eventually lead to reform of the offender, making him an honest member yet again. Considering such sanctioning anyone reflecting on turning disloyal may abstain from this. In this manner one may uphold a stable balance where all fishers are kept honest[7].

Within this attitude of "balanced honesty" fishing families and good neighbours will still be able to obtain "black" fish cheaply since this most likely is something everybody in the group participates in - it is considered natural, a silent agreement and therefore poses no grounds for sanctioning. Only the really grave swindles will thus be avoided.

Let the construction of the hierarchic multilevel system remain as in figure 3.1 with four levels. Presume that all vessel groups (level 2) in a super vessel group (level 3) are loyal but that one of the vessel groups turns crooked by having all its members come to an agreement of for instance participating in black market retails of fish without anyone in the group reacting against it. This may be discerned by members of another loyal vessel group, and because of economic losses the swindle may be revealed to the fisheries authorities. Providing proof is given the illoyal vessel group may be penalized by having its flexible group quota reduced for the next regulation period. This threat may in the long run prevent such dishonest agreements and as was the case at the lower level, will instill a stable balance where all vessel groups remain loyal.

Following the same reasoning further up into the hierarchy a dishonest super-duper vessel group (at level 3) may be detected by another honest super-duper vessel group. Such a threat of disclosure will instill a balance in which all super-duper vessel groups, or all participants in the industry will seek to avoid black market sales of fish. This is correspondent with the highest level (level 4) being honest, and this "honest attitude" creates a balancing effect on the whole network.

In this day and age "black" fishing is common amongst fishermen. It is as if all fishers have a tacit agreement that enables everybody to participate in black market dealings without anyone reacting against it. In the hierarchic multilevel system this is analogue to the highest level (level 4) being dishonest. Since this level contains all vessel there are no other group of the same standing (in this case a super-duper-duper vessel) that may reveal the highest level. Since the attitude is so all-encompassing no sanctions against all the fishers may be implemented as a result of this tacit agreement. Proving that such an agreement even exists will of course also be quite impossible. This attitude may be very difficult to change. Those initially honest actors in today's system may be unwilling participants in the swindle. Even in a system of individual flexible quotas with minor joint accounts, they will be considered "stupid" if refraining from participating in the black market fisheries since otherwise they will lose a

[7] This is the Folk theorem: Nash balance in a repeated game. (Kreps, 1990).

lot economically. Since the lower levels are dependent on honesty in the higher levels for a balance of honesty to be spread downwards in the hierarchical network, a hierarchic system of individual flexible quotas will also have a balancing point for attitudes where "all" fishermen will be corrupted.

The stability of the either "honest" or "dishonest" balance is difficult to determine. If not for the fact that fishermen today may have difficulties making ends meet and that participation in the "honest" balance is "punished" by public taxation on accountable incomes, the "dishonest" balance would probably be much more unstable than the "honest" balance. In introducing a new system and increasing efforts in control on behalf of the authorities, a situation might appear where some of the involuntarily "dishonest" fishermen are given the incentive to work actively in altering the present-day attitude. Hopefully one then may have the opportunity to tip the balance in favour of balanced "honesty and remain there. This is a kind of balance that does not exist in today's regulatory systems.

3.5 Practical implementation

A switch-over to this regime will not necessarily require any great changes in present-day organization of fisheries management. In principle the parameters for a system of individual flexible quotas may be determined on the basis of an individual nontransferable quota system. The difference being only that each vessel, instead of a fixed quota, is allotted an account of catches with an individual profit function equal to a flexible quota below the fraction line (equation 3.2). Depositing of dues and reimbursement of subsidies on prices does not necessarily have to be "physical". The fishermen need only regular updates on their accounts.

Such updates for a specific vessel may contain specifications on taxation calculated for deliveries up to date for this vessel. In addition specifications on how much total tax is calculated for all vessels participating in the fishing and the share size of the total sum due this vessel under the system of reimbursement. A skipper with a total catch closing on to the anticipated quota will then find that estimated taxation for depositing in the joint account approximately equals what he receives through price subsidization. The update is only thought of as an aid to the fishermen and will not necessarily entail more paperwork.

At each establishment for landing catches it will be necessary with a computer, that is part of an integrated network where accounts are registered. In that way, each fisher's quantity of catches can be updated regardless of place of delivery, giving the authorities and oceanographers a sufficient overview and adequate means of control. Since relatively cheap modern information technology is being used, expenses for such a regime of administration and control will probably not exceed the costs of that in a system of individual transferable quotas. During an initial switch-over period, costs may be more excessive at first.

To get this regulatory system going one has to pass through a learning phase for fishers and managers of the system. Targeting the TAC may also be difficult at the outset. Therefore try-outs of such a system should initially be kept on a lower scale.

Lots of problems in need of solutions will of course surface as one goes along and many clarifications will have to be made in connection to the practical implementation of such a system. There are bound to be many loopholes, some which may be plugged and others that are unpluggable. Some of the solutions will be compromises and lots of judicial questions will arise.

In the long run one may consider extending the system by reorganizing the vessel groups, introducing the hierarchical multilevel model and adding data on catches and different taxation rates to a multistock model. This may entail a real-time social-biological-economical multistock model where frequent updates on catches create a basis for well managed taxation rates where also updates on hauling costs and market prices are taken into consideration. This could optimize the whole of the fishing industry and minimize uncertainties of the totality.

4. Comparing different systems for fisheries regulation

In this chapter I will discuss certain problem areas concerning different types of fisheries regulation systems based on catch observation. The present-day "free access within a total quota"- , "nontransferable vesselquotas"- and "individual transferable quotas (ITQ)"-systems of regulation will be compared with my suggestion for fishing control by means of flexible vesselquotas.

4.1 Distribution policy, quota infringements and misreporting.

Quota infringements and misreporting of catches are considered the most difficult problems concerning regulatory systems were quotas are set individually. This applies particularly to systems where quotas are nontransferable, when quotas are small compared to hauling capabilities and when profit margins are limited.

This also concern fishing policies and loyalty to authorities. For example the Norwegian quota regulations for 1994 triggered strong reactions amongst the coastal fishers. After several years of loyally supporting a policy of strict total quotas, accepting limited profit margins and being docked, they find that in spite of total quotas being raised they either get smaller quotas than previously, lose their quotas or get a minimal increase. This as a result of the ocean-going fleet consisting of trawlers and autoline vessels having been given a much larger share of the total quota than in previous years. This is considered unfair and may well lead to more "poaching" amongst coastal fishers leading to misreporting of catches.

One may very well speculate on the reasons for a fishing policy where the ocean-going fleet is given priority. From a social economical point of view the sea-going vessels tax the resources in an undesirable manner with catches containing smaller fish than those hauled by the coastal fleet. Another negative aspect concerning sea-going vessel is a lesser need for labor that again has a negative effect on the fishing policy goal of dispersed settlement.

One of the grounds for todays fishing policy concerning the distribution of quotas has most likely to do with the fact that the ocean-going fleet is considered having a better profitability development than the coastal fleet. This is confirmed by data from profit surveys during the period 1980-1987, quoted amongst others in Brox (1991). Here it is intimated that this has something to do with the control-system under which the two fleet types have been regulated and that the ocean-going fleet have been more heavily subsidized. The sea-going fleet has for a longer period been regulated under the principle of fixed individual vessel quotas, by which each vessel has had the opportunity to adjust its capacity without competing with others. Each coastal vessel, on the other hand, has over a longer period had to compete within a total quota, leading to, as we all know, low profits and overcapacity.

Regulations based purely on nontransferable vesselquotas is more difficult and less effective for the coastal fleet than what is the case with the ocean-going fleet. The coastal fleet regulation system has over the last years been through a restructuring resulting in a mix where some of the fleets total quota has been allotted to each vessel as a fixed individual quota, whereas the rest is allotted as a total quota for competition. This is probably a better solution than previously. However, it brings an essentially lower profit margin than what is the case for the sea-going fleet.

The situation when quotas were distributed in 1994, when fishing resources had achieved higher levels, was that the total quotas were set higher. In spite of this the total fishing capacity is such that further reductions are preferable. The regulatory system for the ocean-going fleet is such that it doesn't necessarily lead to an increase in capacity. For the coastal fleet the situation is different since the competition which still exists may increase catching capacity when quotas get bigger due to better profit margins which may be used for such investments. Since a general reduction in capacity of the fishing fleet is preferable this may pose as a rational argumentation for a policy on quota distribution leading to allotting the increase in quotas to the sea-going fleet.

A system of "flexible individual vessel quotas" will perhaps be the most suitable when it comes to the coastal fleet since there will be such a vast difference in participation between vessels that other alternative systems will only trigger competition. A system of "flexible individual vessel quotas" will have such a low competition factor that even an increase in profitability will not necessarily lead to investments increasing hauling capacity. The system may be flexible enough for the capacity to be utilized effectively.

If the potential profitability of the coastal fleet turns out better than for the ocean-going fleet, the authorities may, in the long run, get rational grounds for giving the costal fleet larger shares of the total quotas.

The need to report falsely on time and place for catches will diminish, mainly because the control system allows for extensions above quotas and because fishing will not be aborted. Whereas other regulatory systems may impose pressure on the government to increase quotas, with this the authorities may pass the ball back by claiming that they themselves may increase catches by diminishing costs through for instance better cooperation.

4.2 Mixed fishing.

If there are vessels that base their catches on several types of fish over the same period, fixed quota regulations will pose problems that will of necessity lead to infringements and misreporting. Since composition of catches cannot be foreseen and since a quota for one fish species will be filled before others, continued fishing to fulfill the quota will imply that quotas for the other types of fish are exceeded. This also will be the case within a system of "free access within a total quota" if fishing for one species is prohibited. This may be slightly bettered if quotas are made transferable, but in this case also it is unlikely that quotas and catches will match. It's also uncertain whether the skipper or ship owner will have time and opportunity to deal with quota shares.

Today the authorities are to a certain extent fairly lenient concerning overstepping quotas and sidecatches are allowed for vessels specialized for one species. The problem is that the more tolerance being shown, the more the likelihood of this being abused by "mishaps" becoming more serious. This will apply specifically when permission is given for catching species for which no total quotas are set.

In a system of "flexible vessel quotas", regulations for several types of fish will be made possible in a good and efficient way. Vessels opting for diverse fishing will get several accounts of flexible quotas. Penalty fees for exceeding quotas on one species will be compensated by rewards for going under quota on other types. When nearing the end of a regulation period, decisions on how much to fish of each species may be taken on the last trip.

The sidecatches of other fish varieties that will necessarily occur will, if not taken into consideration, disturb the economical adaptation imposed by the "flexible vessel quota"-system. For instance it is possible that the skipper will "cheat" by pursuing sidecatches as main occupation. Catches originally intended as main occupation will then function as sidecatches.

The best way to avoid this is probably by giving the fishing vessels a flexible quota on the amount of sidecatches. The natural option is to set the size of the quota to match what is usually expected. Most likely it won't be necessary to divide between the different varieties of fish contained in the sidecatches. A joint account for all different species in sidecatches is opened. Catches of varieties for which no total quota is set may trigger the same disturbances and one should therefore also for these circumstances impose a flexible quota. In both these cases, sidecatches and varieties for which no total quota is set, it may be advisable to set a lower rate of progression. This will correspond to more freedom concerning amounts of catches.

4.3 Realization of TAC

Targeting the TAC in a system of individual flexible quotas may be more difficult than what is the case for other regulatory systems. Uncertainties regarding stock sizes, coincidental external influences such as the weather, costs on factors affecting efforts and fish prices as well as deviations in attitudes amongst fishers may pose such problems. However uncertainties regarding the biological basis for determining TAC will be independent from uncertainties concerning what catches are hauled under this regimen. Total uncertainties in the resource management are therefore considered as being only marginally greater.

One problem being that the system for determining TAC is so well established that problems may arise regarding the national obligations towards other countries not to catch more than the TAC. The solution here might be to impose such heavy taxation that overstepping of the limit is unlikely - or to negotiate an understanding of the uncertainties - an uncertainty that will also be present in systems of fixed quotas. A higher progression rate as a regulatory factor may render total catches more predictable. It is essential to the system that the fishermen are allowed to plan their fishing ahead for the whole regulation period. A trust in the stability of the system's parameters during the regulatory period must be ensured and all changes made known in advance.

When the regulation period is determined at a year with a consistent taxation rate this will probably function as incitement for each fisher to make his catches as long as fishing availability is plentiful, i.e. early in the year or early in the season. The effect of interest and the fact that taxation increases with catches throughout the year will presumably strengthen this tendency. Parallel to this effect of effort division in time is the divisioning of spacing on efforts. Many fisheries have different places for hauling which creates a tendency of utilizing the regions with the highest stock density or the regions where delivery distances are the shortest first. Thus the stock will grow smaller throughout the regulation period and competition in reaching the field will increase costs.

In a system of individual flexible quotas it is possible to counteract this tendency by dividing the regulated year into several regulation periods with several regulated regions each with separate flexible quotas. If the year is divided into m equal time periods and n equal regions, the basis might be that the individual flexible quota for the whole year is to be divided into mxn equal shares. When progression rate is higher than *one*, dispersing catches over these periods and regions will be made profitable to the participants. This also gives the fisheries authorities a certain opportunity to manipulate catches to ensure acquirement of TAC. The hierarchical multilevel system makes it possible to fine-tune management of catches from different regions so that a.o. knowledge of local fish stands is included in the governing. Previous periodical experience is used to see how fishers react to taxation adjusting parameters for the next period accordingly.

In more seasonal fishing, it may be sensible that the total flexible quota for each time period is differentiated so that the flexible quota is set higher for the season. The same applies if regional differentiation is called for. Migration patterns could then be taken into consideration in fisheries management.

The system of flexible quotas thus makes it feasible, as opposed to present-day regulation systems to fine-tune catches both in time and space. If realizing TACs turns out to be a major problem, these modifications may be imposed without making the fishers feel bound and overregulated and without control damages emerging.

4.4 Overcapacity and incitements to invest.

Since the escalation of technological development in the fifties the ever increasing overcapacity of the fishing fleet has become a major problem. For instance the result for cod stands in the Barents Sea has been a continuous decrease in stock. At the outset profits were substantial and the industry thereby had access to many performers willing to take risks amaking investments that in turn increased the fleet's hauling capacity additionally. This was strengthened even more as government subsidised financing was available. Due to the increase of hauling capacity the total quantity of catches was kept high well into the mid-seventies when stock became so diminished that catches decreased drastically.

There are two ways of describing the overcapacity of the fishing fleet. Economical overcapacity (overinvestment) is manifested by a gap between operating profits and ability of covering capital costs. In Norway, in the period of 1978-1990, this gap had, for fishing in the cod section, a ratio of 20-55% of earnings. Technical overcapacity (the hauling capacity) manifests when it is physically possible to fish more than TAC implies. Today one may estimate that the technical overcapacity for cod fisheries has a ratio of 30-50%, dependent on what TACs are used as underlying terms. (St.meld.nr.56).

If fishing policy goals of increases of profitability in the fishing industry and protection of basic resources are to be reached, it is today important to reduce incitements for further investments in the fishing fleet. The economical overcapacity, high permanent capital costs, leads the vessels into a situation where they are bound to make a certain amount of catches to avoid bankruptcy. As profitability lessens the basic resources are endangered since many fishers will have to resort to illegal markets in order to "keep their heads above water". In such circumstances large quantities of fish may be transferred outside legal channels. Political pressures to increase quotas may also prevail instead of outtakes being limited to ensure increases in stocks so that these will reach the higher level that will pay off in the long run.

Reducing technical overcapacity is also important. Steps taken by the authorities to withdraw vessels from fisheries by handing out reimbursements to promote condemnation/sales of older, inadequate vessels are direct measures that attack the problems at their source. These steps will open up to the possibility of better earnings since utilization of the hauling capacity of the remaining vessels may be enhanced. Most important, however, is finding the means to reduce incitements for investing in higher hauling capability for vessels and to place obstacles in the way of new constructs. Should an increase in stock density prove feasible this is no argument for an increase in such investments since catch profitability per working day will rise as stocks increase.

Some types of investment made in order to reduce variable costs within the fleet, such as conservation of energy, are deemed desirable. The larger share of variable costs however is wages for crew. Generally reduced incitement for these investment types is also looked upon with favour. One of the reasons for this is the fishing political goal of maintaining the existing pattern of settlements something which indirectly favours a labour intensive fleet. Another reason is that a labour intensive fleet will be more flexible in adjusting to varying stocks and thereby helping to ensure the basic resources.

Compared to a capital intensive fleet a labour intensive fleet will not place such high demands on earnings through meagre periods and in better periods hauling capacities may be enhanced by employing more labour. Capital bound physically and which for instance is tied up in a system of transferable quotas is expected to bring in continuous earning regardless of resources, something which will form a basis for pressure on resources and for black market retails. In principle this will be the case whether the capital is paid off or not since it is basically a matter of to whom the tied-up capital belongs.

The incitement to invest in vessels, thereby acquiring capital costs has a lot to do with the control system under which the vessels are regulated. Berglann (1994) shows that regulation through individual nontransferable quotas will be the system theoretically least likely to incite new investments since competition for resources will disappear. A system of "free access within a total catch" will promote the same investments to reduce fishing costs but this regulatory system provokes a greater incentive for investments in larger hauling capabilities of the vessels. This it is that forms the basis of the well-known problem that profits gained in such a system are eaten up by competition.

For a system of individual vessel quotas the incitement to invest will be dependent on the rate of progression. In Berglann(1994) several studies have been made to show that incitement, with an escalating rate of progression, will diminish drastically to begin with, then level out approaching asymptotic (slowly) to the same level of incitement[8] one finds in a system of individual fixed quotas. This is illustrated in figure 4.2. A huge progression rate ($s \rightarrow \infty$) will resemble a fixed nontranferable quota.

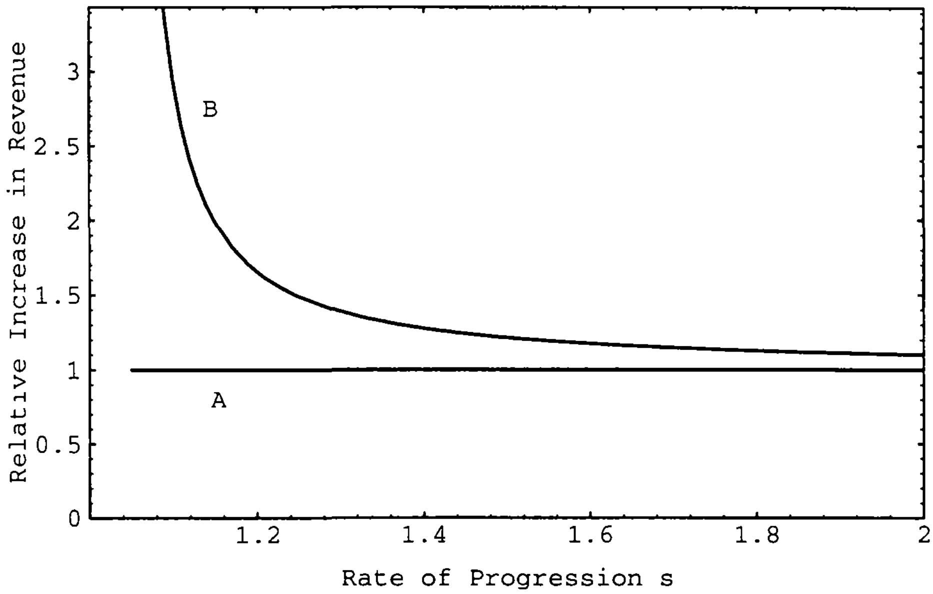

Figure 4.2. Relative incitement as a function of the progression rate for regulation through an individual flexible quota system (curve B). The reference is the incitement of regulation through a system of individual fixed quotas (curve A).

When the rate of progression is very low, the system creates a large incentive for investments. When the point is to reduce investments in the fishing fleet a system containing a progression rate of one will be particularly undesirable since it might promote huge investments in the fleet. In the simple model used in Berglann (1994), with linear cost function, no limit on effort capacity and a stock that are not affected for size, the incitement for investing will skyrocket towards unlimited when the progression rate is nearing *one*.

When the progression rate 's' is equal to one an individual flexible quota for the tax function (3.2) will be calculated against each other and we get a linear taxation system that is proportional to the catch. Clark (1985) shows that such a system for taxation is equivalent to a system of transferable quotas where prices on quotas are equal to taxation. The difference between a system of individual flexible quotas with a progression rate of one and such an equivalent transferable quota system is the measure of reimbursement. When the progression rate is equal to *one*, reimbursements can only be made out in cash. With a profit maximizing fleet cash will not have any influence on catches (Berglann, 1994).

[8]The level of incitement is here equivalent to the size of increase in earnings a certain investment will promote.

The consequences of regulation through individual flexible quotas without making taxation rates progressive is therefore as for regulation through transferable quotas. It promotes a vast incentive for investments and leads in the long run to the industry being dominated by large businesses strong in capital. Huge investments may be made to reduce the need for labour since this has the greatest potential for reducing variable costs of fishing. Labor costs account for about 35 % and 50% of income in the ocean-going and coastal fleets respectively (St.meld.58, 1991-92). A reduction in variable costs for a vessel will, at the next turning mean that a basis is made for hauling more than the flexible quota leading up to a need for investing to increase hauling capacity of the vessels. Some participants will not be able to make it in the competition for reduction of costs. Since the system of individual flexible quotas with a progression rate of one leads to high taxation many vessels will not be able to fish much. Instead most of their share of the income from fishing will be allotted through the system of reimbursement. This will most likely control to what extent the investors will concentrate on those vessels they had initially inciting them instead to buy those vessels that have not been able to follow up on reductions in costs.

As can be seen in figure 4.2, the incentive for investing in a system of individual flexible quotas with a progression rate that is not too small, will be slightly greater than for a system of individual nontransferable quotas. The question is then how much will be invested in a system of fixed nontransferable quotas which theoretically is the type of regulation least likely to incite further investments.

Despite the fact that for instance the ocean-going fleet of Norway in the period of 1972-1990 has been regulated under the principle of nontransferable quotas and public funds have been used for capacity reducing purposes, still investments have been made on such a scale that capital costs have increased considerably. For the coastal fleet which has been competing for a total catch simultaneously capital costs have been relatively stable.

The increasing overcapacity of the ocean-going fleet was particularly fierce in the period from the mid-eighties. This is connected to the deregulation of the credit market, profitable governmental concession schemes, positive outlooks on resources, a rule against allowing interchanges on mandatory licensed vessels was lifted and licenses were given for factory trawlers. Much of the capital came from cheap foreign loans that were allowed since much of the ocean-going fleet's income was made in foreign exchange. With the so-called quota ladder the ocean-going fleet was promised that it would get a larger percentage of the expected increase in TAC than the coastal fleet. The combination of optimism and cheap capital consequently increases the incentive to invest even when quotas are individual.

Today the tendency of deregulation in the credit market continues. If future public financing is to be unsubsidised, this type of financing will have to compete with the other banks and credit businesses offering such financing. Larger ship owners holding vessels in the ocean-going fleet will in this situation have an advantage over ship owners operating on a smaller scale in the coastal fleet. The companies appear more solid financially by often being integrated with interests in the fishing industries having several crutches to lean on and often considerable available equity. The sea-going fleet will therefore, as opposed to the coastal fleet, have easier access to capital for the investments it desires, and since fishing quotas are limited investments will usually be made in order to substitute labor.

One of the steps authorities may take to control this development is to continue subsidizing capital simultaneously limiting investments by introducing huge taxes on investments. To limit effects of varying stock conditions mortgages may be formulated with shorter periods of down repayment and a fluctuating interest rate proportional to the general situation for resources (the better the resources situation, the higher the interest rate).

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