Ragnar Arnason*

Assigning ITQs: An Economic Analysis

A report prepared for Claro y Cia law firm

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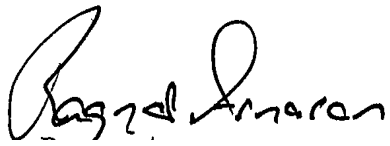
* Professor of Economics
University of Iceland

Preface

On May 7, 2010, I was requested by Claro y Cia law firm to compile a short report on the assignment of ITQ-rights and the economic implications of assigning them by auctions compared to the usual procedure of assigning them on the basis of historical participation in the fishery (grandfathering). This subject is large and technically quite demanding. The following represents my attempt at summarizing and explaining its most pertinent aspects to the case at hand.

In preparing this report, I have cooperated with Dr. Birgir Thor Runolfsson, docent at the Department of Economics University of Iceland. We have been assisted by two economic researchers Illugi Gunnarsson MBA and Anna G. Ragnarsdottir B.Sc. I alone, however, am responsible for the final product.

Reykjavik, June 21, 2010



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Acronyms and abbreviations:
E&D = Exploration and discovery
IQ = Individual quotas
ITQ = Individual transferable quotas
R&D = Research and development
TAC = Total allowable catch

Executive Summary

- Property rights, especially private property rights, are necessary for a high level of economic production and growth. [**Chapter 2**]

- Quality of property rights is important. The more exclusive, durable, secure and tradable the property right, the higher is its quality. Any deviations from full quality property rights will reduce economic efficiency and, therefore, also the total availability of goods for society. [**Chapter 2**]

- ITQs are one type of property rights in fisheries. They are harvesting rights — rights to a certain share of the total allowable catch (TAC). ITQs are not property rights in fish stocks or the ocean ecosystem.[**Chapter 3**]

- Any gains in economic efficiency from ITQs depend wholly on the quality of the property rights embedded in the ITQ rights. The higher the quality of the ITQ-rights the more economically efficient will the fishery be and vice versa. Thus, if the quality of the ITQ- property right is reduced in some way, e.g. by reducing the duration or the security of the right, the economic efficiency of the fishing activity will be correspondingly reduced. [**Chapter 3**]

- The employment of ITQs in fisheries has expanded rapidly in the world over the past 30 years. Currently, at least 22 nations employ ITQs in one or more of their fisheries. The total volume of catch taken under ITQs is probably close to 25% of the global ocean capture fisheries harvest. [**Chapter 4**]

- The initial assignment or allocation of individual quotas has almost always been to existing fishers or fishing companies, i.e. on the basis of first possession or grandfathering-in. [**Chapter 4**]

- The only exceptions to initial assignment on the basis of first possession (grandfathering-in) I have managed to find is in comparatively small fisheries Chile in the early 1990s. [**Chapter 4**]

- There are apparently two cases of a subsequent assignment (i.e. following the initial one by grandfathering) of individual quotas by auctions. This happened in certain fisheries in Russia and Estonia in 2001. In both cases, the auctions were deemed to be unsuccessful and were discontinued after three years (2003). [**Chapters 4 and 8**]

- Fisheries generally exhibit little tendency to monopolistic behaviour, at least not in output markets. A major reason for this is that fish products are widely traded around the world and have many close substitutes. [**Chapter 5**]

- It doesn´t appear that ITQ-managed fisheries are significantly more susceptible to monopolistic behaviour than other fisheries. [**Chapter 5**]

- There doesn't appear to be any reason to expect that any monopolistic behaviour that may exist in ITQ-fisheries will modified or altered as a result of auctions of ITQ-shares. In fact, auctions may cause their own problems of monopolistic behaviour with respect to the bidding as the empirical examples of quota-auctions in Russia and Estonia make clear. [**Chapters 5, 7 and 8**]

- Auctioning of ITQ-rights does not seem to be a good idea from virtually all major perspectives. **[Chapters 7 and 9]**

    - By their negative impacts on the property rights quality of ITQ-rights, auctions will almost certainly lead to a reduction in the economic efficiency of the fishery.
    - By similarly undermining property rights quality in general, they are very likely have a negative impact on economic efficiency in other industries as well, not to mention the exploration and discovery (E&D) activity.
    - Thus, auctions of ITQ-rights are likely to reduce the gross domestic product and, therefore, in due course, the real incomes of most members of society.
    - ITQ-auctions are very unlikely to have any noticeable effect on possible monopoly power and monopolistic behaviour in the fishing industry.
    - While ITQ-auctions will almost surely increase government revenues in the short run, they are likely to reduce the same revenues in the longer run as their negative economic impacts materialize.
    - It is by no means clear that auctions of ITQs promote social fairness compared to leaving ITQ-rights in the hands of the fishers (grandfathering).

- Adding auctions of ITQs to an already exisiting ITQ system is very likely to increase overall transaction costs of ITQ trading. **[Chapter 7.5]**

- Where resource users are already in place, the usual rule for assigning rights is by grandfathering. **[Chapter 7.6]**

- Due to the complexity of fishing and the strong incentives ITQ-holders have for collectively engaging in economically beneficial activities in the fisheries

and marein use in gwneral, arguments for auctions in ITQ-fisheries are substantially weaker than they may be in some other resource-sue activities.**[Chapter 7.6]**

- In the Chilean case, auctions of ITQ-rights is subject to exactly the same disadvantages as ITQ-auctions in general. Moreover, there do not appear to be any significant special features of the Chilean fisheries situation that render auctions more attractive. [**Chapter 9**]

- In the Chilean fisheries situation it appears to be much more in the common interest to strengthen the property rights value of the existing ITQ-rights by extending their term of duration rather than weakening them by auctions. This will promote economic efficiency both in the fishery and other sectors of the economy. For the same reason, limitations on ITQ-ownership and -trades to pre-specified groups should be relaxed to include, preferably, all Chileans. [**Chapter 9**]

1. Background

It may be taken for granted that the social objective of economic production is to contribute as much as possible to the common good or, in more modern economic parlance, overall social well-being. Clearly this involves maximizing the total availability of desirables (generally referred to as goods in economics) to society.

Two things should be noted in this connection: First, goods here include not only commodities (which are typically traded in the market) but also environmental goods, security and other things people desire. Second, maximization of desirables is not only at a point of time but over time. It is the sum total now and at all dates in the future (appropriately discounted) that should be maximized. This is often referred to as the present value of production. In this way, maximization of the availability of desirables also takes the interest of future generations into account.

It follows that the social purpose of any industry is to contribute as much as possible to this main objective. This implies that it be run at maximum economic efficiency. Provided effective markets exist, this is equivalent to saying that industries should maximize the present value of profits.

Distribution of goods

Social welfare depends not only on the quantity of goods made available but also on the distribution of these goods to households and individuals. Any economic system implies some distribution of the available goods. Thus, the market system tends to distribute goods according to the contribution of each household/individual to the overall production.[1] Usually, social and political processes modify the distribution of goods that come out of the economic system. Thus, the ultimate distribution of the available goods depends on economic, social and political processes.

Is there a conflict between maximum production and distribution?

It is sometimes asserted that there is a conflict between maximum production and the most desirable distribution of goods. Therefore, the argument typically goes, we must relax the requirement of maximum net production in the interest

[1] Individual savings lead to accumulation of capital the ownership of which generally generates additional income (i.e. access to goods) above what the current labour of the individual produces. This may even happen over generations by inheritance. Capital, however, is the fruit of savings from previous contribution to production and income from capital, therefore does not violate the principle stated.

of equity or fairness. Arguments of this type are often used in political discourse.

This argument, while not entirely without foundation, is often given far too much weight. One of the most important results in economic welfare theory, the second welfare theorem (Debreu 1959), states that any distribution of goods that is desired is compatible with maximum production and, indeed, the market system..[2] So, at least theoretically, there is no fundamental conflict between the two objectives. Consequently, even in particular empirical cases, there can be no a priori reason to sacrifice economic efficiency, i.e. reduce the total quantity of good s available, for a more fair distribution of the remaining goods. This is not because distribution doesn't matter. The reason is that distributional considerations can, at least in principle and often in practice, be taken care of without reducing efficiency in production. Thus, it appears that those who want to sacrifice economic efficiency should be required to prove (i) that the gain in fairness outweighs the loss in production and (ii) no other ways to a fairer distribution exist.

Fisheries and the fisheries problem

Fisheries are just another production industry. Therefore, their social purpose, as that of other industries, is to utilize naturally occurring fish stocks to contribute as much as possible to the long run living standards of the population. To achieve this aim usually implies modest harvesting, relatively large fish stocks and minimal environmental damage (Anderson 1986, Word Bank 2009). Thus, maximizing the contribution of fisheries to social well-being normally implies sustainable fisheries.

The problem is that because of inappropriate institutional structure, primarily the so-called common property arrangement, the potential net benefits from fisheries areoften not realized. Under the common property (or common pool) arrangement everyone, at least everyone belonging to a well-defined group, can extract from the fish stocks. This, virtually inevitably, leads to a loss of all the potential profits from the fishery (Gordon 1954, Hardin 1968). As a result, although there are individual exceptions, fisheries are not generating much net economic profits globally speaking. If anything, they are losing a good deal of money which is made good by subsidies (World Bank 2009). The economic waste in global fisheries, the fisheries rents loss, has recently been estimated to

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[2] What Debreu proved is that always existed an initial allocation of goods that could meet any distributional consideration. Note, however, that this initial allocation is once and forall and has to have taken place in the past. The theory does not permit current or future reallocations to deal with perceived inequalities, not to mention repeated or continuous reallocations. That would clearly create a huge incentive problem which would reduce production efficiency.

amount to some 50 billion US$ per year (World Bank 2009).

Solving the fisheries problem

Since the fundamental reason for economic waste in fisheries is the common property arrangement, the obvious solution to the problem is to replace it with some form of private property rights often referred to as rights-based fisheries management (Neher et al. 1989, Shotton 2000, Hannesson 2005). Indeed it has been found that the only types of fisheries management that are both theoretically and empirically capable of generating substantial economic benefits from fisheries are property rights based ones (Shotton 2000, Arnason 2007).

One such system of property rights is the ITQ-system (system of individual transferable quotas). ITQs constitute property rights in harvesting shares. If these harvesting rights are of sufficiently high quality, both theory and experience show that these rights can substantially increase the efficiency of the fishery.

2. Property rights theory: Basics

Property rights are necessary for a high level of economic production. To see this note that a high level of production is based on (Smith 1776, Solow 1956, Barro and Sala-i-Martin 1995):

(1) Specialization in production.
(2) Accumulation of capital (physical , biological, human).

A little reflection shows that property rights, especially private property rights, are a fundamental prerequisite for these two foundations of high level of economic production to occur.

Specialization requires trade. If there is no trade, people, if they specialize in a single production process, will not be not be able to obtain the various goods they desire. Hence, in a situation of no trade, people will be forced to be self-sufficient, i.e. to produce all their needs themselves. This, of course, is the typical situation in very primitive societies. Obviously, under these circumstances, firms, which are based on the idea of selling specialized products, couldn't exist. So, it seems that the modern day economic structure of specialized production and production units, i.e. firms, with the accompanying economic benefits is fundamentally based on the possibility to trade.[3] Trade, in

[3] It may be illuminating in this context to wonder about the most likely organization of a

turn, requires property rights. This, of course, is obvious. After all, trade is nothing but a transfer of property rights. So, without property rights there can be no trade. Hence, we must conclude that without property rights, there can be very little economic specialization.

Accumulation of capital also requires property rights. Obviously, no one is going to save valuables in the form of physical capital, natural resources or even human capital unless he enjoys adequate property rights over his accumulation. There are two reasons for this. First, accumulation of capital necessarily means sacrifice of current consumption. Hence, to do so one must be reasonably sure of not only retaining possession of the accumulated assets but also gaining from their existence.[4] Without property rights, this of course is not possible. Second, even if some people decided to accumulate nevertheless, this accumulation would be seized by others and, in order to avoid a similar fate, quickly consumed. So without property rights there will be (i) no accumulation and (ii) what capital there might exist will be quickly seized and squandered.

So, basically, we have established that property rights are necessary for a high supply of goods and, indeed, what is generally regarded as economic progress in general.

2.1 What is a property right?

A property right is a social institution. It defines a certain relationship between an individual (the owner) and an entity (the property). This relationship is usually thought of as a right to the entity. However, it is not a single right. It is really a bundle of distinct (or distinguishable) rights. As pointed out by Alchian (1965), Demsetz (1967) and Scott (1989, 1996) any property right consists of a collection of different rights which they refer to as attributes or characteristics of the property right as a whole.

2.2 Property rights characteristics

The number of distinguishable characteristics that make up a property right is high. However, according to Scott (1996, 2000) the most crucial property rights characteristics are:

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society where trade is not possible. Under these circumstances, it seems that it might be advantageous to organize society in closely knit communities where some specialization can occur on the basis of traditional sharing of the community's production with people attending to their pre-assigned duties according to tradition and social pressure. The family, of course, is an example of this kind of organization.

[4] This, of course, assumes something less than perfect altruistic individuals.

- Security
- Exclusivity
- Permanence
- Transferability

Let us now briefly discuss the content of these characteristics.

Security

A property right may be challenged by other individuals, institutes or the government. Security, here refers to the ability of the owner to withstand these challenges and maintain his property right. It is perhaps best thought of as the probability that the owner will be able to hold on to his property right. Probabilities range from zero to one. A security measure of one means that the owner will hold his property with complete certainty. A security measure of zero means that the owner will certainly lose his property.

Excusivity

This characteristic refers to the ability of the property rights holder to utilize and manage the resource in question (his property) without outside interference. An individual's personal things such as his clothes, generally have a very high degree of exclusivity. A right to the enjoyment of a public park has almost zero exclusivity. The right of a fisherman to go out fishing has exclusivity reciprocal to the number of other fishermen with the same right. An ITQ holder has a right to a specified volume of harvest from a given stock of fish over a certain time period. However, when it comes to the actual harvesting, the question of exclusivity refers to his ability to take this harvest in the way he prefers and to prevent others from interfering with this ability. Any government fishing regulations clearly subtract from this ability. The same applies to the actions of other fishermen that may interfere with his ability to harvest his quota in various ways. Thus, an ITQ right generally provides substantially less than 100% exclusivity to the relevant asset, i.e. the fish stock and its marine environment. It should be noted that *enforceability*, i.e., the ability to enforce the exclusive right, is an important aspect of exclusivity.

Permanence

Permanence refers to the time span of the property right. This can range from zero, in which case the property right is worth nothing, to infinite duration. Leases are examples of property rights of a finite duration. By verbal convention, the term "ownership" usually represents a property right in perpetuity or for as long as the owner wants. Note that there is an important difference between an indefinite duration, which doesn't stipulate the duration of the property right, and

property right in perpetuity, which explicitly stipulates that the property right lasts forever. The duration of a property right may seem related to security; if a property right is lost then, in a sense, it has been terminated. Conceptually, however, the two characteristics are quite distinct. Thus, for instance, a rental agreement may provide a perfectly secure property right for a limited duration.

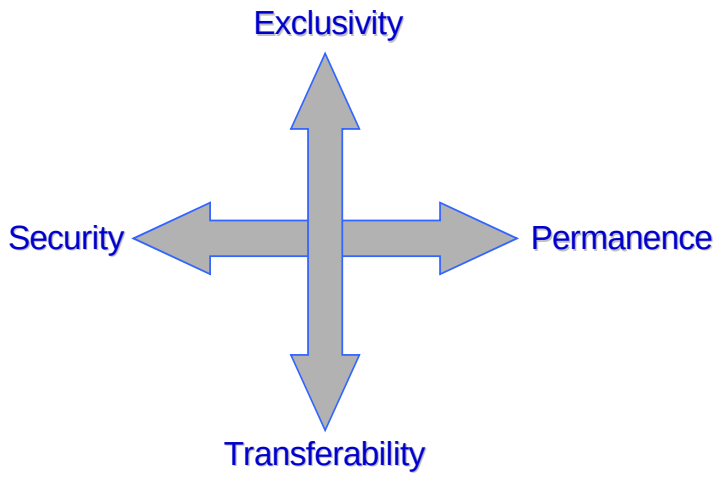
Transferability

This simply refers to the ability to transfer the property right to someone else. For any scarce (valuable) resource, this characteristic is economically important because it facilitates the optimal allocation of the resource to competing users as well as uses. An important feature of transferability is *divisibility*, the ability to subdivide the property right into smaller parts for the purpose of transfer. Perfect transferability implies both no restrictions on transfers and perfect divisibility.

Property rights characteristics: Graphical representation

As suggested by Scott (1989), it is helpful to visualize these characteristics of property rights as measured along the axes in four-dimensional space. This is illustrated in Figure 1. Obviously, if more than four characteristics are needed to describe a property right, the number of axes in the diagram would simply be increased correspondingly as in Scott (1989).

Figure 1
Characteristics of property rights



A given property right may exhibit the different characteristics to a greater or lesser extent. To represent this, it is convenient to measure this on a scale from 0 to 1. A measure of zero means that the property right holds none of the characteristic. A measure of unity means that the property right holds the characteristic completely. Given this we can draw a picture of perfect property rights as a rectangle in the space of the four property rights characteristics illustrated in Figure 2.

2.3 Property rights quality

We refer to the map of the property rights characteristics as in Figure 2, as the characteristic footprint of a property right. Obviously, the characteristic footprint of a perfect property right represents the outer limit for the quality of all property rights. It follows that the corresponding characteristic footprint of any actual property right in the same space of characteristics must be completely contained within this rectangle. This is illustrated in Figure 3.

Figure 2
A perfect property right

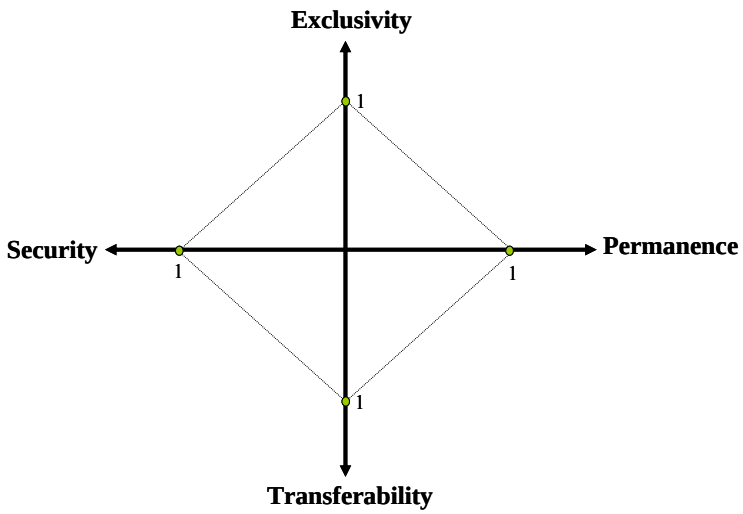
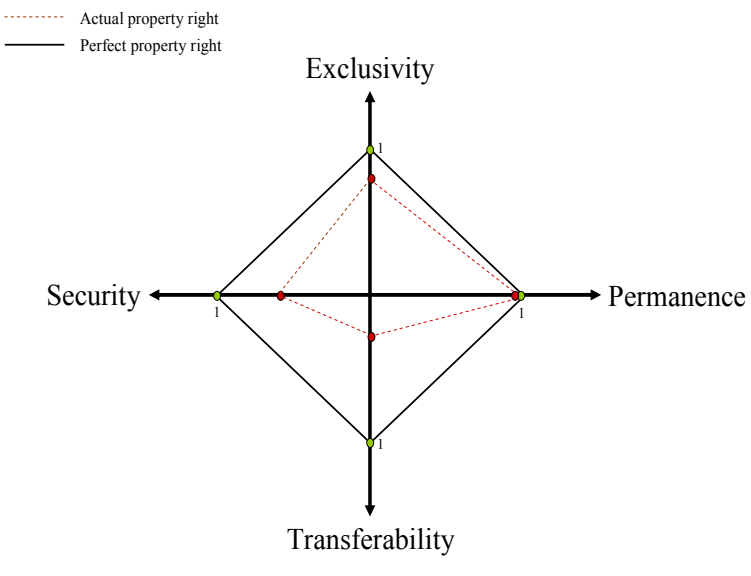


Figure 3 illustrates the characteristic footprint of some actual property right within the characteristic footprint of a perfect property right. The ratio between the two areas enclosed by the two quality maps provides an idea of the relative quality of the actual property right. Henceforth, the term *quality of a property righ*" will refer to this ratio (which is always positive and less or equal to unity.). Obviously the closer the characteristic footprint of a property right is to that of a perfect property right, the higher is its quality.

Figure 3
The quality map of a property right



2.4 Property rights quality and economic performance

Perfect property rights (property rights quality of unity) generate maximum possible economic efficiency. This is easy to see. As already explained, economic efficiency is generated by accumulation of capital and specialization in production. With perfect security, permanence, exclusivity and tradability (transferability) of assets, economic agents reap all the benefits of their capital accumulation (i.e. investment). Therefore their incentive to invest is exactly right from a social perspective. Similarly, with perfect transferability and exclusivity of assets the appropriate social incentives for specialization are created.

Any deviations from perfect property rights (property rights quality less than unity) will reduce economic efficiency (Arnason 2007). A rigorous argument for this assertion is somewhat involved and cannot be repeated here. The reader is referred to Arnason 2007 for a thorough presentation and appendix 5 in section 7 for partial proofs. In any case, the basic intuition is simple enough. Imagine for instance that the security of a property right is reduced slightly. Then obviously the expected benefits from investing in the property right are correspondingly reduced. Therefore, investment is reduced below what would be socially optimal. In the extreme case, security would be zero, i.e., the asset would surely be taken away from the owner. Clearly in that case, there would be no investment and economic production would gradually decline to a very low level. Obviously similar arguments apply to all the other main characteristics (dimensions) of property rights. For instance, with no transferability, there can be no division of labour and, therefore, no specialization in production.

The conclusion inevitably is that any reduction in property rights quality will reduce the level of production and, therefore, also the total availability of goods for society.

It is important to realize that this effect is not limited to the period in which the reduction in property rights quality occurs. If such a reduction is expected with some probability in the future, for instance because of political platforms or the threat of lawlessness, investments now are likely to be affected. The more long-lasting the investment (e.g. investments in human capital or the environment) the bigger will this effect be.

2.5 Philosophical underpinnings of private property rights

Private property rights are not only an efficient economic arrangement which promotes high level of production and economic growth. They are also a social

institution with important socio-political ramifications. Among other things, perhaps naturally, they are often a source of envy and social disagreement. Sometimes they are even labeled unjust. Therefore, it should come as no surprise that the political philosophers who, primarily in the 17th and 18th century, laid the philosophical foundations for the structure of modern society went out of their way to explain and justify private property rights. This applies for instance to the towering figures of John Locke (1632-1704), David Hume (1711-76) and, of course, Adam Smith (1723-1790). Here we only mention the important and interesting contribution of the earliest of the three, John Locke.

John Locke is undoubtedly one of the most influential political philosophers of the western world. Among his most important contributions is the work "*Two Treatises of Governmen*t", published anonymously in 1689 (Ashcraft 1987). In the second treatise he argues that private property stems from the fact that each person owns itself and thus its labor. By mixing ones labor with the fruit of nature, ownership is established. In a famous example Lock argues that he who picks an apple of a tree has by doing so mixed his labor with the apple and has thus become owner of that apple.

In his exposition Lock puts forward two caveats that impose a restriction on how much can be taken from nature by single person. The first one states that one can not acquire more than one can use. The argument for this is to avoid economic waste. There is only so much, he says, a single person can possess of apples until they start to either rot or lie unused. Such property rights can not be defended.

The second caveat is that enough has to be left for others. This caveat has obviously more complicated implications than the first. Locke bypasses most of the problems by asserting that the state of nature is a state of plenty and therefore there is enough for everyone to enjoy. From this Locke concludes that private property originates from a natural state and is created by individuals combining their labour and enterprise with the gifts of nature. In particualr, according to Locke, private property does not derive from government. However, according to Locke, civil society is founded on private property. Therefore the government of the people is obliged to protect it.

This line of argument developed by Locke, with of course the proper adjustments to later day technology and conditions, has formed the basis of how private property rights are justified and explained as a part of the institutional structure of modern society.

Application to private property rights in fisheries

An economically valuable natural resource is one whose products fetch a higher price than the cost of producing them. The difference between the revenue and cost constitutes the economic value of a particular natural resource at any given moment. Increase of the economic value of a resource such as a fish stock is therefore derived from (i) higher prices of existing products, (ii) new products from the resource or (iii) technological changes that lead to lower cost of harvesting. A well managed fish stock is therefore likely to increase in value, since over time cost of fishing is likely to subside because of restoration and improvements in the fish stock, investments in more efficient production methods and technology, the development of new products and the discovery and development of new markets.

This, however, does not happen by itself. A complex process of attempts involving trial and error, success and failure leads to improved technology, new products and new markets. This process is driven by individuals who are willing to spend effort and take risks to increase their economic well-being. A fundamental requirement for such a process to take place is a reasonable degree of confidence that the economic value generated by such risk-taking is not confiscated by other individuals or the government.

Employing the Lockeian argument it can be stated that individuals who have invested their time and money in finding ways to create value from a fish stock have by doing so established some sort of property rights in the fishery. Due to the special nature of fish stocks it is not as straight-forward to define their property rights as for example it is in the case of the picked apple in Locke's example. That, however, is merely a technical issue. The principle of establishing property rights described by Locke is clear enough.

Not only is it in line with Locke´s approach to property rights that those who have created value by invention and risk taking should hold the property rights, it is imperative for future use of and benefits from natural resources that such an approach be taken. If an existing natural resource like a fish stock, that yields profit to its users, is claimed by government and, for example, sold to other users or auctioned off at regular intervals, it will have serious consequences for the future development of this and other natural resources. Basically, the incentives to find ways to enhance the value of the current resource and to discover and develop new resources will be reduced. This will diminish the available economic goods for society in the future.

Not all natural resources have been discovered and put to utilization in some form. Neither have all the possible uses of current resources been identified. The

incentives to undertake the necessary investments and assume the associated risks are highly dependent on the security and durability of the property rights stemming from such discoveries. If an individual knows that as soon as he or she has created value from a previously unknown natural resource, the government will step in and seizes the resource in order to auction it off or tax it in other ways, that individual will obviously be correspondingly more reluctant to risk time and money in order to develop the resource. Thus, such uncertainty will over time decrease the overall wealth of society.

But what about the two caveats the Locke put forward? How do property rights in fisheries measure against them? The first caveat is rather straight-forward. In modern economies, fish caught in excess of what an individual can consume is easily be sold through a market mechanism. Subsequently the individual that has more fish than he or she can eat does not have to let it rot or lie otherwise unused. Thus the first caveat is fulfilled.

The second caveat is somewhat more involved. Obviously fish stocks are natural resources but they are also limited. Therefore if a fish stock is fully utilized, an increase in effort, ceteris paribus, will lead to decrease in economic value. In his treatise on property rights Locke does not tackle this problem in any depth. He assumes that the bounty of nature is inexhaustible and therefore enough for late-comers to claim possession of through their labour. This assumption seems inappropriate for limited natural resources such as fish stocks.

However, on closer examination it turns out that Locke's assumption of inexhaustability is not as far-fetched in this context as it may appear. Even if some or all natural resources are limited, our ability to increase net production by investment and technological progress seems endless. At least the limits seem sufficiently far off to be irrelevant. It is easily seen that successful utilization of a specific limited natural resource such as the fishery can by investments lead to the discovery of new valuable resources or the development of new technologies in other industries. Many examples can be cited to illustrate this phenomenon. Consider for instance the links between development of oil drilling technology, energy intensive machinery and cars and current research in alternative energy or the development of complex financial instruments to hedge against fluctuation in fish prices.

Thus, in essence, there is plenty for everyone. Property rights by comparatively few in some resource do not reduce the opportunity of others to apply their labour to gain similar property rights in the same or other resources. On the contrary, the economic surplus generated by private property rights creates new opportunities for all members of society. Moreover, a part of it is likely to be invested generating new technologies, new opportunities and even new valuable

resources that can be enjoyed by everyone.

3. ITQs as property rights

ITQs constitute one type of property rights in fisheries. More precisely, they are harvesting rights — rights to a certain share of the allowable harvest (total allowable catch, TAC). ITQs are not property rights in fish stocks or the ocean ecosystem. Thus, while ITQs may be reasonably high quality property rights in harvests, they are not property rights in the underlying marine resources. Although harvesting rights imply some rights in the resources generating the harvests, these rights are very limited and, therefore, weak as property rights in these resources.

3.1 The economic efficiency of ITQs

In spite of their limitations as property rights in fish stocks and the underlying marine resources in general, it has been found that ITQs substantially increase the economic efficiency of the fisheries (OECD 1997, National Research Council 1999, Hatcher et al. 2001, Arnason 2007)

- By reducing fishing effort and fishing fleets.
- By contributing to fish stock protection and restoration.
- By restoring economic profits and rents to the fishery.
- By creating a basis for a better overall utilization of marine resources.

The reason for this gain in economic efficiency is that ITQs, by assigning individual harvesting rights to fishers, go a long way toward solving the most damaging common property problem in fisheries which is thecompetition for harvests from fish stocks.

It is important to realize that any gains in economic efficiency from ITQs depend wholly on the quality of the property rights embedded in the ITQ rights (Arnason 2007). If the quality of these property rights is perfect or close to it, the fishery will, at least in time, become fully efficient. If the quality of the property right is reduced in some way, the economic efficiency of the fishing activity is correspondingly reduced. In the extreme case where some characteristic (dimension) of the property rights value of ITQs, such as exclusivity, duration or security becomes zero, the quality of the property right also becomes zero and the fishery reverts to a *de facto* common property fishery. An example of this is when the ITQ constraint is not enforced (exclusivity goes

to zero). Another example occurs when the duration of the ITQ-right goes to zero.

3.2 The worldwide adoption of ITQs

Due to their manifest economic benefits, ITQs have been adopted in hundreds (probably well over a thousand) of fisheries around the world and at an increasingly fast rate. Currently over 15 major fishing nations use variants of ITQs or as an integral part of their fisheries management system[5] and close to 25% of the global catch is currently taken under ITQs (Arnason 2005. See also section 4 below).

4. Assigning ITQ rights

An important aspect of any ITQ system is the initial assignment of ITQ-rights to economic agents (companies/individuals). Assigning these rights to the existing operators in the fishery — often referred to as first possession rule or grandfathering in — is by far the most common way in ITQ fisheries around the world (Shotton 2000, Hatcher et al. 2001, Libecap 2007, Anderson et al. 2010).[6] As explained in Libecap 2007, 2008 and Anderson et al. 2010 there are good economic and social reasons for this.

(i) **Economic efficiency**. Existing operators are the ones most likely to hold the best expertise, knowledge and ability to run a fisheries operation. Thus, assigning rights to other agents would reduce the economic efficiency of fishing. Even if, following a different assignment, trading would later reallocate the ITQs to the initial operators this process would take some time during which there would be efficiency losses and transaction costs incurred.

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[5] Among these nations are: New-Zealand, Australia, Namibia, Morocco, Chile, Peru, USA, Canada, Greenland, Iceland, Norway, Denmark, Russia, Netherlands, Estonia, South Africa and others.

[6] I am aware of three cases of auctions being used as a primary tool to allocate ITQ rights in fisheries. This happened in certain fisheries in Russia and Estonia in the late 1990s (Vetemaa et al. 2002, Honneland 2005. See also section 8 in this report) and certain relatively small fisheries in southern Chile (Pena-Torres 1997). In Russia and Estonia the outcome of these auctions was found to be unsatisfactory and was discontinued.

(ii) **Pareto improvement**. [7] The switch to ITQs is a major regime change in the fishery. Existing fishers are the one most directly affected by the regime shift. If they receive ITQ-rights in accordance with their previous participation in the fishery, they are almost certain to share in the future benefits. In that case, the regime shift would represent a Pareto improvement as far as the fishers are concerned and is, thus, more likely to represent a social improvement. If on the other hand, the fishers were not assigned ITQ-rights — in effect thrown out of the fishery although they might be able to buy into it later — there is a high likelihood that they will lose by the change. In that case, the regime shift would almost surely not be a Pareto improvement.

(iii) **Fairness**. Assigning ITQ-rights to existing operators in the fishery comes reasonably close to being a Pareto improvement —the recipients (may) gain; no-one else loses. Assigning the ITQ-rights to someone else is clearly Pareto-inefficient —the existing operators clearly lose while others not previously operating in the fishery gain. This does not seem fair.

(iv) **Legality**. In most legal systems, it is simply not a part of the social contract (basic law, common law) and, therefore, unacceptable to remove working/operation rights from people who have been utilizing such rights and possibly invested human and physical capital as well as a good part of their lives in the activity.

(v) **Political feasibility**. *Inter alia* for the reasons listed above, it is often not politically possible to forge sufficient support to introduce ITQs unless the ITQ-rights are assigned to the existing operators. Thus, for society to reap the economic gains offered by ITQs, assigning the ITQ-rights to existing operators may be necessary.

(vi) **Expedience**. It is simply administratively easiest and most straight forward to allocate these rights to the already existing operators.

Clearly, as indicated in the text, the above items are not independent of each other. They are linked in various ways, witness legality and fairness, fairness and Pareto efficiency and so on.

Whether for these reasons or others, the almost universal method of initially assigning ITQ-rights to fisheries around the world is to the existing operators in the fisheries. Within that broad rule, assignment on the basis of historical catch

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[7] A Pareto improvement is a social change under which no-one loses and at least one person gains. A change that represents a Pareto improvement, i.e. is Pareto efficient, is unequivocally a welfare increasing change (Varian 1992).

(usually 2-5 years history) is most common. Sometimes, however, this rule is tempered by assigning partly on the basis of investments in the fishery and/or vessel capacity. Occasionally, fish processors and others dependent on fish supply receive certain ITQ-rights (Shotton 2000, Hatcher et al. 2001, Libecap 2007.

The main fishing nations employing ITQs around the word and the initial allocation of quota rights are summarized in Table 1.

Table 1: Some nations using ITQs in their fisheries

No	Country	Year (ITQs introduced)	ITQ coverage of fishieries*	Initial assignment of quotas	Auctions ever used	Auctions now	Comments
1	Netherlands	1974 (stages)	Large	Existing fishers -grandfathering	No	No	
2	Iceland	1979 (stages)	Dominant	Existing fishers -grandfathering	No	No	Some discussion of introducing auctions
3	New-Zealand	1982 (stages)	Dominant	Existing fishers -grandfathering	No	No	
4	Australia	1984 (stages)	Substantial	Existing fishers -grandfathering	No	No	
5	USA	1990s (stages)	Substantial	Existing fishers -grandfathering	No	No	
6	Canada	1990s (stages)	Substantial	Existing fishers -grandfathering	No	No	
7	Greenland	1991	Large	Existing fishers -grandfathering	No	No	
8	Namibia	1991	Dominant	Existing fishers-investments in industry	No	No	
9	South Africa	1979	Some	Existing fishers -grandfathering	No	No	Complicated history with the new regime going back on previous ITQ fisheries
10	Russia	1990s	Large	Existing fishers -grandfathering (directly to regions. From them to fishers)	Yes	No	Auctions in 2000 abandoned in 2003. Poor industry economics and opposition
11	Estonia	1998	Substantial	Existing fishers -grandfathering	Yes	No	Auctions in 2001 abandoned in 2004. Poor industry economics and opposition
12	Denmark	1994/2007 (stages)	Large	Existing fishers -grandfathering	No	No	
13	Norway	1990s	Substantial	Existing fishers -grandfathering	No	No	
14	Morocco	2000	Substantial	Existing fishers -grandfathering	No	No	
15	Chile	1992/2006 (stages)	Large	Auctions (some early ITQ systems) otherwise grandfathering	Yes	?	
16	Peru	2009	Large	Existing fishers -grandfathering	No	No	
17	Sweden	2009	Some	Existing fishers -grandfathering	No	No	
18	UK	Late 1990s	Some	Existing fishers -grandfathering. Initial allocation to POs (producer organizations)	No	No	
19	Germany	1986/1990	Some	Existing fishers -grandfathering	No	No	
20	Falklands	2006	Large	Existing fishers -grandfathering	No	No	Significant extraction of fees
21	Portugal	1992	Some	Existing fishers -grandfathering	No	No	
22	Spain	1997	Some	Existing fishers -grandfathering	No	No	

*Dominant >90%; large 70-90%; substantial 30-70%; some 10-30%; few <10%

Table 1 lists 22 nations which have adopted ITQs in some or most of their fisheries. The almost universal rule adopted for the initial assignment of ITQs is to existing fishers without a special charge and usually on the basis of their prior participation in the fishery.
The only exceptions to this rule of initial allocation that I have managed to find is in comparatively small fisheries Chile, the red shrimp fishery and the cod fishery in the southern part of the country, in the early 1990s (Pena-Torres 1997).

There are apparently only two cases of a subsequent assignment (i.e. following the initial one by grandfathering) of individual quotas by auctions. This happened in certain fisheries in Russia and Estonia in 2000 and 2001. In both of these cases the practice was discontinued after three years (i.e. 2003 and 2004). The reasons for abandoning auctions are reported to have been primarily the resulting poor profitability of fishing companies and, therefore, upheavals in the industry and general industrial opposition to the system. (Anferova et al. 2005, Eero et al. 2005. Huppert 2005, Chu 2009). The experience of these auctions is further described in section 8 of this report.

5. Monopoly power and monopolistic behaviour under ITQs

Firms have market power if they (individually or in collusion with others) can affect the market clearing price. Technically, this happens if they are faced with less than perfectly elastic demand curve and/or supply curves for their products and/or inputs (Varian 1992).

If firms take advantage of their market power, they engage in so-called monopolistic behaviour (Chamberlain 1933, Robinson 1933). Monopolistic behaviour is characterized by reduced supply (to increase output price) and reduced demand for inputs (to reduce input price). Monopolistic behaviour generally reduces economic efficiency.

As is easy to show (see the appendix to this section e.g. Nicholson and Snyder 2005, Varian 1992) the less elastic the supply and demand curves faced by the firm, the more damaging will its monopolistic behaviour tend to be and vice versa. Thus, for instance, even if the firm is a monopolist (i.e. the only firm in the market), if it is faced with a near or perfectly elastic demand it will behave as a firm in perfect competition.

5.1 Monopolistic behaviour in fisheries

Fishing firms may, just as firms in other industries, conceivably have some market power. This market power may lead to less than fully competitive behaviour. However, in fisheries monopolistic behaviour is less likely than in some other industries. There are three main reasons for this. First, the elasticity of demand for fish products is usually high. Second, fish products are to a great extent globally traded products. Third, in most fisheries the number of participants is quite high.

It has been shown in numerous empirical studies (see e.g. Schrank and Roy 1991 and the meta studies by Asche et al. 2005 and Gallet 2009) that in fisheries, as a general rule the elasticity of demand for the output is high. Typical estimates of this elasticity is between [-1, -5] (Asche et al 2005, Gallet 2009). The elasticity of demand facing individual firms, even comparatively large ones will be much higher (Appendix 2 to this chapter). It follows that there is correspondingly reduced reason to be concerned about the impact of monopolistic behaviour in fisheries, even if (which is very rare in fisheries) one or a few firms dominate the industry.

The reason why there is generally a high elasticity of demand for fish products is that there are many close substitutes (Schrank and Roy 1991). These substitutes are first of all the same or similar kind of fish from producers in other fisheries, possibly abroad. Secondly, the substitutes may be other types of fish. Thirdly, the substitutes may be similar non-fish products e.g. poultry, pork or other animal or even vegetable products.

Fish products are to a great extent, and increasingly so, traded around the world. In fact, fish products are among the most traded agricultural products in the world (World Bank and FAO 2009). It follows that that producers from fish find themselves increasingly competing in a common global market with fish producers from many different fisheries and, indeed, fish farming operations from all over the world. Even in their own home markets, foreign fish products can easily replace their own products, if the supply price becomes too high. This basically means that each single fish producer, even if he is large in his own fishery is competing with producers from a great number of other fisheries and fish farming operations around the world. Consequently, his market power is correspondingly reduced.

In most fisheries, the number of operators is large. This is not only because of the typical common property or open access arrangement. Even in fisheries subjected to individual property rights such as ITQs, a relatively large number of operators have continued in the fisheries. The reason seems to be that returns to

scale in most fishing operations are relatively limited. That is probably because of (i) the pervasive agency problems in fisheries (Varian 1992, Stiglitz 1987) rendering large units less efficient and (ii) the heterogeneous and variable conditions of fishing with respect to catchability, density of fish, location of fish, and geographical fishing conditions. As a result, the best technology for fishing tends to be non-uniform and heterogeneous and for most fisheries very large fishing corporations are rarely seen. With increasing fish stocks under improved management regimes, it is to be expected that smaller scale fishing vessels will become comparatively more profitable which will further serve to encourage small scale operations.

For all these reasons, monopolistic behaviour in output markets is rarely seen in fisheries. Where it happens to a small extent seems to be primarily in small specialized fisheries supplying the local market.

Monopolistic behaviour in input markets, i.e. regarding labour and other inputs, may be another story. To the extent that these inputs are specific and localized and cannot be supplied to alternative activities in the same market area or other markets, the fishing firms may have some input market power. The question then becomes the degree of competition between individual fishing firms, which is related to their number, and their ability to collude. This side of the matter has not been subjected to much research and, consequently, very little empirical knowledge seems to be available. In any case, possible monopolistic behaviour in fisheries input markets would depend strongly on local conditions and valid generalizations would probably not be available. A priori, it seems rather likely that a degree of monopolistic behaviour regarding input markets occurs in some fisheries.

5.2 Monopolistic behaviour in ITQ fisheries

The general theory of monopolistic behaviour discussed above applies equally to ITQ fisheries. However, ITQs alter the situation a bit. First, there is additional market, the market for ITQs which, just as the output and input markets, may be subject to monopolistic behaviour. Second, the since the TAC (total allowable catch) is now shared by quota holders, it may be easier to curtail the output level than under certain (but not all) other management regimes.

Regarding the second point, however, two comments are in order. First it is important to realize that under ITQs as other strong fisheries management regimes, the total supply of fish tends to increase compared to that form weak fisheries management regimes (Arnason 2006). The reason is that under strong fisheries management regimes, the stock of fish tends to increase and the optimal sustainable catches for most species is higher than the usual

arrangement (World Bank 2009). Thus, even with some monopolistic behaviour by the fishers, the supply of fish is higher and, therefore, the price, if anything, lower.

Second, note that under ITQs it is much more costly to curtail output than in normal production. The reason is that to curtail output in an ITQ fishery, it is necessary to keep unused quotas. These quotas normally have a price, often quite a high price in the quota market. Thus, those who want to exercise their possible monopoly power by withholding quotas from being used lose not only the value of the output but also the market value of the quota itself.

By far the most complete available study of possible monopolistic behaviour in ITQ fisheries is the paper by L.G. Anderson (2008). This paper examines possible monopolistic behaviour in output markets in ITQ fisheries. Based on available data on demand elasticity of fish, the paper finds that this kind of monopolistic behaviour is unlikely and can only happen if the companies have quite a large share of the total fishery.[8] In the author's own words:

> "From a casual perusal of the two tables [published in the paper] and understanding that the elasticity of demand will tend to be high and the MC/P [marginal cost/price] ratio will tend to be small, it does not appear that monopoly restrictions of output will be very likely in ITQ fisheries. It is an indication that concern over monopolistic excessive share may be ill founded." (Anderson 2008, p. 35)

So, what is the critical share the company has to have in the fishery which may give rise to monopolistic behaviour? According to Anderson's analysis, this company share generally has to be 50% or more, and in almost all plausible cases has to be over 10% of the fishery. As Anderson himself says:

> "Put another way, the excessive share limits [upper bound on the shares of individual companies in the TAC] that have been set in real world fisheries (20% in New Zealand and 1% in the Alaska halibut fishery)[9] will likely prevent any monopoly problems whatever the reason for their implementation" (Anderson 2008, p. 35).

So, according to Anderson's analysis, monopolistic behaviour in the ITQ fishery regarding output markets is extremely unlikely to occur, and it can only happen if the share of the monopolistic firm in the fishery is very high.

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[8] The essence of Anderson's analysis is presented in Appendix 3.

[9] In other countries this upper limit is usually between 1 and 20%.

Anderson's results are supported by observations from actual ITQ fisheries around the world. For monopolistic behaviour to occur, quotas must consistently be kept unused. This is not seen in ITQ fisheries around the world.

Monopolistic behaviour in quota markets imply that the firms engage in less trade in quotas than they would otherwise do. The conditions for this happening are equally stringent as in the case of monopolistic behaviour in output markets. However, due to the elasticity of quota price with respect to supply, the likelihood of this happening may well be higher than regarding output markets. Note, however, less trades in quotas merely affect quota prices. It does not imply any direct misallocation of resources. Therefore, the resulting economic inefficiencies, if any, are of a low order of magnitude.

Finally, it appears that ITQs, to the extent that they reduce fleets and fishing effort, may enhance any monopoly power regarding input markets. Note, however, that this is not particular to ITQ systems. The same holds for any rationalization of the fishing activity.

The key question is: Are ITQ fisheries more prone to monopolistic behaviour than other fisheries? The above discussion suggests two answers to this question depending on what type of fishery the ITQ fishery is compared to.

Compared to fisheries in general, most of which are open access fisheries, heavily overexploited with numerous small operators, the answer is most likely "yes". The imposition of ITQs in these kinds of fisheries is likely to lead to a great reduction in the number of vessels and probably fishing firms. Thus, individual market power and the ability for operators to collude will be greater than before. Whether, this increase in market power will be (i) significant — for this firms need to constitute a substantial fraction (preferably above 20%) of the market production, and (ii) likely to be used is another question.

Compared to fisheries subject to other types of effective fisheries management (e.g. TURFs, community rights, taxation etc.) the answer is probably "no". The reason is that if these other fisheries management systems are effective they will lead to broadly the same number and size distribution of firms so their market power will be similar. In the case of community rights, the relatively small number of communities compared to number of fishing vessels, may even imply greater market power.

Appendix 1.
Simple monopoly analysis

Let the profit function of a firm be

$$P(q)\cdot q - C(q),$$

where q represents the output $P(q)$ the (inverse) demand function and $C(q)$ the cost of production. Note that $P(q)$ is the demand price.

Under perfect competition the firm will behave according to the rule:

$$P(q) = C_q(q).$$

I.e. price will be set equal to marginal cost, , $C_q(q)$ which is socially optimal.

If the firm has monopoly power, it will maximize profits be following the rule:

$$P(q) = C_q(q) - P_q(q)\cdot q.$$

I.e. price will deviate from marginal cost by the term $-P_q(q)\cdot q$. This term is closely related to the elasticity of demand. More precisely denote the elasticity of demand with respect to price, p, by $E(q,p)$. Then:

$$-P_q(q)\cdot q = -p\cdot E(q,p)^{-1}.$$

So, if the elasticity of demand approaches infinity (horizontal demand curve), $-P_q(q)\cdot q \to 0$ and the fully competitive rule applies. If the elasticity of demand is greater than (minus) infinity $-P_q(q)\cdot q > 0$ and the greater it is, the smaller the $E(q,p)$ is.

This shows that for a firm with monopoly power, the greater the elasticity of demand, the less will its monopoly behaviour (distortion) be and vice versa.

Appendix 2
Elasticity of demand for individual firms

Let the demand function for the market be $P(q)$. For a single firm i, the same demand may be written as: $P(q_A + q_i)$, where q_i is the production of firm i and q_A the supply of the other firms.

For the market as a whole the elasticity of price with respect to quantity is defined as:

$$E(p,q) = P_q \cdot \frac{q}{p}.$$

For the individual firm the elasticity of price with respect to quantity is:

$$E(p,q_i) = P_q \cdot \frac{q_i}{p}.$$

It immediately follows that the relation between the elasticity of price with respect to quantity for the single firm and the market as a whole is

$$E(p,q_i) = E(p,q) \cdot \frac{q_i}{q}.$$

Noting that the elasticity of demand is the inverse of the elasticity of price with respect to quantity we find:

$$E(q_i,p) \equiv E(p,q_i)^{-1} = E(q,p) \cdot \frac{q}{q_i}$$

So, if e.g. the firm is quite large, e.g. 1/10 of the industry, its elasticity of demand is ten times that of the market elasticity of demand!

Appendix 3
Monopolistic behaviour of ITQ firms in output markets

Under the ITQ system where a company has some monopoly power (perceives a downward sloping demand curve) the profits may be written as:

$$B = p \cdot (Q - (q_1 - q_2)) \cdot q_1 - s \cdot q_2,$$

where Q is the TAC, q_1 the firm's catch and q_2 its quota holdings (purchases). The parameters p and s represent the price of fish and price of quotas, respectively.

The ITQ system implies the constraints:

$$q_2 \geq q_1,$$
$$Q \geq q_2.$$

Maximization of profits subject to these constraints implies the optimality condition:

$$E(p,q_1) = -1.$$

If $E(p,q_1) < -1$, the firm will want to increase production and purchases of quota and vice versa. It will even want to purchase quota to withhold it from the market. So, $E(p,q_1) < -1$ is a necessary (but not sufficient) condition for the firm to withhold quota from fishing, i.e. engage in monopolistic behaviour.

The relationship between $E(p,q_1)$ and the market elasticity is:

$$E(p,q_1) = E(p,Q)\cdot\frac{q_1}{Q} \equiv E(p,Q)\cdot s_1,$$

where s_1 is the share of the firm in the TAC. On this basis we find the necessary size of the company for it to be possibly optimal to hold unfished quota::

If $E(p,Q)$=-0.5 => s≥2. But s≤ 1. Hence, monopolistic behaviour will not occur.
If $E(p,Q)$=-1.0 => s≥1. But s≤ 1. Hence, monopolistic behaviour will not occur.
If $E(p,Q)$=-2.0 => s≥0.5. Monopolistic behaviour may occur.
If $E(p,Q)$=-4.0 => s≥0.25. Monopolistic behaviour may occur.

However, as already pointed out for most fisheries $E(p,Q)$>-1. Hence monopolistic behaviour is very unlikely to occur.

6. Auctions: Basic Theory

As discussed in chapter 2 above, one of the two fundamental pillars of economic production is specialization. Specialization is made possible by trade. The economic function of trade is to allocate (productive and consumption) resources to those who can make the most use of them. In this way, overall social well-being is maximized.

Buyers and sellers engage in trade to gain. Therefore, voluntary trades are, at least ex ante, value-adding for both — they add to the wealth of both buyers and sellers. We refer to this as the *gains from trade*. The gains from trade are maximized if the trade (i) moves the resource to the best possible use and (ii) does so at the least possible cost. Trades that accomplish this may be called efficient.

Although the essence of trade is always the same — namely the exchange of valuables, to accomplish trades is more complicated than it may seem. For trades to occur, potential trading partners must first of all find each other. This is inherently a difficult problem especially in large heterogeneous populations spread over a wide geographical area. Secondly, they must be able to come to an agreement about a mutually advantageous trade. This is not automatic either. Essentially, the situation is one of bargaining with all the strategic complications involved (Myerson 2001). The social institutions and procedures to deal with these problems may be referred to as *trading mechanisms*.

There are many, perhaps an infinite number, of possible trading mechanisms. For example, sellers may invite potential buyers to purchase certain goods at a certain place at an announced price (typical retail). Sellers may also invite buyers to make bids for their goods (e.g. specialized labour). Buyers may invite potential sellers to sell them goods at a price (e.g. purchasers of raw materials). Potential buyers and sellers may engage in bargaining for a mutually agreeable exchange price (used cars and real estate). Sometimes, agents, often referred to as brokers, set up a place of trade and invite bids and offers for certain goods valuables (e.g. stock exchanges). There are many other ways or mechanisms for effecting trades including. Auctions are one of them.

Given the immense economic benefits of efficient trading mechanisms and the benefits they confer to both individuals and society, it may be taken for granted that an evolution toward the most efficient trading mechanisms for each type of business has taken place. In fact, it is well established in economic history and institutional economics that this has indeed been the case (Schumpeter 1955, North 1981, 1990, Eggertsson 1990, Furubotn 2003). Thus, for assets (or property rights) and, therefore, exchanges that have some history, it is likely that

the trading mechanism that has evolved is reasonably efficient in terms of (i) the allocation of resources and (ii) the cost of trade. Thus, it seems most sensible that those who propose replacing existing trading mechanisms with new ones should be required to prove their case.

Auctions have been a component, albeit a comparatively small one, of the economic allocation process for a very long time. For instance, the Romans often used them to sell slaves and other spoils of war (Shubik 2004). Even before the time of the Romans, in Babylon some 500 years B.C. according to Herodotus, women were auctioned off for marriage and any other method was supposedly illegal (Shubik 2004). While this account by Herodotus may not be accurate, it shows that the concept and most likely also the practice of auctions was well known during his time (450 B.C.).

Although economists have long been interested in auctions, the modern theory of auctions is relatively recent. Its beginnings may be somewhat arbitrarily traced to Vickrey's seminal article in 1961. The aim of economics of auctions is to explain economic behaviour as relates to auctions and deduce the resource allocation, welfare and other implications of that behaviour.

Auctions inevitably place economic agents in a situation where the behaviour of other agents (namely their bids) can affect their personal outcomes. This inevitably gives rise to strategic interactions. The natural tool to study strategic interactions is game theory, primarily the non-cooperative variety but also the co-operative game theory. Indeed, auction theory is generally seen as that branch of game theory that considers human behaviour in auctions and the ensuing outcomes of the auctions (Myerson 1981, Klemperer 2004).

Auction theory (see e.g. Milgrom 2004 and Klemper 2004) has identified two main reasons for the use of auctions:

(1) Improve resource allocation.
(2) Maximize the revenue from selling a particular asset or set of assets.

The first reason is the pure economic reason. It has to do with maximizing economic efficiency and thus the available goods for human use. Note that it implicitly assumes that auctions are more efficient mechanisms for trade than the available alternatives which may include pre-existing trading mechanisms.

The second reason is more normative. An owner of an asset will naturally desire to get the highest possible price for it. Auctions may or may not accomplish that objective. The crucial point, however, is that there is no a priori economic reason why maximization of sales revenue will necessarily also maximize

overall economic production or benefits form the asset.[10] Indeed modern auction theory (e.g. Milgrom 2004, Klemperer 2004) recommends that to accomplish (1) auctions should be conducted in a way that does not maximize the revenue from selling the asset.

In the context of this case it is important to note that countering monopolistic or oligopolistic competition is not one of the arguments forwarded by economic theory in favour of auctions. (Milgrom 2004, Klemperer 2004). Obviously, auctions do not in general alter the conditions for monopolistic behaviour regarding production of goods on the basis of the assets auctioned off. Moreover, the auctions themselves are by no means immune to monopolistic behaviour. In fact, one of the major problems in designing and conducting auctions is to cope with the danger of collusion and monopolistic behaviour by the bidders (Klemperer 2002). Another problem is the incentive for whoever is selling by auction to maximize revenue by limiting the supply of the asset (Bulow and Roberts 1989, Milgrom 2004, Zhen 2008).

From a social perspective the overriding objective of auctions is economic efficiency, i.e. to effect the most beneficial resource allocation at least cost. Although it can be shown that certain auctions under certain conditions can accomplish economic efficiency in this sense, this dos not hold for auctions in general (Maskin 2003, Ausubel 2004, Klemperer 2004, Zhen 2008). Therefore, claims to the effect that auctions are economically efficient allocation mechanisms are not true.

The question then becomes whether auctions are economically more efficient than the alternative allocation mechanisms that are available. The answer to this question is pretty much the same. It depends. Under certain circumstances, auctions might be more efficient. Under other circumstances they might not. The question is empirical. There is simply no economic theory stating that one allocation mechanism is uniformly more efficient than another.

Observing what allocation mechanism has been selected by economic agents, thus, provides indirect evidence about what the most efficient allocation mechanism may be. Remember that economic agents have great economic interests in adopting the most efficient allocation mechanism. If they are not restricted by regulations they can select from the set of all possible allocation

[10] To see this it is sufficient to work out how a owner of given resource (e.g. fish stock, or electromagnetic spectrum rights) facing a declining demand curve can maximize his revenues by limiting the quantity to auction off. Basically he will act as a monopolist and auction off less than would be socially optimal. Another cause not so dependent on limited competition or market imperfections is when the maximization of auction revenues awards the asset to an overoptimistic buyer. This is often called winner's curse.

mechanisms. It follows that the prevailing allocation mechanism is most likely to be the most efficient one. Auctions certainly are among the available allocation mechanisms. Indeed we see that economic agents sometimes choose auctions as a means of allocation or trade. The overall conclusion, however, is that if trading has been possible for some time, then most likely the prevailing trading mechanism is the most efficient one. In particular, if auctions have not been chosen, most likely they are not economically efficient.

This suggests that from the perspective of economic efficiency, auctions are most suited for resources which have hitherto not been subject to property rights and for which, therefore, trading mechanism has not yet evolved.

Forced auctions of already existing assets, i.e. resources already subject to some property rights and, therefore, trade, are particularly problematic from the perspective of economic efficiency. First of all as we have discussed, this is quite likely to replace an efficient resource allocation mechanism with a less efficient one. Second, note that such auctions imply the expropriation of any pre-existing property rights. This will reduce the security and hence the property rights value of the asset even after the auction — if expropriation takes place once, why not again? It will also reduce the property rights value of other assets for the same reason — it happened there why not here? Reduced property rights value, as we have seen, implies reduced economic efficiency. Third, note that there are not really any new resources. All resources have to be discovered and methods to exploit them profitably developed. This is sometimes called the E&I (Exploration and Innovation) process and is a major factor in economic progress. The E&I process is generally conducted by economic agents motivated by the possibility of private gain. If successful E&Is are subject to subsequent expropriation and auction, this will clearly weaken the incentive to engage in the E&I activity.

An important argument for the efficiency of auctions is that transaction costs in auctions are lower than in many other types of trades (Milgrom 2004). In fact, most auction theory implicitly assumes that preparing, conducting and participating in auctions is virtually costless (Milgorm 2004, Klemperer 2004). This, however, is highly questionable.

6.1 The cost of preparing and conducting auctions

To design an auction that is economically efficient is not a simple matter. The overall situation has to be studied carefully and the auction designed to fit the situation. In this process it is easy to make mistakes. Even with very high expenses, it is easy to make serious mistakes which invalidate the possible benefits of the auction (Klemperer 2002, Milgrom 2004). A case in point is the

New Zeland auction of TV licences in 1990 (see e.g. Hazlett 1998, Milgrom 2004). Many other cases of mishandled auctions exist (Klemperer 2002, 2004). The US auction of radio spectrum licences is widely thought of as having been successful (Milgrom 2004, Klemperer 2004). This, however, took a long time in preparation involving numerous experts at undoubtedly very high cost.

Since, there is no universal ideal form of auctions and to be economically efficient, the design of the auction must fit the empirical situation, it is clear that there will always be substantial costs associated with the preparing the auction. Even more importantly note that that the cost of preparing an auction is largely independent of the value of the auction. The problems of designing an efficient auction are pretty much the same irrespective of whether the auction value is large or small.

Finally, it should not be forgotten that there is an additional cost in actually conducting the auction. While this cost may in most cases be expected to be relatively small, the possibility of subsequent disputes and lawsuits may alter the picture.

6.2 The cost of participating in auctions

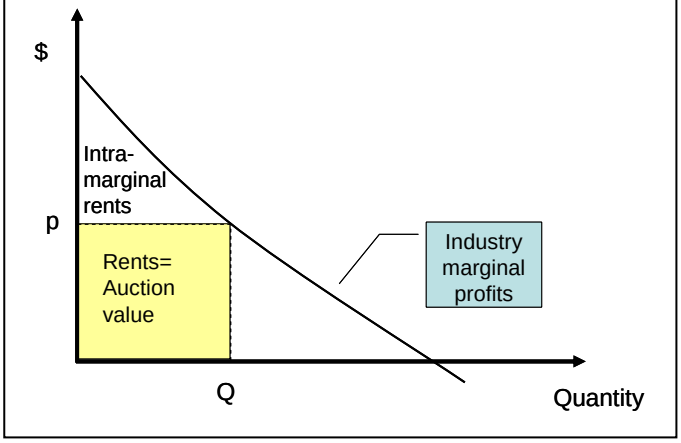
There are substantial costs of participating in auctions. It is not the case, as seems to be assumed in simplistic discussions of auctions, that potential bidders have their reservation price available. To make an informed bid requires systematic evaluation of the expected benefits for having the asset. This is essentially an extensive cost benefit study involving future costs and benefits, a high degree of uncertainty and expected present value calculations and risk analysis. Any bid made is essentially an investment with a very uncertain pay-off; partly because the bid may not succeed, partly because of the uncertainty of the net benefits if it succeeds. These uncertainties represent costs in the sense that the bidders would be willing to pay to avoid them. They will also have complicated impacts on the bids themselves (Dixit and Pindyck 1994) some of which, incidentally, may invalidate economic efficiency.

An important cost related to auctions, although not exactly a participation cost, is the cost of financing the auction bid. For valuable assets the amount of finance necessary can be a very substantial. This means that the successful bidder will have to find and finance the required funds. How great these funds are depends on the payment conditions stipulated in the auction. However, if the payments are not synchronized with the income from using the asset, there is a financial problem.

6.3 Revenue generation

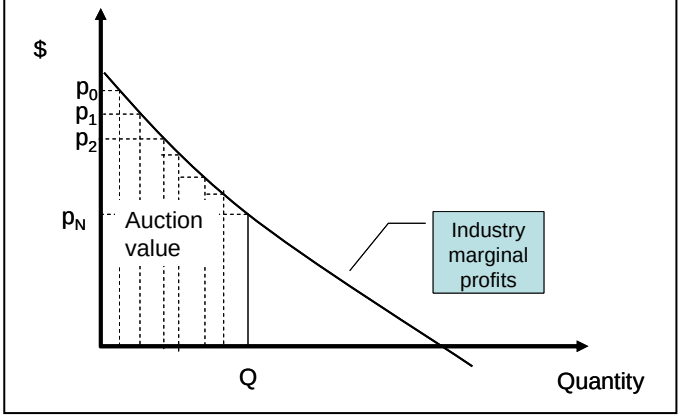
In principle, it is possible to extract all the rents attainable from a resource by the means of auctions. Allowing non-uniform auction prices (each pays his own bid price) it is even possible to extract virtually all economic surplus from using the asset. To see this, consider the diagram in Figure 4. In the diagram, the marginal profits from using varying quantities of the resource is drawn. This downward-sloping curve is equivalent to an (inverse) demand curve for the resource. It represents the whole industry so it is an aggregate of the marginal profit functions of a possibly very large number of firms. Now, let us assume that the quantity for auction is *Q*. Auctioning this off so that every successful bidder pays a uniform price will, in a well designed auction, lead to the auction price p and the auction revenue or value $p \cdot Q$, which happens to be equivalent to the economic rents for the quantity *Q*. Note that the successful bidders will enjoy some intra-marginal rents in spite of paying the auction price. These intra-marginal rents may be expropriated as well by the auctioneer.

Figure 4
Auction: Uniform price



Now consider the situation where every bidder offers to buy a certain quantity at a certain price and, then, if successful pays that price. Assuming as above that the auction is well designed so that every bidder bids his valuation. In that case the situation is more like the one illustrated in Figure 5. As illustrated there, the most efficient firm will bid p_0 for a certain quantity. The second most efficient firm will bid p_1 for another quantity and so on. Bids are accepted in order of unit price until the total quantity Q has been sold. As evident from the diagram, the auction value, i.e. the total auction revenue now collects a substantial proportion of the intra-marginal rents on top of the resource (or basic) rents and is close to the

Figure 5
Auction: Each bidder pays his bid price



total profits form the resource. Obviously by asking for bids for a finer subdivision of the total quantity, the auctioneer may, in principle, extract all possible profits from using the resource.

It is of course tempting for anyone with the right to auction off assets to maximize his revenue from the auction. The government is not immune to this temptation. Indeed a large section of the literature on optimal auctions is concerned with exactly this (Milgrom 2004). While financing of government expenditures may be an important objective, auctions may not be the best way to accomplish this.

We have already seen that auctions can have negative economic efficiency implications problems, not least if the assets are already in use. This means that revenue generation by means of auctions may be counter-productive, i.e. lead to less government revenue later. The question then is whether other methods of raising government revenue may be less damaging. The general answer is "*yes*". First, externality correcting taxes, i.e. green taxes and similar will raise revenue while actually improving the operation of the economy. Second, it appears that income taxes are in general less distortive than most other forms of taxation including taxation by auctions (Arnason unpublished research). Third more exotic tax forms based on random taxation and the concept of lump sum taxation are also preferable.

7. Auctions of ITQs: Economic implications

It is technically possible to assign ITQ rights by auctions. This holds both for the initial assignment and subsequently during the operation of the ITQ-regime. Auctions of ITQ-rights can, in principle, be done once-and-for-all or repeatedly. They can involve all or part of the ITQs (ITQ-shares or ITQ quantities). In between auctions, the ITQs are held by the industry and the system operates, apart from certain implications of the auctions, as other ITQ systems.

ITQ-holders can of course sell their ITQ-rights in privately arranged auctions. Alternatively, under many legal systems the sovereign, e.g. the state, has or can claim ownership of the ITQ-rights and, subsequently sell them off in auctions. The following discussion refers to the latter type of auctions, i.e. auctions by the state.

Auctions of ITQ-rights have some fundamental economic impacts:

(i) State auctions of quota-rights imply the expropriation of any pre-existing rights. What these pre-existing rights are or thought to be exactly is debatable subject to legal and social arguments. From

an economic perspective, it is sufficient to note that compared to the alternative of assigning the rights to existing operators (grandfathering), the auctions are equivalent to the expropriation of ITQ-rights.

(ii) Auctions of ITQ-rights, compared to assigning them to the existing operations, weakens the quality of the property rights embedded in the ITQs and in the national property rights system in general. This is more pronounced for repeated auctions than for once-and-for-all auctions (Arnason 2007, Anderson et al. 2010)

(iii) State auctions imply a payment by the successful bidders (fishers) to the auctioneer (government authorities) This payment will normally[11] amount to most or all the expected net future profits (all the resource rents and possibly a good part of any intra-marginal rents that may exist) from using the ITQs during the period. Thus, the auctions amount to close to 100% taxation of expected future profits (McAfee et al. 1987, Milgrom 2004, Klemperer 2004).

These impacts have far reaching economic implications. Among other things, they generally reduce the economic efficiency of the fishing activities as well as other economic activity (Johnson 1995, Arnason 2007, Lund 2009, Anderson et al. 2010).

7.1 Economic and social implications of ITQ auctions[12]

The implications of repeated auctions are somewhat different from the implications of once-and-for-all auctions. Broadly speaking, the former are *ceteris paribus* more economically detrimental. The fundamental reason is that repeated auctions imply limitations on the duration of the ITQ-rights. That, as discussed in sections 2 and 3, substantially reduces the property rights quality of the ITQs with the corresponding reduction in economic efficiency. Once-and-for-all auctions, on the other hand, only limit the duration of ITQ-rights before the auction takes place. Following the auction the ITQ-rights are, presumably, held in perpetuity as most other assets.

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[11] If the auction is not competitive or somehow manipulated in other ways, the auction price may be reduced to leave some net profits with the successful bidders.

[12] All of the following assertions can be rigorously proven. Many already have been published in scientific papers (Johnson 1997, Arnason 2004, 2007, 2009, Libecap 2007, Lund 2009, Anderson et al. 2010) Some proofs are summarized in an appendix. However, due to the newness of ITQ auctions as a research field, some results have only been presented in lectures, seminars and discussion papers or only exist in notes and working papers yet to be published.

Since the present case before the Chilean Antitrust Court concerns repeated auctions, the following discussion will proceed on that basis. Besides, it is doubtful that once-and-for-all auctions can really exist in an economic and social sense — if the government has used its powers to auction ITQs once, there is always a probability that it may decide to do so again at a later data, irrespective of assurances to the contrary.

We no turn to the main economic implications of ITQ-auctions

1. **Reduced assets of successful bidders**. The auction is really a 100% tax on economic rents and probably close to a 100% tax on net profits in most cases. This has a number of further implications:

   (i) The (active) industry being financially weaker and therefore riskier will be charged higher interest by financial institutions. This means higher capital costs for the companies. Their discount rates (weighted cost of capital) go up. This, from an economic perspective, is equivalent to a shorter time horizon by the firm and implies:
      a. Desire for higher current catch rates and lower long run stock levels, i.e. reduced conservation.
      b. Less concern for the long time health of the ecosystem.
      c. Investment in human and physical capital will be distorted toward shorter rather than longer run gains.

   (ii) The industry's competitive edge, with respect to both other domestic industries and international fishing companies not subject to auctions, will be eroded. In an increasingly globalized world the latter may turn out to be particularly damaging for the domestic economy.

   (iii) Due to the rent extraction accompanying auctions, some companies may find it profitable to leave the fishing industry to engage in other industries. These companies will be replaced by less efficient companies. As a result, the overall economic efficiency in the fishing industry will be reduced. The magnitude of the efficiency reduction depends on the extent of company switching which is an empirical issue. It is worse for repeated auctions than for once-and-for-all auctions, but potentially exists even for the latter. In any case, this switching of companies between industries because of auctions represents an economic distortion with economy wide costs.

   (iv) Reduced research and development (R&D) activity and less innovation and exploration (I&E). The reasons are (a) less funds and (b) less benefits for R&D and I&E (for repeated and yet to take place auctions) and (c) shorter time horizon (higher discount rates).

   (v) Possible financial difficulties for some companies and lending institutes as reduced ITQ-prices due to auctions (yet to happen or repeated ones)

reduce the asset value of companies and therefore their creditworthiness and even formal collaterals. Basically, the expropriation of economic rents by means of the auctions reduces the value of the private capital base. It turns living capital into dead capital in the sense of de Soto [22].

2. **Increased uncertainty**. Auctions increase uncertainty. Companies can not be sure of whether they will succeed in the auction and be able to operate. This uncertainty will then, of course, also be suffered by their labour which may or may not keep their jobs and the communities in which they reside. Uncertainty is always costly. It requires costly adjustments including the following:

   (i) Maintenance of excessive capital to meet the uncertainty. If successful, a company has to have the fishing capital, vessels, factories, human resources etc. to do the fishing. This will have to be kept to a certain extent even if the company is unsuccessful. Under repeated ITQ auctions, the fishing industry will have to operate a bit like the building contraction industry which is infamous for its instability and excessive capital.
   (ii) Provisional short term planning. Given the uncertainty, everyone; companies, labour and communities, is forced to resort to more short run plans. This further reduced the incentive to conserve the resource, invest for the future and so on. In short, the pattern of investment and behaviour, not only by companies but everyone associated with the fishing industry, will be distorted toward what is beneficial in the short run.

3. **Subsequent costly adjustments**. Both the successful and the unsuccessful bidders will have to engage in adjustments of their operations to reflect the outcome of the auction. These includes among other things the following:

   (i) ITQ-trading adjustments. Since many of the successful bidders will not be the ones most qualified for fishing (there could even be speculative bidding, i.e. bidding to gain in subsequent trades), the ITQs will have to be reallocated to the most efficient fishers by trades. This, if feasible, will take some time and incur some costs. This will also lead to some uncertainty and shifts regarding the location of the fishing activity.

   (ii) Subsequent reallocation of fishing/fish processing activities (between companies and over geographical areas). To the extent that the auctions do reallocate ITQs from what applied before the auction and is economically efficient, there will be a reallocation of fishing

activities (in terms of geographical location and companies) with the associated difficulties and costs for labour and communities.

4. **Reduced quota prices.** With repeated auctions and before a once-and-for-all auction ITQ-share prices (not annual quota rental prices) will be reduced. This is because the quota-share price must in market trades reflect the present value of the expected profits of using these quotas for their duration. With the prospect of losing the quotas to auctions at some date in the future, this quota price is correspondingly reduced. This further reduces the asset value of the fishing firms, and possibly that of the nation as a whole, increases the risk of lending to these companies and, thus, increases the rate of interest at which they can borrow.

5. **Distorted quota prices**. With repeated auctions and before a once-and-for-all auction ITQ-share prices (not annual quota rental prices) will become distorted. This is because of the expectation that a good chunk of the economic rents from holding ITQs will be expropriated by the auction. This means that the quota prices will now contain much less information about the real conditions of the fishery. Therefore, as a result, effective fisheries management (setting the TACs and other fisheries management system parameters) will become much more difficult (Arnason 1990).

6. **Less benefits to co-operation with other fishers and marine resource users to achieve the optimal joint utilization of marine resources**. ITQ-rights form a basis for ITQ-holders to come together to undertake joint actions to maximize the value of their ITQ-assets. This would typically involve measures to enhance the fish stocks, avoid habitat damage due to inappropriate fishing methods, joint enforcement of fishing rules and so on. This could even involve negotiations with other users of marine resources including recreational fishers, the tourist industry and environmentalists (Pearse and Arnason 2008, Arnason 2008, Arnason 2009). The motivation for this is the desire to maximize the value of ITQ-holdings. With auctions (repeated or expected ones) and the accompanying expropriation of economic rents and reduction in ITQ-values, this incentive will be greatly reduced

7. **Winners curse**. Future profits are uncertain. The optimistic (and less well informed) bidders will bid unduly high amounts and are therefore likely to disproportionately succeed (McAfee et al. 1987). This will lead to (a) subsequent problems of financial difficulties, bankruptcies etc. so well known from the construction industry which is characterized by bidding

for projects, (b) less qualified companies being disproportionately successful in the auctions.

8. **Cost of auctions**. There is a cost associated with participating in auction. A bid has to be prepared. That requires research, prediction, calculations etc. There is also a cost, albeit a relatively small one, of holding the auction. These are all social costs which could be avoided if there were no auctions.

9. **Reduced property rights quality of other rights**. The expropriation of ITQ-rights by the state for subsequent auctions can only increase the perceived likelihood that something similar will happen for other valuable natural resources and possibly other productive assets as well. So, the security by which these other assets are held is reduced. Their property rights value is correspondingly reduced. As a result the pattern of utilizing these resources will be altered. More precisely, it will be distorted toward a shorter time horizon as if the rate of time discount had increased. Investment in these resources and the technology of using them will be reduced. There will be diminished tendency to conserve the resources. It is important to realize that these economically detrimental impacts will also affect undiscovered and undeveloped resources. The increased likelihood that they, once discovered and developed, will be subject to a similar process of expropriation and auctions will obviously reduce the incentive for private operators to engage in the process of discovery and development.

10. **Income to the state**. Countering these economically detrimental effects is the income to the state coming from the net revenues generated by the auctions. Initially, this will undoubtedly improve the finances of the state. However, in the longer run, these financial gains may disappear or even be reversed. The detrimental economic effects of the auctions discussed above will reduce the efficiency in the fishery and the gross national income (GDP) compared to what it would otherwise have been. This will reduce state revenues from other taxes. The extent of this is an empirical question. The point, however, is that in the longer run it may be the case that net income to the state will actually be reduced as a result of auctioning off ITQ-rights.

7.2 Auctions and taxation

Auctions extract payments from the industry to the state. In this sense auctions can be seen as another form of taxation. Since the auction price reflects expected profitability of using ITQ-rights, auctions are most like income tax. In the case of auctions, however, the tax is on the present value of expected future profits

for the period until the next auction. Although, this is a matter of auction design, presumably, the tax, i.e. the auction price is paid before the income is realized.

There are reasons, however, to believe that repeated auctions (not necessarily once-and-for-all auctions) are economically more damaging than income taxation. Basically this is because repeated auctions reduce the property rights value of the ITQs more than an income tax raising the same revenue would. Repeated auctions limit the duration of the ITQ-right in a way that is probably more damaging than income taxation. More importantly, auctions generate uncertainty regarding success or failure in the auctions which does not have a correspondence in income taxation.

7.3 Auctions and monopolistic behaviour

As discussed in section 5, ITQ fisheries as any other industry may give rise to monopolistic behaviour. Broadly speaking, monopolistic behaviour may occur regarding (i) input markets, (ii) output markets and (iii) the market for ITQ-rights. The probability of monopolistic behaviour occurring in these markets was discussed at length in section 5 above. An important point brought out in that discussion is that there is little reason to expect monopolistic behaviour to be much more of a problem in ITQ fisheries than other fisheries, and no reason to expect it to be greater in ITQ-fisheries than other well-managed fisheries.

In the current context, the key question is whether auctions of ITQ-rights are likely to reduce monopolistic behaviour in ITQ fisheries.

First, auction do not alter input and output markets or the supply and demand in these markets. Thus, conditions in these markets are unaffected by auctions of ITQs.

Second, auctions of ITQ-shares are unlikely to materially alter the number or composition (including the size distribution) of firms in the fishing industry. In fact, one of the major arguments for auctions is that they allocate ITQ-rights to the most efficient fishing companies, just as normal trades for ITQ-shares are likely to do. Subsequent trades of ITQ-shares and annual quotas following the auctions increase the likelihood that the number and composition of firms will be as without auctions. Thus, there is no a priori reason to expect auctions of ITQs to alter the monopoly power of individual companies or a collection of companies in the fishing industry.

What (repeated) auctions of ITQ-shares do is to reduce the property rights quality of the ITQ rights by limiting the duration of the rights and increasing the

uncertainty of these rights. It is hard to see, however, how these changes would reduce monopoly power or discourage monopolistic behaviour in the fishery. If anything, it may be argued that the auction cost and the financing of the auction price would encourage larger companies than before with the correspondingly increase in monopoly power.

It may be argued that the existence of repeated auctions of ITQ-shares reduce monopoly power and therefore make monopolistic behaviour in ITQ markets less likely. The argument is that auctions are perfectly competitive and, thus, at the time of auctions ITQ-holders have no monopoly power over ITQs. This seems like a valid argument. However, to see it in its proper context a number of comments need to be made. First, as discussed in section 5, monopolistic behaviour in ITQ-markets primarily distorts ITQ-prices and does not have an impact on real variables i.e. production levels due to the TAC constraint. It is therefore not a problem of the same importance as monopolistic behaviour in input or output markets. Second, note that reduced monopoly power is only at the time of auctions. Between auctions, the ITQ-holders regain their previous monopoly power. Third, counteracting any gains with respect to monopoly power in quota markets, there is the potential problem of monopolistic behaviour regarding the ITQ auctions themselves. If ITQ-holders are large enough to exercise some monopoly power in ITQ markets, it would appear that the same would apply to some extent regarding the ITQ-auctions. This would hold even more so, because ITQ-holders share a common interest to minimize quota auction price and the common stake there is very high relative to their expected benefits from fishing. In any case, collusion and monopolistic behaviour by bidders generally regarded as a major problem with auctions (Klemperer 2002, 2004). One of the reasons why auctions of quota-shares in Russia and Estonia were abandoned was precisely this (see chapter 8 of this report).

To summarize: There does not appear to be any theoretical reason to expect auctions of quota-shares to significantly reduce possible monopolistic behaviour in ITQ-fisheries.

7.4 Articles recommending auctions of ITQs

Very few scientific papers examining auctions of ITQ-rights have been published. A literature search has located only two papers that attempt to systematically provide arguments for the superiority of auctions over grandfathering in ITQ-systems. These are the papers by Morgan (1995) published in the policy oriented journal, Marine Policy, and by Peterson (2009) apparently unpublished but submitted at the EAFE (European Association of Fisheries Economists) conference. Several published papers mention auctions of

ITQ-rights in passing as an allocation (assignment) option without providing analysis of the implications.

In addition to these papers, Trondsen (2004) discusses auctions of seasonal quotas in the Norwegian fisheries. That paper, however, is placed in an entirely different context of fish catch trade arrangements peculiar to the Norwegian demersal fisheries. Its focus is the marketing of fish and fish products. The paper, therefore, has nothing to do with the usual ITQ fisheries. Finally our literature search has located a couple of papers running laboratory experiments on quota auctions. Those are the papers by Anderson and Holland (2006) and an apparently unpublished conference paper by Moxnes (2007).

Closer examination reveals that the fundamental paper providing arguments for auctions of ITQ-shares is the one by Morgan (1995). In a couple of subsequent publications, Morgan pushes the same idea without adding to the initial analysis Morgan (1997, 1997b). The paper by Petersen (2009) is largely based on Morgan's seminal paper adding a few technical items from more recent auction theory. Besides, it is more limited in scope. It is only concerned with the revenue generating aspects of ITQ-auctions. In what follows we will therefore focus on Morgan's 1995 paper.

Morgan's (1995) paper is neither closely argued nor rigorously presented. It consists primarily of series of assertions which appear to be variously theoretically and empirically based without clearly specifying these foundations. The reader is largely left to either believe Morgan or not. For this reason, it is difficult to take the paper seriously as scientific contribution. In fact, it is probably not even supposed to be one. It is published in a policy oriented journal and the author is not an academic.

It is clear from the context that in his paper Morgan is dealing with the initial allocation (assignment) of ITQ-rights. He is not considering auctions of ITQ-rights that have already been allocated. Already for this reason, the relevance of his paper for the Chilean situation is questionable.

The empirical background on which the paper is based in the New Zeland experience with initial quota assignments which was unusually rocky (Lock and Leslie 2007). It is clear from some of his statements, however, that his empirical knowledge of ITQ systems is quite limited.[13]

[13] For instance he asserts (p. 379) that ITQs were first introduced in New Zealand in 1987 while the Netherlands introduced ITQs in 1976 and Iceland in 1979. He doesn´t even get the dates for New Zealand, which started on its first ITQ system in 1982, right. The paper contains many other empirical errors of this and similar kinds.

Morgan considers three "basic alternatives" for allocation of quota-shares: (1) Allocation by administrative decision; (2) allocation by lottery; and (3) allocation by auctions. He, strangely, omits to include first possession allocation or grandfathering as one of these options. He makes much of the difficulties of allocating quota-shares by administrative decision, in my opinion largely correctly. Under the heading of administrative allocations heading, he finally mentions allocation on the basis of first possession, i.e. grandfathering which he seems to acknowledge avoids many of the administrative allocation problems. However, he has two major objections to grandfathering:

(1) It will represent an inefficient allocation unless there are secondary markets for quotas.
(2) It may enhances the potential control (really market power) some fishers may have in the fishery.

He does not offer arguments for these assertions. I believe they are largely without a theoretical and empirical basis.

First, by the definition of ITQ-systems, there are always secondary markets for quotas and quota-shares. Thus, the premise for the first objection is simply invalid. Besides, it is actually highly likely that existing fishers are the economically most efficient operators. Before the ITQ system they clearly are, at least in a reasonably free economic system; otherwise s they would not be in the fishery. Immediately after the introduction of the ITQ-system, fish stocks, fishing capital and technology is unchanged-d so they remain the most efficient operators. As the ITQ system evolves, some initially existing operators may lose some of their comparative advantage (become relatively less efficient than others). That process, however, takes time, usually years and is, therefore, most properly taken care of by secondary trades and not the initial allocation of ITQ-rights.

The second objection to grandfathering holds a little bit more water. It is possible that under ITQs, which usually lead to a reduction in the number of firms in the fishery, the monopoly power of ITQ-holders is enhanced. However, as discussed at some length in section 5 below, effects of this nature are unlikely to be significant and if they are, which is most likely in the market for ITQ-shares, they will probably not have a noticeable effect on economic efficiency. Morgan, however, although he is not very clear, seems to be at least as concerned with some undefined "control over a fishery" preventing quota trades and an economically beneficial relocation of quota-shares in the secondary market (p. 381-2). Thus, he talks about fishers refusing to sell their quotas (p. 382) to preserve "cooperative behaviour". What Morgan seems to be talking about is collusion by <u>all the initial</u> fishermen to somehow gain by a cartel

control of the fishery. This is first of all very unlikely. It is extremely difficult to keep a cartel of this kind together. If a fisherman is offered a price in excess of what he is currently getting, which a more efficient operator could do, it is almost inconceivable that he could be forced to stay within the cartel. In fact, the cartel will not be in a position to compete with more efficient outsiders. Thus, almost certainly, the new more efficient entrant would enter the fishery, and if he has any sense, he would simply take his place in the cartel. So, basically, the existence of a cartel does not at all prevent more efficient operators to replace existing ones. In fact, the only way the cartel can survive is to facilitate this process and try to get the new entrants into the cartel.

Interestingly the empirical evidence from real ITQ-systems is in direct contradiction to Morgan's beliefs in this respect. Studies of the New Zealand quota market (Batstone and Sharp 2003, Newell et al. 2005) and Iceland's ITQ-markets (Institute of Economic Studies 2010) report brisk trade in ITQ-rights in both countries.

Morgan (pp. 382-3) claims three advantages of auctions over the other two alternatives he specifies (namely administrative allocations and lotteries, see above). These are (1) economic efficiency in the sense of allocating the ITQ-rights to the most efficient fishers, (2) generation of government revenues and (3) ability to achieve other allocation objectives.

The first assertion is simply wrong as partly explained above and more thoroughly in section 6 and 7 below. There are many efficiency problems with auctions, even when they are well designed as Morgan admits they must be. Many of these problems are discussed at length in section 7. Morgan, however, completely ignores them. He doesn´t provide any arguments as to why auctions should be efficient. He simply takes that for granted. Subsequent literature (Maskin 2003, Ausubel 2004, Klemperer 2004, Zhen 2008) has shown that this certainly does not hold for auctions in general. Besides, there are substantial costs with designing conducting and participating in auctions, which are generally ignored in the above literature on auctions and, thus, implicitly assumed to be zero.

The second assumption is correct if it is limited to the short run. By auctioning off ITQ-rights, the government will in most case be able to raise substantial new revenues. However, as explained in sections 6 and 7, this extraction of revenues and weakening of property rights is likely to lead to lower economic growth and, therefore, reduced government revenues in the longer run.

The third assertion is somewhat peculiar. It is true that by the appropriate design of auctions (which may be complicated and, therefore, problematic) certain

social objectives such as keeping quotas in disadvantaged areas etc. may be attained. This, however, contradicts both the previous arguments for auctions in terms of economic efficiency and government revenues. The main point, however, is that the same social objectives can, obviously, be much more easily achieved by administrative allocations of ITQ-rights. So, why claim this as an advantage with auctions? Moreover, if the social objectives are some preservation of existing fishing pattern, which is the usual case, allocation of ITQ-rights to current fishers comes almost as close to that objective as is possible.

In summary: The above papers recommending auctions of ITQ-rights are not, in my opinion, rigorous scientific papers. They do not prove, or even argue convincingly that ITQ-auction shave the attractive attributes they claim they have. In particular, their assertions (Morgan's papers) that auctions of ITQs are economically efficient are not supported by any valid arguments in their paper. The papers, however, are essentially correct in their claim that ITQ-auctions can raise added government revenue, provided the time horizon is limited to the short run. In the longer run, this assertion is much more doubtful and most likely wrong.

7.5 Transactions costs in ITQ systems with and without auctions

Consider auctions in an ITQ-setting. The auctions take place at certain intervals over time. At the auctions, a certain fraction (between zero and unity), of ITQ-rights or quota shares is auctioned off. Thus, the auctions imply that at the auction times, a part of the ITQ-rights (quota shares) revert from fishing companies to the government to be auctioned off. It is assumed that between the auctions, the ITQ system proceeds in the normal fashion with trades of ITQ-rights and annual quotas.

Our concern in this chapter is not with the many economic implications of the weakening of the ITQ property rights implied by the auctions. This aspect of the matter was discussed at some length in previous sections of this chapter (especially 7.1 and 7.2). The topic of this chapter is the transaction costs associated with adding auction to a pre-existing ITQ system. The basic question is: Are the overall transaction costs increased or reduced as a consequence of the auctions?

It is convenient to break the answer to this question into the impact of auctions on

(i) the volume of transactions (number and size),
(ii) unit costs of trades and

(iii) fixed costs of the trading systems.

(i) Volume of transactions

It appears that adding auctions to a pre-existing ITQ-system almost certainly lead to an increased volume of transactions. Reasons for that prediction are the following:

(1) Quota trades occur for primarily two reasons: (i) as a part of the company's plan to reach a desired quota position and (ii) as a modification of the desired quota position in response to altered conditions and outlook. Quota trades therefore, tend to occur at irregular intervals over time. Due to altered conditions, e.g. in fuel prices, there may at any time emerge a demand for trades. This kind of trading need is unlikely to be met by auctions that happen at considerable intervals.

(2) Auctions, by removing ITQ-shares from companies, force some companies, even companies which were in equilibrium before the auction and would not have traded, to trade after the auction to achieve their desired quota position. These may be referred to as auction corrective trades. Therefore, virtually inevitably, auctions will increase the total volume of trades.

(3) Trading between auctions will continue. Even if some auction-trades substitute for trades which would otherwise have been made in the normal quota market, this would only represent a part, probably a small part of these trades. Therefore, the great majority of auction trades represent pure addition to the total volume of trades previously existing.

(4) To the extent that auctions will move quotas from the eventual quota users, which may happen because of (i) speculative auction bids, (ii) overoptimistic bids (winners curse), (iii) auction imperfections (see below) etc., auctions trades may not substitute for normal market trades. Instead they will represent a need for additional normal market trades to correct for auction distortion.

We conclude that when auctions are superimposed on and ITQ system, the total volume of trades is highly likely to significantly increase.

(ii) Unit cost of trades.

Little is known about the unit cost of trades by auctions. However, for a number of reasons, it appears that they are most likely considerable and most likely

higher than the unit costs of trades in the normal ITQ-market.

Normal ITQ markets

In countries where the ITQ system has been implemented, quota trades are effected by direct contract between companies and by the intermediation of quota brokers. Quota brokers often advertise their services and list bid and offer prices.

The extent of quota trades (number and volume) tends to be quite high (Newell et al. 2002, 2005, Arnason 2005, Hagfræðistofnun 2010). Quota markets, therefore, tend to be effective and efficient.

Obviously, however, the number of quota trades depends on the fishery (especially its size), the number of companies in the fishery and the variability and equilibrium/disequilibrium properties of the fishery. For the efficiency of the ITQ-markets, however, the crucial point is not the number of trades but the transaction costs which may prevent trades from happening and market hindrances which may facilitate monopolistic behaviour.

Transaction costs in ITQ markets appear to be quite low. In Iceland and New Zealand where quota trades have been taking place for some decades (Iceland since late 1970s and New Zealand since early 1980s), brokers usually charge 1-3% of the value of the trades as fees. Unusually large trades tend to command a lower fee. Presumably direct trades are less expensive.

There is a good reason for transaction costs for ITQ-rights (both annual and permanent) to be low. ITQ-rights s are a homogenous, non-physical commodity. They can be traded electronically and don´t require storage. In this respect, they are very similar to many financial instruments. Thus, in principle, transaction costs for ITQ-rights could be similar to those for financial instruments which are typically well under 1% of the value of the transaction. In the case of ITQ-trades, a certain lower limit is set by fixed costs and the size of the transactions which tend to be smaller than for many financial transactions.

For a typical trade in Iceland, brokers usually charge a fee of 1%, half of which is paid by each party. For this fee, the broker arranges the trade, fills in the necessary documentation and registers the trade according to official requirements (KM-Rosa 2010 and SM Kvótaþing 2010).In New Zealand, the usual quota trading fee is between 1 and 3% and is payable by the seller (Newell et al. 2002). Apparently, services similar to those in Iceland are provided. In both countries a substantial number of trades take place directly between companies without the intermediation of quota brokers.

Information on quota transactions fees from other quota markets (including Australia, Canada, the USA, Holland etc.) is in conformance with the Iceland-New Zealand experience. Some trades are effected directly between the parties. Other trades are taken care of by brokers. Brokerage fees appear similar to those in Iceland and New Zealand.

Auctions

Auctions are by no means costless, although, simple texts extolling the virtues of auctions tend to ignore them. There are many costs associated with auctions. These include:

1. Auction design costs
2. Auction running costs
3. Auction participation costs

These costs may be seen as the transactions costs associated with auctions.

The proper design of auctions is a complicated task. In this it is easy to make serious mistakes as the experience of several auctions in the past has shown (Klemperer 2004, Milgrom 2004), including fisheries specifically (Eera et al. 2005).

Since it is so easy to make mistakes in auctions, it crucial to try to avoid them by a careful design. Each situation is unique. Therefore, there is no standard auction form that is optimal. It follows that that the empirical situation must be carefully studied. In addition, it should be recognized that auction designs are subject to legal challenges which can also be costly.

So, to plan and design the auction requires extensive research and high level of expertise which is inevitably costly.

The implementation and operation of auctions is also quite demanding and entails significant costs.

(1) There are the costs of the auction itself. Care must be taken to conduct it in a structured, fair and transparent way. The associated costs are normally far from being insignificant.

(2) There may be considerable costs associated with the assessment of the bids submitted.

(3) The implementation and operation of the auction may be subject to legal challenges which may be costly.

The cost of participating in auctions, i.e. the cost of preparing and submitting bids, is normally very substantial. This cost, of course, falls on the companies making or contemplating making the bids.

(1) To make an informed bid (non-informed or frivolous bids can be economically costly) requires assessment of the value of the asset. This involves analysis and prediction of the future economic of the fishery including stocks of fish, catchability, input and output prices, capital costs, technology and so on. Obviously, getting this information and conducting these studies is very costly.

(2) It should be noted that this information is similar to that which is required to sensibly purchase ITQ-shares in the usual market. There are important differences, however:

- When it comes to auctions, the bid is usually for larger chunks of quotas than in normal trades. This is partly because companies have now lost all or part of their desired quotas to the auction process and are now in a state of larger disequlibrium than normally.
- It is likely that some of the bids represent potential new entrants to the fishery which have now quotas at the present.
- It is likely that there will be speculative bidders who are buying for resale only
- There is a distinct possibility that the auction price will not reflect the subsequent market price in which case, the successful bidders will experience a capital loss or gain.
- Related to this last point, there is the fundamental problem of the winner's curse which also represents a substantial loss to the successful bidders.
- By the nature of auctions, communication with the seller is not possible and therefore there is more uncertainty about the right price.
- For all these reasons, it can be argued that the risk of buying quotas in the auction is greater than in normal trades. Therefore, there is greater need to invest in careful study of the proper bid than when one is trading in the normal quota market.

(3) It should be noted that all serious bidders need to incur the costs above, irrespective of whether their bid is successful or not.

(4) In auctions, normally, the bidders have to put up some proof of finances and ability to pay the bidding price. This applies whether the bid is successful o not. This entails an additional cost.

Auctions, inevitably, place each potential bidder in a strategic or game-theoretic situation with respect to all other potential bidders. It is well known that in such a situation, it pays each game player to form and play a strategy (Myerson 2001). It is easy to show that each player will be willing to invest in this game-playing activity, with the amount depending on the actual situation. This game playing cost is added to the usual transaction costs.

Certain auction designs reduce or eliminate the need for game playing of certain types (such as not bidding one's reservation price, see e.g. Klemperer 2004). It would be naive, however, to believe that game-playing and the associated costs can thereby be eliminated:

(1) The potential bidders would have to study the auction structure carefully to satisfy themselves that this type of game does not work.
(2) There are many other moves in the game against the other potential bidders. The list of possible moves is probably endless, but includes the deliberate issue of misinformation, collaboration with other bidders, multiple bids in the name of different companies formed for the purpose, influencing the auction design etc. etc.

All of the above costs can be seen as the costs of setting up, operating and participating in auctions. The auction set-up and operation costs would normally be charged to the auction participants. They are therefore properly seen as transaction costs.

It is clear that these costs are substantial. More, importantly, they seem to be much higher than corresponding costs for normal trades. The conclusion, therefore, seems to be that transaction costs associated with auctions are generally higher than normal trades.
A powerful empirical support for this conclusion is that we generally do not see free enterprise having resorted to auctions to effect quota trades. If auctions we truly equally or more efficient (equal or lower transaction costs) than normal trades, one would expect them to occur spontaneously in some ITQ-fisheries. The private sector would employ them just as they have for certain types of trades (e.g. art –usually heterogenous goods).

ITQs exist in 22 countries covering hundreds, perhaps well over 1000 fisheries. Decentralized ITQ-trades are very extensive in many of them. In this large sample, auctions of ITQ-rights are extremely uncommon. Some countries which

have tried them have subsequently decided to scrap them (Russia and Estonia). Remaining examples of auctions of ITQs are probably less than a handful and, moreover, represent small fisheries. This seems to be

In Iceland, an attempt was to centrally formalize ITQ trades via an official quota exchange (Hagfræðistofnun 2010). This attempt failed, primarily because of the comparatively high transaction cost and inefficiency of this exchange.

(iii) Fixed costs

Each trading system entails some fixed costs. These are costs associated with the set-up of the system, investment in knowledge and the built up of physical and human capital to run the operation and the subsequent costs of maintaining this capital base and, perhaps, adding to it. These costs are fixed in the sense that they do not depend on the volume of transactions.

So, basically, the fixed cost of the auction system is added to the fixed cost of the pre-existing trading system. It follows that the operations of the two systems will result in higher fixed costs of trading, irrespective of the volume of trades.

This will be the case, unless the auctions completely replace the previous trading system. That, however, is virtually inconceivable. Even if the auction system were more efficient than the normal trading system, the latter would be needed between auctions.

Conclusion

The conclusion of this discussion, therefore, seems to be that when auctions are added to an ITQ-system:

1. The volume of transactions will probably increase.
2. The unit cost of trading is likely to increase
3. Fixed costs of trading will increase, most likely substantially.
4. Therefore, total transaction costs will probably increase.

An example

To provide some idea of the transactions costs that could be at stake in the Chilean horse mackerel fishery, it may be useful to consider a numerical example. It is stressed that this is just an example. It is constructed to provide some idea about the change in transaction costs when auctions are added to a pre-existing ITQ-system. This example is not based on empirical estimates.

To construct this example, we make the following assumptions.

1. The value of ITQ-rights: US$ 200 m.
2. The annual volume of ITQ-trades as a fraction of ITQ-values: 20%.
3. Auction transaction costs per unit the same as commercial transaction costs: 1%.

The advantage of explicitly stating these assumptions is that it is easy to redo the calculations with other, possibly more realistic assumptions:

On this basis, we can now easily calculate the changes in transaction costs for different assumptions concerning changes in the volume of transactions following the introduction of auctions and the fixed costs of the auctions.[14] The results are summarized in table 1.

Table 2
Possible increase in transactions costs due to auctions

Change in volume of trades	Fixed costs of auctions m.US$			
	0,100	0,200	0,300	0,400
0%	25%	50%	75%	100%
5%	30%	55%	80%	105%
10%	35%	60%	85%	110%
20%	45%	70%	95%	120%
40%	65%	90%	115%	140%

As can be read from table 1, according to this example, the introduction of auctions on top of the existing trading system for ITQs, leads most likely to a substantial increase in annual transaction costs. Since, according to the above assumptions, current transactions costs are about US$ 0.4 m., a 100% increase amounts to an additional cost of US$ 0.4 m.

7.6 Why auctions are particularly inappropriate in ITQ fisheries.

Numerous natural resources, in addition to ocean fish stocks, are subject to weak or missing property rights. Among these are many environmental resources including clean air, unpolluted healthy water, climate, view, quietness etc.

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[14] The equation for the change in transaction costs is: $\Delta = \alpha \cdot Val \cdot (Vol_1 - Vol_0) + fk$, where α=the unit transaction costs (1% by assumption), Val is the current value of quota trades (200·0.2 by our assumptions), Vol_1 and Vol_1 are the volume of transactions before and after the auctions respectively and fk is the fixed costs of the auctions.

Weak or missing property rights in resources always leads to economic misuse (Hardin 1968, Hanley et al. 1997). If the resource can produce benefits it will be subject to overuse which in certain cases may be most severe. The problem of overuse may, in principle, be solved, or at least greatly alleviated, by the introduction of tradable individual rights, often in the form of quantity permits which are similar to individual harvesting quotas in fisheries. This, however, raises the question of how to initially allocate these rights.

Apart from fisheries, there have been several well published cases of allocation of rights to natural resources. Consider for instance (i) oil exploration and extraction rights, (ii) electromagnetic spectrum use rights and (iii) pollution permits. In the first two cases, the rights have generally been auctioned off. In the third case, the rights have primarily been allocated by grandfathering (Mckenzie et al. 2005, Böhminger and Lange 2005). In ITQ fisheries, as we have seen the rights are generally grandfathered.

Thus, the individual rights to utilizing natural resources seem to be allocated basically in to ways:

(i) by grandfathering
(ii) by auctioning or other method of sale.

The question is what determines which method is used. An obvious follow up question is: If auctions are appropriate in the allocation of some types of rights, why would not they be in ITQ-fisheries?

(i) Oil and spectrum rights

The reason for auctions rather than grandfathering in oil exploration and extraction and the use of the electro-magnetic spectrum can be explained in a straight-forward manner. There simply are no previous users (grandfathers) to allocate the rights to. Therefore, the question of grandfathering, at least in the normal sense, is totally irrelevant.

In the case of oil exploration and extraction, this is totally clear. Basic geology has located promising areas for oil deposits. These areas belong to the state or no-one, there is no current oil exploration or extraction. So there are no users or stakeholders which can be grandfathered in. In this situation, the economic problem is to allocate rights in the economically most efficient way.

The case of spectrum rights is perhaps not as obvious. After all, broadcasting has been using the electro-magnetic spectrum for a long time before the

spectrum auctions took place in the 1990s and subsequently. However, basically the high demand for spectrum rights came from primarily new technology (mobile communications) and it used previously unused bands of the spectrum in technologically more advanced ways ((McMillan 1994b). Thus, in fact, there were few if any established users of the spectrum bands in question. Thus, as in the case of oil, there were no obvious candidates to grandfather in.

The main options for allocation of rights when there clear pre-existing operators are (McMillan 1994a):

- Administrative process
- Random allocation; lottery
- Auctions

In this situation, there are good arguments that, auctions constitute an economically efficient effective, transparent and fair way to allocate the initial rights.

So, in summary; in situations where there are no pre-existing property rights and no clear existing users of the common resource, grandfathering is not an option. Moreover, to wait for users to emerge before assigning rights, entails common property costs which may be very substantial.

(ii) Pollution permits

Over the past two decades, there has been a significant development in the introduction of individual quantity permits to deal with airborne emission problems. Most prominent are the cases of the SO_2 emission permits in the US (Stavins 1998, Schmalensee et al. 1998) and the EU CO_2 (EU 2003, Bode 2005, Böhringer and Lange 2005).

These emission control systems consist of two things: (i) a cap on the total amount of allowable permissions and (ii) allocation of parts (shares or quantity) of these overall caps to individual companies in the form of emission permits. Typically, the individual emission permits are transferable within a pre-specified group, usually other licenced emitters in the region. Thus, at least as regards their structure, these systems of individual transferable emission permits (ITEPs) have many similarities with ITQ systems.

The initial allocation of individual transferable pollution permits (ITEPs) has usually been on the basis of grandfathering in. That is to say, the emitters (i.e. companies) in the business at the time of the introduction of the system have received ITEPs proportional to their historical emissions in the past. There are many political, legal and economic advantages with this method compared to the

suggested alternatives (Stavins 1998, Requate and Unold 2003, Mackenzie et al. 2005).

In academic circles, a considerable discussion about the most efficient initial allocation of ITEPs has taken place (Burtraw et al. 2001, Crampton and Kerr, 2002, Requate and Unold 2003, Böhringer and Lange 2005, Jouvet et al. 2005, Bode 2006, Mackenzie et al. 2008). This discussion is still in its early stages. It is some distance away from reaching a definite conclusion. Indeed, it may well be said that it has so far proceeded on a fairly simplistic basis, for instance ignoring many of the points raised in other sections of this report (esp. section 7.1).

However, some reasonably robust results seem to have emerged:

- The allocation of rights may have an impact on the economic efficiency in resource use.
- This holds for two reasons:
  - (i) If actions now can influence the allocation in the future. This might e.g. hold prior to the initial allocation of rights or in subsequent re-allocations.
  - (ii) Because of the wealth effect. Allocation of valuable rights implies an impact on distribution of wealth which may affect the evolutionary path of the economy. This impact may be for the better (in welfare terms, or the worse).
- Allocation by grandfathering is generally economically efficient (Böhringer and Lange 2005, McKenzie et al. 2008).
- Other allocation rules, including auctions, may also be efficient (Jouvet et al. 2005, McKenzie et al. 2008).

In summary: In the case of airborne pollution, natural resource users (those who use the atmosphere to pollute) are already in place. Therefore, the question of grandfathering is relevant. For pollution permits, there has been some considerable research into allocation by grandfathering vs. auctions. The broad conclusion of this research seems to be that both mechanisms can be economically efficient.

(iii) ITQ Fisheries

Individual emission permits (IEPs) are designed to correct for one relatively simple externality, namely the environmental impact caused by the emission of certain homogenous molecules (usually SO_2 and CO_2).

In fisheries, the situation is much more complicated. The basic externality stems

from the fishing activity which is a multidimensional use of a complex marine ecosystem consisting of many species and the ocean habitat. In addition to this, the act of fishing interacts with a number of other uses of marine resources.

The harvest is not a homogenous quantity. A given volume of harvest is differentiated with respect to:

- The age composition (cohorts or yearclasses)
- The size distribution of the catch (usually closely correlated to the age distribution, but not completely)
- What sub-stocks of the species are featured in the catch
- Other specific attributes of relevance (fat content of the catch, gender, flesh quality etc.)

These attributes, and possibly others, may have very different implications for the impact of a given volume of harvest on the growth of the fish stock.

Fishing activity is not just the harvest (catch). It consists of various activities including the following:

- Vessel type
- Fishing gear type
- Fishing methods — how is the gear applied
- Fishing area
- Fishing time of the year
- Discarding of unwanted catch
- Dumping of other refuse at sea.

The way in which the fishing activity is conducted does not only affect the harvest, but also other species and the ecosystem at large. It may also affect other uses of marine resources to be discussed below.

Then there are the ecosystem implications of fishing. The harvest of one species may have important implications for the stock development of other species. This happens via ecosystem interactions which may be very complex (Clark 1976, Arnason 2000). Thus, the ITQ for one species does not necessarily reflect the impact the catch has on the ecosystem and therefore the harvesting possibilities of other species.

In addition to the above, there are various other uses of marine resources which may affect or be affected by commercial fisheries. These include inter alia:

- Recreational fisheries
- Mariculture
- Marine tourism
- Ocean mining
- Ocean transportation

- Marine resource conservation. This represents a particular use of marine resources which has a real economic value (Hanley et al. 1997).

Thus, for the optimal use of the marine ecosystem, fishing activities should take account of these alternative marine resource use and vice versa.

The above should make it clear that the fishing activity has many important economic implications apart from the mere quantity of fish taken. The composition of the catch and the way in which it is taken has various impacts within the fishery the fishery in question. It also has implications for other fish stocks and fisheries via ecosystem connections. Finally the fishing activity has implications outside the fishing industry. All of these are of economic importance, frequently of great economic importance. It follows that for the fishery to operate in a socially optimal manner, all of these implications have to be taken fully into account.

It is important to realize that this optimal overall use of fish stocks and marine resources in general is informationally extremely demanding and complicated to implement. Thus, this is a problem, which is virtually impossible to solve in a centralized manner. The central government is not well placed to solve it (Arnason 1990).

However, it can be shown (Arnason 2008, Pearse and Arnason 2008, Arnason 2009) that:

(i) It is possible, on basis of ITQ-rights, to adjust the fishery operations including catch volumes to reflect these other values.
(ii) ITQs generate important incentives to utilize these possibilities.

The key to this are the rights embedded in the ITQs and their market value. On the basis of the ITQ-rights, ITQ holders are in a position to get together to jointly set rules for the conduct of the fishery that maximizes their joint benefits. Moreover, since maximization of the joint benefits from fishing will increase ITQ values, all ITQ-holders have an interest in agreeing on such rules and enforcing them. If, for some reason, there are ITQ-holders who do not benefit directly by the increase in the value of their ITQs, they can be compensated by their fellow ITQ holders, since this is a positive sum game (the total net benefits increase).

This co-operation between ITQ-holders is of fairly obvious relevance in specific fisheries. It is of no less relevance in the joint utilization of fish stocks that are ecosystem linked (Arnason 2000). In that case, what counts is the maximization of total ITQ-values over all the fisheries. For everyone ITQ-holder to support

that policy, ITQ-holders in fisheries which may have to cut down or closed for ecosystem reasons may have to be compensated by the others.

The cooperation between ITQ-holders also applies to the optimal harmonization of different marine resource uses including recreational fisheries, aquaculture, ocean mining and conservation (Arnason 2009). In that case, ITQ-holders, acting as a group will find it in their joint interest to solve the conflicts in a value maximizing way. Thus, for instance, if aquaculture and fisheries interact, negotiations between the two groups conducted on the basis of ITQ and aquaculture rights can, at least in principle, lead to a jointly optimal resolution of the conflict along the lines explained by Coase in 1960.

These predictions are largely based on theoretical analysis. However, the analytical basis is strong and has many parallels with similar incentive analysis in other areas of economic life and cooperation. Besides, there is considerable evidence that this kind of co-operation is already taking place in at least some ITQ countries, i.e. New Zealand, Iceland and the Netherlands (Arnason 2008, McClurg 2008 and van Hoof 2010).

Now, to realize the benefits of joint action for the above kinds, takes time and effort. In other words it is costly. The incentive ITQ-holders have for making this effort and to incur the corresponding costs is the reflected in the increase in the value of their ITQ-rights. This increase in ITQ-values represents increase economic rents.

As already established, auctions will expropriate all economic rents of the auctioned rights. Hence, it immediately follows that the incentive to engage in above socially beneficial, rent maximizing activities, will be reduced and, depending on the frequency and extent of the auctions, possibly eliminated totally by auctions.

In this way, auctions of ITQs in an already established ITQ-fishery are economically damaging. They reduce the incentive to organize joint initiatives to increase the value of the fishery, other fisheries and other marine resource utilization industries.

Note that these disadvantages, which may be very substantial, are on tope of the other problems with auctions of ITQs discussed in previous sections.

It is important to realize that with respect to the above, there is a fundamental difference between ITQs and pollution permits. The costs of inferior fisheries operations are to a large extent borne by the ITQ holders and they reap the benefits of improved fisheries management. Thus, the ITQ-holders as a group

internalize many of the benefits of more effective fisheries operations. Thus, provided they are allowed to keep their ITQ-rights intact, they are subject to powerful incentives to act in the common interest, both individually and, just as importantly, collectively.

For the ITEP-holders (individual transferable emission permit holders), the situation is somewhat different. The cost of their pollution is only to a very small extent borne by themselves. It mostly falls on the shoulders of other members of society. Therefore, they do not, — not even collectively, have a significant interest in cutting back on their emissions or moving them to a socially more optimal level. Virtually all the benefits of that are realized by other member of society.

It follows that, even if they, for some reason, decided to move their emissions to a socially more optimal level, the increase in ITEP-values would not be sufficient to compensate them for the reduction in profits.

Since ITEP-values do not provide ITEP-holders with sufficient incentives to arrange their emissions so as to maximize social values, it follows that auctions of the ITEP-rights will not materially affect their behaviour in this respect. In this sense, auctions of ITEP-rights are perhaps more appropriate (or less inappropriate) than auctions of ITQ-rights in fisheries.

Note, however, that even if ITEP rights do not provide the ITEP-holders with an incentive to come together to collectively reduce emissions, the ITEP can serve as a basis for negotiations with other users of the environment to cut back on emissions. In this way, the ITEP-rights may operate as ITQ-rights to facilitate an improved overall use of the environment. If this is the case, it is clear that auctions of ITEPs would eliminate at least some of these incentives and thus also be potentially economically damaging.

Conclusions

- We have seen that auctions are used to allocate resource use rights primarily in resource industries without prior participation and, thus, where grandfathering can not be an option.
- There is little theoretical research into the relative efficiency of different allocation mechanisms.
    - The general result, based on simplistic models, is that both grandfathering and allocation by auction may be efficient.
    - Much, however, depends on whether the rights already exist or not.

  - When rights have already been established by prior participation, there are strong arguments for grandfathering
  - Auctions are comparatively more attractive when there is no prior participation and rights have not been established.

- Arguments for superiority of auctions are much weaker for an ITQ-fishery than, e.g. pollution activities, or emission permits. Important reasons are: (i) the relative complexity of the fishery and (ii) the greater incentives holders of strong ITQ-rights have to collectively act in a socially beneficial manner.
- If ITQ-rights are auctioned, ITQ-holders will have correspondingly diminished incentives to engage in value-enhancing activities.

Appendix 4
ITQ prices and their usefulness

It is well-established that quota-share market prices reflect the expected present value of economic rents obtainable by using the quota shares (Arnason 1990). More formally it is shown in Arnason(1990) that:

$$s(0) = \int_0^T \Pi_q(q) \cdot Q \cdot e^{-rt} dt ,$$

where $s(0)$ is the quota share price at time 0. The integral on the right hand side is the present value of resources rents over the period $[0,T]$. The duration of the quota share right is T. $\Pi_q(q)$ represents the marginal profits of using the quota share q (identical across companies) and Q represents the total allowable catch, TAC. The multiple $\Pi_q(q) \cdot Q$ is total resource rents at time t. r is the discount rate so $e^{-r \cdot t}$ is the discount factor at time t.

Now, profits equal resource rents + intra-marginal rents (Figure 4 in section 6, World Bank and FAO 2009). In other words:

$$\Pi(Q) = \Pi_q(q) \cdot Q + \phi(Q) ,$$

where $\phi(Q)$ represents the intra-marginal rents for TAC equal to Q.

It is argued in Arnason (1990) that in fisheries with equal access to technology and a reasonably high number of operators (say 50 or more) the intra-marginal rents would probably be quite small relative to the resource rents. In that case the quota share price would be approximately equal to the present value of expected profits:

(1) $$s(0) \approx \int_0^T \Pi(Q) \cdot e^{-rt} dt .$$

In the more general case the quota share price would be the present value of expected profits less the present value of expected intra-marginal rents.

(2) $$s(0) = \int_0^T \Pi(Q) \cdot e^{-rt} dt - \int_0^T \phi(Q) \cdot e^{-rt} dt .$$

Quota rental prices (i.e. price of quota bought for one fishing season only) are sometimes of interest. They are related to quota share prices, $s(t)$ in the following way Arnason (1990):

$$v(t) = r \cdot \frac{s(t)}{Q} - \frac{\dot{s}(t)}{Q} ,$$

where $v(t)$ is the quota rental price and $\dot{s}(t)$ is the instantaneous change in quota share prices at time t.

In a fishery equilibrium $\Pi(q)$ and $\phi(Q)$ are constant and (1) and (2) are reduced to:

(1') $$s(0) \approx \frac{\Pi(Q)}{r} \cdot \left(1 - e^{-r \cdot T}\right),$$

(2') $$s(0) = \left(\frac{\Pi(Q)}{r} - \frac{\phi(Q)}{r}\right) \cdot \left(1 - e^{-r \cdot T}\right).$$

To simplify the presentation, we will, in what follows, restrict our attention to fishery in equilibrium and ignore intra-marginal rents. It should be mentioned that the key results derived apply to the more general case also.

ITQ-share prices are useful because they are generally observable and reflect (at least approximately) the profits that ITQ-holders expect from their fishing activities. A fundamental behavioural theorem follows from this:

"***ITQ-holders individually and collectively will attempt to arrange their individual operations and the fishery as a whole so as to approximately maximize ITQ-share prices."*** (Arnason 1990)

Of course what really motivates the fishers are profits. However, as we have seen, quota prices are closely related to profits so they can be used as a convenient proxy for profits.

It should be emphasized that this implies not only that fishers will arrange their own fishing operations to maximize the value of their quotas but also that they have a strong incentive to act collectively to arrange the fishery so as to maximize the market value of quota shares. This implies among other things an incentive for fish stock and fish habitat conservation, the employment of environmentally friendly fishing gear, accommodation of other marine use interests (for a payment) and so on (Arnason 2008)

Now, any actions by the government that alter quota prices will also alter the profits and, therefore, according to the fundamental behavioural theorem, the behaviour of fishers. In other words, if the government undertakes acts that affect quota-share prices, the behaviour of the fishing firms becomes distorted from what it would have been. This applies, among other things, to increased uncertainty about quota holdings, reduction in the quota period and most types of special taxation of quota values.

Appendix 5
Reduction in the property rights value of ITQs

Reduction in the duration of quota holdings and increased uncertainty about the future of quota holdings, both of which are associated with auctions of quota shares, will reduce the property rights value embedded in ITQ-shares and directly reduce quota prices (Arnason 2006).

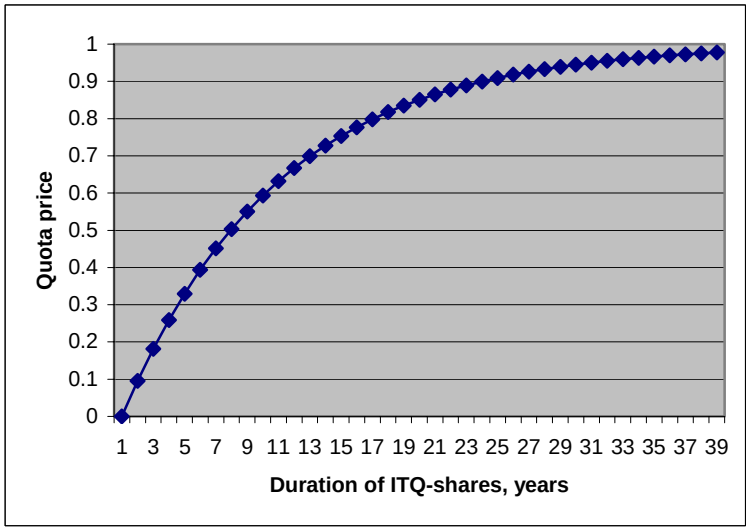
The effect of reducing the duration of quota-holdings can be read directly from equation (1'):

(1') $$s(0) \approx \frac{\Pi(Q)}{r} \cdot \left(1 - e^{-r \cdot T}\right),$$

where T is the duration of the quota-share. Clearly, the quota price and, consequently, both

the asset value of the quota share and the present value of expected profits from using it increase with *T*. The relationship is illustrated in Figure 6. With no duration, i.e. quota shares that last not even one second, clearly the value and price of quota shares would be zero. However as the duration of the quota-share gets longer, quota-share price increases reaching the maximum (here, unity) when the duration approaches infinity.

Figure 6
Relationship between quota-share price and quota-share duration



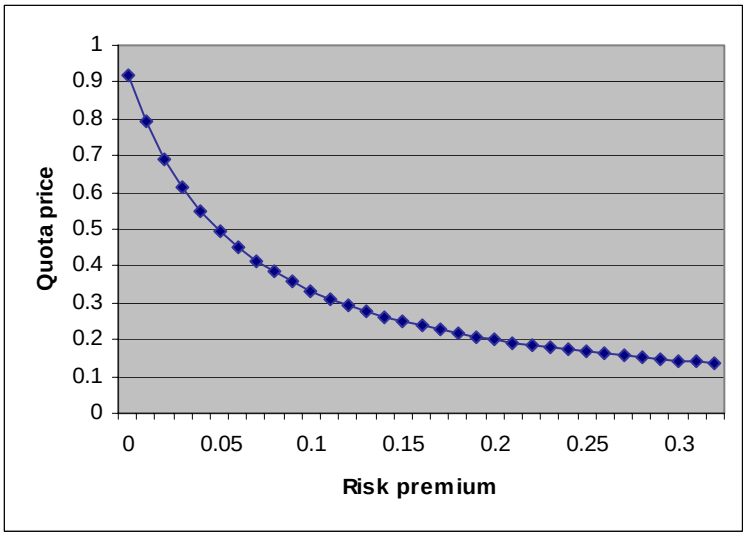
Increased uncertainty about holding onto quota-shares may be approximately represented by a higher discount rate, in which case the uncertainty corresponds to a risk premium. Write the increased discount rate as:

$$\hat{r} = r + \varepsilon ,$$

where ε denotes the risk premium. Then the relationship between quota-share price and the uncertainty (risk premium) assuming $T \to \infty$ is given by:

$$(1'') \qquad s(0) \approx \frac{\Pi(Q)}{\hat{r}} .$$

Figure 7
Relationship between quota-share price and risk premimu (uncertainty)



Obviously, the quota price is monotonically declining in the risk premium. The general relationship is as illustrated in Figure 7. As the uncertainty increases the quota-share price falls monotonically converging to zero as the risk premium approaches infinity.

The reduced quota price (i.e. present value of expected profits) as a result of reduced duration and increased uncertainty implies altered behaviour by fishers. In particular, when the quota price is reduced they become less interested in conservation of the resource and co-operation with other fishers to enhance the joint economic yield from the marine ecosystem.

Appendix 6
The impact of auctions on quota prices

Auctions obviously imply reduced retained profits by the fishing industry equivalent to the auction price. Repeated auctions also imply reduced duration of share-quota rights. The same applies to once-and-for-all auction in the period before they are held. Auctions, moreover, especially repeated ones, tend to lead to increased uncertainty regarding holding on to the quota–share.

With auctions, the share-quota price in the market for quota-shares is at a minimum just before the auction and jumps to a higher level just after the auction. The size of the jump is equal to the auction price. In what follows we will represent the auction price by *PA* irrespective of whether the auction is once-and-for-all or repeated.

Once-and-for-all- auctions

In once-and-for-all auctions, the duration of the quota-share once the auction has been held is infinite. That implies a certain quota-share price defined by (1'). Just (a nanosecond) before the auction, however, that price is reduced by the (expected) quota price, *PA*. More precisely:

Quota-share price just before the auction: $s(t_A) = \frac{\Pi(Q)}{r} - PA$.

Quota-share price just after the auction: $s(t_A) = \frac{\Pi(Q)}{r}$,

where t_A is the date of the auction. Clearly, this path represents distorted quota prices before the auction and, therefore, distorted (economically inefficient) fishing behaviour as well.

Repeated auctions

For repeated auctions, duration of the quota-share right is by necessity limited. Let this duration be *T*. Then we have:

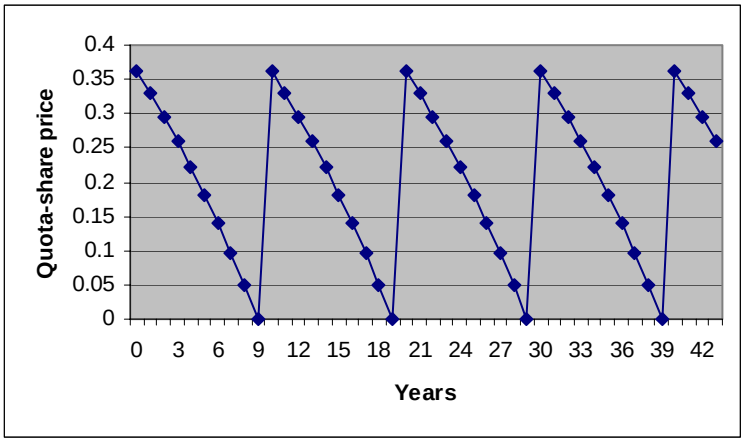
Quota-share price just before the auction: $s(t_A) \approx \frac{\Pi(Q)}{r} \cdot \left(1 - e^{-r \cdot T}\right) - PA$.

Quota-share price just after the auction: $s(t_A) \approx \frac{\Pi(Q)}{r} \cdot \left(1 - e^{-r \cdot T}\right)$

So the path of quota share prices over time for a 10 year period repeated quota-share auctions is approximately as illustrated in Figure 8.

Clearly, this path of quota prices, illustrated in Figure 8, is severely distorted compared to the true quota-share values. It follows that the fishing behaviour will be correspondingly distorted. That of course implies economic inefficiency in the fishing activity and associated processes.

Figure 8
Quota-share price: Repeated auctions (10 years cycle)



8. The Experience of Auctions in ITQ Fisheries

Although theoretical advantages of auctions have long been argued by economists there are extremely few examples of auctions being used in allocating fishing rights. In fact, there seem to be only three examples; Estonia, Russia, and Chile; suggesting some mismatch between theory and practice.

Russia and Estonia auctioned fish quotas and fishing gear quotas (Estonia) for a few years at the beginning of this century. In both countries the auctions were established through a government initiative, in order to divert more of the fishery rent to the government and to increase efficiency in the industry. In both countries the auctions were abandoned, however, because of pressure from industry. In Chile, quotas for a few but valuable fish species are still put up for tender, although the current legislation is due to expire in 2012 (see section 9).

In Russia the fees settled at the auctions were quite substantial, resulting in drain on the cash flow of existing fishing firms and leaving many indebted. More seriously, perhaps, the auctions led some firms, who bought small amounts of quotas, to use them as a pretext for fishing above their quota (poaching), an option made possible because of lax monitoring and enforcement.

The way the auctions worked, and the reasons why the system was abolished only a few years after it was put in place, makes the experience with the quota and fishing gear auctions in Estonia quite interesting. Before the auctions were put in place Estonian fishermen had to pay a fee for fish quotas and fishing gear, but these fees were rather low. The auctions were organized in such a way that the starting price was equal to the previous fee. In the auction process the price of quotas and gear units increased many times over. Parts of the fishing industry boycotted the auctions for 2003, the last year for which auctions were organized. Due to pressure from the industry, the Estonian parliament voted to abolish the auctions in 2003. The industry had complained that the auctions threatened the viability of the industry through the exorbitant fees. Also, the argument was put forward that Estonia was on the verge of joining the European Union where the fishing industry pays no user fees for fishing and in fact receives substantial subsidies from Brussels.

8.1 Auctions of quotas in Estonia

The fisheries of Estonia were a part of the planned economy during the Soviet period. Fishing activities were carried out by collectives and state enterprises. The fishermen were employees of these collectives and enterprises without any rights to the fish resources. After independence there was a rapid transition to a market economy and this process caused very significant changes in all facets of

life and in the economic framework.

Fishermen working in the Soviet fishing collectives usually managed to privatize equipment (boats, gears) at low cost. Most of the commercially important fish stocks were in a good condition at the end of the Soviet period and catches were good. Even more important was the possibility to export to the western market had opened up and caused an increase in prices. Coastal and inland fisheries became very profitable as a result (Vetemaa et. al., 2002).

In the trawling sector, which targeted herring and sprat, the development was very different. During the Soviet period, the sector used machines produced in the Soviet Union. Although they were uneconomic in terms of fuel use, the sector could rely on cheap fuel during the Soviet period. With independence central planning and subsidies for the fisheries disappeared. While smaller-scale fisheries found new markets in the west, the only markets to export products made from herring and sprat to were the Russia and the Ukraine. Prices in those markets were low and Russia enforced some trade barriers on the runaway Baltic states. The profitability of Baltic trawling was therefore low and in addition the volume of catches decreased.

Up until 1997 the Estonian trawl fishery was regulated simply by a national TAC for herring and sprat. There was no regulation to limit the size of the fleet or the capital stock in the trawl fishery, which increased year by year. There was much overcapacity in the Estonian trawling fleet, especially in light of a declining of national TAC. An overcapacity of 25% was estimated for 2001 using a technological approach (Eero et. al., 2005).

With the fishing capacity surpassing the TAC by the late 90s a new management system was needed. An IQ system based on historical fishing was established in 2000 and rights were allocated to fishing enterprises. The establishment of this system was not without criticism and debate. Some claimed that since the fish stocks are public property, there should be a mechanism by which all interested enterprises could enter the fishing industry. As all fishing enterprises in Estonia were relatively young, at least as private companies, the fishing carried out during the short time span after the collapse of the Soviet Union was considered insufficient to give fishermen a real ‘‘historical right’’ for the exclusive use of fish stocks comparable to the fishing enterprises of most western countries, some of which can trace their history back several decades. It was also argued that such a system would act against the need to increase efficiency. Competition between different actors in general leads to survival of the most efficient. A historical fishing right limits or eliminates competition and is therefore inefficient way of using fishing possibilities. The idea of auctioning fishing possibilities or quotas arose in this debate.

Another concern arose in this debate and that was the question of stability and protection capital value in the sector. Auctioning all or a large part of the quotas annually, although presumably allocating rights to the most profitable enterprises, could decrease operational security for the enterprises as well as affecting the value of their capital investments, such as vessels, gear, etc. A compromise solution was arrived at; 90% of the fishing rights each year would be allocated on the basis of recent catch history and 10% by auctions. The ‘‘historical right’’ was defined as the catches taken and gear or fishing days used during the previous 3 years.

The Quota Auctions

The main principle of the auctions was the same in all sectors of the Estonian commercial fisheries. All fishing rights depreciated by 10% yearly. This part of the fishing rights was allocated again each year through open auctions, while the remaining 90% was allocated on the basis of historical right. Fishing rights purchased and used during a particular year were in the following years taken into consideration in the same way as the fishing rights obtained on the basis of historical rights. Once purchased, the fishing right was usable indefinitely, but at a steadily decreasing (10% yearly) rate (Eero et. al., 2005).

Quota auctions were held for 2001 and 2002 for the trawl fisheries. For the 2001 auction, prices increased to about 20 times starting price, while for 2002 the results were radically different. The quotas were auctioned in 100 “lots” of four different sizes. Because fishing enterprises received 90% of their fishing possibilities on the basis of historical rights (and with low fees), they could afford a large price increase when purchasing rights on auction, i.e. the average price of a gear still remained quite low. Finally, interviews with fishers revealed that at least in the first auctions they were somewhat confused, and in fear of losing the rights they overbid each other rather carelessly. For these reasons the extraordinarily high prices did not reflect the real value of fishing rights on an annual basis, and may have overestimated the present value of the right over the long-term.

The bidding at the 2002 auction started out lively and lots were sold at prices several times the starting price (Eero et. al., 2005). There was a half hour break in the auction with some 10% of the quotas already sold, and after the break all competitive bidding ceased , and all the remaining lots were sold at the starting price. It seems as if the participants had reached an agreement during the break to stop competing for the remaining lots. The remarkable thing about this is the number of bidders present at the auction, about 80. Whether payoffs were a part of this is unknown. An additional auction was arranged later in the year for

pre-allocated quotas that had not been claimed. There was much competitive bidding at this auction, with selling prices at 30 times the start price. For 2001, 23 of 95 enterprises participating at the auction purchased quota, while 36 of 87 did so in 2002. The wider distribution of quota at the auctions for 2002 may have been due to agreements between fishermen. This may be supported by the fact that a large part of the quota was sold at the starting price in 2002 without any competitive bidding taking place.

Fishermen boycotted the auction for trawling quotas for 2003. They agreed not to participate in it, claiming that their economic situation was difficult due to the decline catch prices. The national TAC for 2003 in these stocks had also decreased substantially compared to earlier years. Representatives of the fishing enterprises came to the auction hall at the time of the auction just in case, but none of them registered for the auction. The auction was organized twice for 2003 and on both occasions nobody registered (Eero et. al., 2005).

It is of some interest to look at which enterprises bought quotas at the auctions. One approach is to divide the enterprises into 4 groups based on the size of their historical fishing rights. In the auctions a small group of the biggest enterprises increased their quota share while the shares of the other 3 groups decreased slightly. Only enterprises in the group with the smallest shares did not buy any quota, and only 1 new enterprise entered the fishery through buying quota at the auction. The auction therefore promoted some concentration in the ownership of the fishing rights.

The boycotting of the auctions led to a change in the law, an amendment of the Fishery Act. Opinions expressed in the national media indicated that by and large the general attitude in Estonia was against the auction system (Eero et. al., 2005). With Parliament elections coming up in March 2003 the political parties acted in January to abolish the auctions, and base the ITQ system wholly on historical catches.

Another issue that may have affected this change was the Estonian accession to the EU had become a reality (Eero et. al., 2005). As the preparation for accession started comparisons with the EU became important in arguments in all sectors of the economy. In the EU member states fishing quotas/rights were generally allocated free of charge or for a nominal fee, and in the EU fishing quotas were based mainly on historical catches. In addition there were large subsidies in the most of the EU fisheries, and programs to compensate for scrapping of vessels. In Estonia this was not the case; before accession to the EU in 2005 there was no financial support of fishers. Fishers complained that while most countries support their fishers, Estonia on the contrary auctioned the rights, taking all profits out of the fishing sector and thereby seriously hindering new

investments, modernization, etc. All these arguments were also put forward before the creation of the auction system, but without success.

Auctions of Quota in Estonia: A Summary

The auction system in Estonia was short lived. It operated only for 2 years and only applied to 10% of the fishing/quota. The fisheries sector had argued against the adoption of the system, and although fishers did participate and bid for quotas for 2001 and 2002, they were working their political representatives to abolish it. For the 2003 auction the fishers boycotted the auction and within weeks the Parliament voted unanimously to abolish auctions and instead base the whole system on historically determined ITQs. The actual performance of the auctions and their affect does not seem to have been particularly important for this decision.

8.2 Auctions of quotas in Russia

Fish quotas in Russia were allocated by auction for 3 years in 2001–2003. One purpose with the auctions was to divert some of the resource rent to the state. Another was to increase the transparency of the quota allocation mechanism (Hønneland, 2005). A lot less of the TAC was sold by auctions than originally proposed, even though the auctions provided a substantial income for the government. A decline in industry profits and greater indebtedness of the industry accompanied the auction of quota, and arguably they also led to more illegal fishing, as firms were not well monitored. In 2004 the auction system was abolished, in part due to pressure from the industry.

Quota allocation before the auctions

The basic principle for harvesting quota allocation during the Soviet era was the potential for production, or the catch capacity (Eikeland and Riabova, 2002). This same rule basically applied in the immediate post-Soviet years. In addition to the criteria of catch capacity and harvested quotas in previous years, several additional circumstances could affect quota allocation. Among these were the rights of indigenous peoples, the interests of fishery-dependent communities, contributions to research funding, rescue service, supervision and reproduction of fish stocks, and compliance with fishing regulations. Some attempt was made, unsuccessfully, in the late 90‘s to introduce a criteria that favored vessels that delivered the catch to domestic markets and used Russian shipyards for renovation and maintenance. In 1997 the quota system was revised and from then on quota owners were allowed to sell the quotas.

During the Soviet period, up to two-thirds of the annual fish production in

Russia came from the Far East. The bulk of commercial fishing activities was managed through ‘‘Dalryba’’, which was a typical huge state organization, responsible for fishing throughout the Russian Far East (Anferova et.al., 2005). A smaller part of the catches were taken through smaller fishing cooperatives (kolkhoz’es). The fishermen were employees of these farms and enterprises and all quotas belonged to the state. There was no competition between different enterprises and fishing capacity was built up through the central decision making of the plan. The fisheries were a part of the planned economy.

After the break-up of the Soviet Union there was a rapid transition to a market economy and this process caused very significant changes in all facets of life and in the economic framework. The Dalryba was divided into smaller units, which became economically independent. By 2003 more than 90% of all fishery firms were either private, or joint ventures with foreigners or the state. The remainder was still state owned. Many new fisheries enterprises were established in the post-soviet period, increasing the total number of enterprises from 306 in 1990 to 1600 in 2001. The number of cooperative (fishing kolkhozes) declined in the same period from 67 to 50.

Before auctioning was introduced, fishing quotas in the Far East were allocated in the following three ways (Anferova et.al., 2005):

1. Commercial quotas allocated without prepayment of a small resource fee which was paid after (and only if) the quota was used. Most of these quotas were allocated to the Russian coastal regions through regional Fishery Councils for distribution to harvesters and processors operating in Russian territory. The remainder was allocated directly from Moscow.
2. Commercial quotas allocated to foreign enterprises under bilateral agreements. These quotas formed the Russian exchange fund of fishing opportunities, which were traded against fishing opportunities in foreign waters.
3. Research quotas, which besides their research function, were meant to provide some economic support for research institutions.

In 2000 the rules were made more stringent and commercial quota allocation by the local governments was set by the central government. According to these the quotas could be allocated only to enterprises which (1) did not owe taxes, (2) had Russian flag, and (3) delivered and/or sold the catch in Russia.

Commercial quotas for Russian enterprises were before the introduction of the auction system distributed approximately according as follows:

50% - free commercial quotas to large fishing enterprises,
20% - free social quotas for fishing villages,
20% - free quotas to stimulate industry development and new technology,
10% - quotas open to tender to Russian enterprises.

Russia began selling quotas to foreign enterprises in 1994. Up until 2000 about 300–400 thousand tonnes of Pollock quotas in Far East Russia were sold annually to foreign companies and joint ventures (Anferova et.al., 2005). From 2000 domestic fishers could also increase their quota through purchase from the National Fish Resources state company. These quotas, totaling 294 thousand tonnes and between 12-14% of the TAC, fetched $126.4 million in 2000. Domestic users accounted for 55% of these.

The auction system

After the fall of the Soviet system, problems with quota allocation to the coastal regions increased from year to year, partly because the TAC became smaller in light of fishing capacity. Also as a result of catches being much higher than TACs, the stocks of many important species declined. TACs of some valuable species had declined by more than one half (e.g. Pollock, in Far East Russia, from 2.27 million to 0.93 million tonnes during the period1998–2002). The crab fishery is another example. In the crab fleet in the Russian Far East was around 300 boats owned by 158 enterprises in 1998 or about twice the number necessary in terms of the allowed catch (Anferova et.al., 2005). In 2001 the number of crab boats had increased to about 380 in Far East basin, while the crab quota had shrunk and was only 55 thousand tonnes. Many smaller boats only got rights for 10–50 tonnes of crab per boat. This was too low to guarantee profitability. As enforcement of the system was lax, illegal catches increased. The quota auctions established sizes of lots at no less than 50–100 tonnes with the intention to reduce the number of boats operating in the fishery and decrease capacity.

The pre-auction quota allocation system was much criticized. Local governments complained about small regional quotas. In the central government circle there was also dissatisfaction with the system. As quotas were allocated for at only a low fixed fee (price) this gave rise to favoritism and bribes at that allocation level. There were even claims by ministers that it was an illusion that no fees were paid before the auctions. Payment was always collected; but it wasn’t collected in accordance with transparent rules and it certainly did not go into transparent pockets and not into the state‘s purse.

In December, 2000, the Russian government announced the start of an auction system for fish quotas. The auction system was designed to be a market

mechanism with the purpose of improving the allocation of quotas to the industry. Its objective was to provide a transparent access of enterprises to the fisheries and prevent corruption, and it was supposed to eliminate demand and price uncertainties and reduce illegal activities of the fishers.

Any company registered in Russia was allowed to participate in an auction of quotas. The auctions were divided into ‘‘closed’’ and ‘‘open’’ ones. Foreign enterprises were allowed to participate only in open auctions and to bid for lots which were not sold to Russians in closed auctions. Open auctions were held after closed ones. The detailed results of auctions (winners, prices, etc.) were not usually made public.

Quotas bought through auctions were valid for the current year only. The re-selling of quotas bought in an auction was not allowed. All auctions were held in Moscow (Eikeland and Riabova, 2002).

For auctioning, catch quotas were divided into so-called ‘‘lots’’. The number and size of lots was decided by the auction committees. Lot sizes were set based on the available TAC and price of the species. There were numerous problems with technical parameters of auctions, such as optimal lot sizes often being defined improperly.

It had originally been the intention to auction up to 80% of the TAC. After much debate, only about 20% of the TAC in Far East Russia was auctioned in 2001. In 2002 22.7% of the quotas were auctioned and 36% in 2003 (Anferova et.al., 2005). The Ministry of Economic Development and Trade repeatedly suggested that 80% of all quotas be auctioned but the State Fisheries Committee and others argued for much smaller numbers. In 2001, nineteen fish and seven crab species quotas were auctioned. In 2001, 558 thousand tonnes remained unsold (53% of all auctioned quota) due to the lack of interest of both Russian and foreign firms. Some quotas of species of lower value were purchased only to have a legal base to enter the fishing zones where valuable species could be caught ‘‘as a by-catch’’. For example, quotas of red king crab were purchased for the purpose of targeting snow opilio crab as well. Such a scheme is confirmed by the fact that some boats having quotas for red crab were not even equipped to catch this species. Something similar also occurred for mollusks.

One aim of establishing the auctions was to increase income to the state. Considerable increase of revenues in 2002 in comparison to the earlier years was a strong argument in favor of the auction system. The auctions in 2001–2002 provided more income for the state than was expected when setting the starting prices.

Catch, production and profits all declined much in 2000-2002, and a large majority of companies were all but bankrupt at the end of that period. High quota prices in auctions obviously resulted in additional costs to fishing enterprises. The fishing industry's debt increased by 30% in 2000-2002, which amounts to two thirds of the annual value of production in the fisheries sector. The State Fisheries Committee argued that the auctions drained away a considerable part of the working capital of fishing enterprises and resulted in this increase in their debt.

The auctioned quota was in essence just an additional cost to the fishing firms and with the increased cost the economic performance of fishing enterprises deteriorated even more. In order to stay in business, many enterprises faced a need to catch more than their quotas permitted. Since the enforcement system was not up to its task, the auctions became an additional incentive for poaching.

Most of such illegal catches in Far East Russia were landed abroad. By some calculations the ratio of legal and illegal catches of the most valuable species increased from 1:2 to almost 1:5 under the auction system. About 400 boats in the Far East Russia in 2002 caught and exported all their fish illegally. According to Japanese statistics, there were twice as many crabs landed in Japan from Russian boats as the Russian official sources mention. Moreover, the biggest volumes of landings of fish caught by Russians were registered in China (Anferova et.al., 2005).

The end of the auction system in Russia

The Russian Government decided in late 2003 to cancel the auction system and, instead, quota allocations from 2004 onwards are based on historical catch (average catches during previous 3 years).

The cancellation of the auction system was not a surprise. The auction system harmed the economic performance of the fishing enterprises due to additional cost, and the debt of the fisheries sector increased. This in turn resulted in growing incentives to increase catches. This encouraged illegal fishing, as existing enforcement capacity and legal regulations were too weak to control the fisheries. The existence of foreign markets nearby aggravated the situation and made the enforcement of the TAC much harder than it would be without easy access to foreign markets. Increasing imbalance between TACs and catches resulted in deterioration of the stocks, which in turn, adversely affected the performance of the sector.

The auction system also allowed new enterprises to enter the fishing sector. With a legal base to carry out some fishing activities (even using small quotas),

such enterprises could fish much more than they were allowed.

The auction system did not lead to a perceptible decrease in fishing capacity. One reason probably was the possibility to pursue illegal fishing on the basis of small quotas. However, the technical situation of the fleet deteriorated, since there was not enough capital for maintenance and modernization.

The system of holding closed auctions before open ones was meant to guarantee domestic user access to resources. Rising quota prices also meant increased dependence of Russian fisheries on foreign capital. Some claim that foreign enterprises financed more than a half of the total quota purchase of Russian enterprises at the 2003 closed auctions.

The deterioration of the financial situation of fishing enterprises impacted not only the industry itself, but also the larger public. The Russian Far East is very dependent on the fisheries, and healthy economics of this sector is crucial for the whole region (Anferova et.al., 2005). It seems clear that the auction system did not stimulate business development in fisheries, but rather pushed the sector into the illegal economy.

There was also strong and permanently increasing pressure from the industry to abolish the system, and more and more people in government realized that the auction system was not working as planned. Russia‘s Government therefore decided in 2003 to cancel the auction system and instead base quota allocations from 2004 onwards is be based on historical catch (average catches during previous 3 years).

The auction system had only applied to some species, largely the commercially important ones. With the change the quotas are allotted for five years in advance, based on the catch over the previous three years. Quotas are therefore more predictable for the vessel owners.

The State Committee for Fisheries was assigned the task of setting up an inter-ministerial group to oversee quota distribution. The system only covers species for which quotas are established in partnership with foreign states. The remaining fish stocks, which are of limited commercial value, are allocated according to previous procedure. In the Russia’s Northwestern fishery, regional authorities no longer exercise control over cod, haddock, and capelin quotas. One aim of the changed system is to reduce the number of vessels and companies involved in capture of fish both in the Northern basin and the Far East.

8.3 Summary

The former Soviet republics Russia and Estonia experimented with auctions of catch quotas and fishing gear quotas (Estonia) for 3 years at the beginning of this century. In both countries the auctions were established through a government initiative. One reason for the auctions was to divert more of the fishery rent to the government. Another was to increase efficiency in the fishing industry. And still another reason was to make the allocation of quotas more transparent. This last reason derives from the changes that had taken place in these now independent countries.

The fisheries in the Soviet republics were a part of the planned economy during the Soviet period. Fishing activities were carried out by collectives and state enterprises. The fishermen were employees of these collectives and enterprises, without any rights themselves to the fish resources. After independence there was a rapid transition to a market economy and this process caused very significant changes in all facets of life and in the economic framework.

Most of the commercially important fish stocks were in a good condition at the end of the Soviet period and catches were good. More importantly was the possibility to export to the western market that had opened up and caused increase in prices. Coastal and inland fisheries became very profitable as a result. Both countries moved the management of some of their fisheries towards ITQs, and right before the turn of the century the more valuable fisheries in both countries were subject to such a system (there was also some financial interest for the governments in both countries in leasing quotas to foreigners). Besides the interest of some persons in authority to rationalize their economies, including the fishing sector, and rely more on a market system, there were some complaints that the privatization of the collectives and equipment (boats, gears) had not been transparent. In addition, there were complaints that the allocation of quotas was not transparent, even suggestions that the allocation system was corrupt.

Therefore, both countries initiated auctions of quotas. In Russia the auctions only applied to some species, and then only to a 10%-25% of those. In Estonia the auctions applied to almost all fisheries, even to the fisheries of inland lakes. The first auctions, for the 2001 fishing year, were deemed rather successful, and the auctions for the latter two years, 2002-2003, were equally if not more disappointing. In Estonia the fishermen conspired and boycotted the last of these, and with upcoming elections threatened to vote supporters of auctions out of office. The parliament in turn moved swiftly to abolish the auction system and instituted grandfathering if ITQs.

In Russia the auctions were also abolished in 2003, the main reason being pressure from the industry. In addition there were numerous other reasons to support this change, such as a very weak and uncompetitive Russian fishing industry and some regional reliance on the fisheries. The auctions had threatened both with increased (both legal and illegal) foreign participation in the fisheries and the catch being exported (both legally and illegally) unprocessed. The auction prices resulted in a drain on the cash flow of existing fishing firms and left many indebted. The auctions also led some firms, who bought small amounts of quotas, to use them as a pretext for poaching, an option made possible because of lax monitoring and enforcement. Instead of stimulating business development in the fisheries, the auction system pushed the sector into the illegal economy.

9. The Chilean case: Auctions

The Chilean marine capture fisheries are quite large compared to the global industry. In 2006 total catches amounted to some 4.2 million metric tonnes, a volume apparently close to the long run sustainable average (FAO 2009 and previous issues). This volume of catch amounts to about 5% of the total global marine fish catch (FAO 2009). In 2006, Chile was the fifth largest fishing nation in the world in terms of volume. The bulk of the harvest, however, consists of relatively low value species, especially horse mackerel (jurel, sometimes called jack mackerel) and anchoveta. As a result, Chile's share in the global landed value of marine capture fisheries is much less than 5%.

As virtually all marine fisheries, the Chilean fisheries have suffered badly from the common property problem. This led to huge overcapitalization in fleet and processing capacity and, therefore, reduced profitability and industry instability. In the Chilean case, however, primarily due to comparatively effective use of TACs (total allowable catches) and temporary fishery closures, the stock overexploitation has been much less dramatic than in many other fisheries. Thus, in the Chilean case, the common property problem has primarily appeared as overcapitalization, reduced profitability and industry instability, i.e. volatile economic returns and activity in the business.

A system of individual transferable quotas (ITQs) may confidently be expected to remedy this kind of a situation, provided, of course, that the system is properly enforced and the TACs sensibly set. The system of ITQs in similar pelagic fisheries, for instance the Atlantic herring fisheries have yielded great economic and biological benefits (Arnason et al. 2000, Arnason 2005). Indeed, available studies suggest that the ITQ system in Chile has already yielded substantial economic benefits in terms of reduced overcapitalization and

increased profitability (Gomez-Lobo et al. 2007, OECD 2009).

However, as we have seen in previous chapters of this report (especially chapters 2 and 3), the effectiveness of ITQs to generate economic efficiency is totally dependent on the property rights quality of the ITQ-rights. Any limitation on the duration, security, exclusivity and tradability of the ITQ-rights will reduce this efficiency. In the extreme cases of no duration or no security of the ITQ rights, the ITQ fishery converges to a common property fishery and any net economic benefits from the fishing activity will disappear.

This brings us to the question of auctions of ITQ-rights in the Chilean pelagic fisheries. While the law suit in question does not propose any particular type of auction, it refers to the current law which specifies auctioning a significant proportion of of outstanding ITQs annually.

This type of auctions is a repeated one and, consequently, subject to all the detrimental economic, biological and social implications of repeated auctions discussed above.

In particular, it may be pointed out that this type of auction is:

- Equivalent to a 5% higher rate of discount for the fishers.[15] This higher discount rate implies *inter alia*:
  (i) Shorter time horizon.
  (ii) Reduced incentives for resource conservation.
  (iii) Distorted investments.

- Equivalent to a taxation of 5% of quota values. This implies *inter alia*:
  (i) Reduced quota-share prices and distorted *ITQ* price information for management purposes.
  (ii) Poorer companies possibly accompanied by financial difficulties
  (iii) Higher discount rates, shorter horizon and distorted investments
  (iv) Reduced benefits from cooperation with other marine users and therefore less co-operation.

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[15] If α is the auctioned fraction, then the corresponding continuous time interest rate is defined by $x(t) = e^{-r} \cdot x(t-1)$, where $x(t)$ is the quota holding at time t. Simple logritmic transformation and remembering that $x(t) = (1-\alpha) \cdot x(t-1)$ yields r=-ln(1-α). So for α=0.05, r=0.051 and for α=0.1, r=0.105. Note that these are additional rates of discounts because of the auctions.

In what follows we will further delineate some of the more pertinent economic consequences of this.

9.1 Economic (efficiency) impacts

This brings us to the question of auctions of ITQ-rights in the Chilean pelagic fisheries. We have already seen that auctions reduce the property rights quality of existing ITQs. Once-and-for-all auctions do so before the first auction takes place. Repeated auctions do so permanently. It immediately follows that assignment of ITQ by auctions will correspondingly reduce the economic efficiency of these fisheries compared to leaving the ITQ-rights with the existing fishers (first possession or grandfathering rule). The reduction in economic efficiency will among other things appear as distorted investments, shorter time horizons by the firms, less interest in co-operation and long term management of the resources and their ocean environment, less research and development (R&D), diminished financial strength of the companies and higher cost of capital. All these negative consequences will be more serious for repeated auctions than for an once-and-for –all auction.

We have also seen that overall quota transaction coss in the Chilean pelagic fisheries are likely to increase if auctions are adopted. the reason is that the auction trades are not likely to be met by the same reduction in market trades. Besides the fixed cost of the auciton is added to the already fisxed costs of the normal trading system. Finally, it may well be the case that auction costs per unit trade is m-higher than in the normal quota marekt.

The quantification of the efficiency loss due to auctions of ITQ-rights is an empirical question the answer to which depends, among other things, on the type and design of the auctions, the interval between auctions (duration of ITQ-rights), the biological, capital and technological state of the fishery, the fishing firms in the business and so on. However, as suggested in systematic studies on the matter (Arnason 2007, Anderson et al.) the amount of economic loss can easily be a high proportion of the maximum attainable economic rents.

The economic costs of auctions is even greater when the impacts on other industries and the exploration and discovery (E&D) process are considered. Auctions of ITQ-rights do not only reduce the property rights value in the fisheries themselves, they also undermine the property rights in other areas of economic production. Clearly, if the state seizes existing rights in the fishery and auctions them off, the perceived probability that the same can happen in other industries is increased. Thus, at least the security of existing rights is reduced with negative economic consequences as traced out in sections 2, 3 and 8 above. Obviously, this impact will be greatest in industries which are most similar to

the fishery. Other resource based industries, of which there are many in Chile, would be the obvious candidates.

Even more important, especially in the Chilean situation, is the impact of ITQ-auctions on the E&D process. A substantial part of economic progress consists of discovery of new natural resources, discovery of new uses for existing resources, development of new techniques for better use existing resources and the discovery of new industries and techniques in general. The exploration and development required for these discoveries often require substantial investments in time and funds and the outcomes are very uncertain. Most explorations end in failure. The E&D activity, however, is driven by the possibility of large gains. The taking of ITQ-rights by the state and auctioning them off on the basis that under ITQs companies have received windfall gains clearly reduces the expected gains from any E&D activity, especially in the field of natural resources. What happened in the ITQ-fishery can easily happen in these other successful E&D industries as well. The end result is that the E&D activity is reduced. The long term consequences for economic growth and the GDP (gross domestic product) can be large.

9.2 Impacts on monopolistic behaviour

We have already seen (section 5 and 6) that auctions of ITQs are unlikely to have a noticeable impact on any monopolistic behaviour that may exist in the fishery. First, in most fisheries monopoly power is small. In output markets is negligible or non-existent. This is because the product is generally widely traded and has many close substitutes. This certainly holds for the Chilean pelagic fisheries which mainly produce fish meal and oil which are standardized products internationally traded. The same applies to most inputs. Vessels, fishing gear, fuel, financial capital etc. are internationally traded and supply is virtually perfectly elastic as seen from individual fishing companies. In some cases, however, there is some monopoly power regarding local inputs such as labour. This may be the case in some Chilean fishing towns from which the pelagic fleets operates Market power with regard to ITQ-trades may exist, but it requires a comparatively large company at least 10% and preferably much larger and heterogeneous companies. In any case, with an exogenously set TAC, it is hard to see that there would be a significant efficiency loss stemming from this kind of monopoly power, even if it existed. Of course, this assumes that new entrants can enter by simply buying ITQ-shares. If that is not the case, ITQ-auctions would open that door. However, a much easier and non-distortionary way would be simply to allow trading of quota-shares to firms not already in the industry.

Second, assuming, largely against the available evidence, that some

monopolistic behaviour exists in the fishery, it does not appear that auctions of ITQ-rights will have any noticeable effect on this behaviour. First, auctions of ITQs are not likely to lead to different number and composition of firms in the industry compared to what would be generated by normal trades of ITQ-shares between holders. Therefore, the monopoly power of the fishing industry and its individual companies in input and output markets would be largely unchanged. Any monopoly power in the ITQ-market that may exist would of course disappear at the time of the auction. However it would reappear during the period between auctions, which of course is most of the time. So the conclusion is that it can not be see that auctions of ITQ-rights have any significant impact on possible monopolistic behaviour in the fishing industry.

9.3 Impacts on government revenues

Auctioning off ITQ-rights in the Chilean pelagic fisheries will almost certainly bring in substantial revenue. The fishery under ITQs is potentially very profitable. Barring collusion amongst the bidders, the auction price (assuming a uniform price auction) will reflect the expected present value of resource rents in the fishery.[16]

These gains in revenue are of course just a transfer from the fishery to the government. It is like a tax. It dos not generate any new wealth. In fact, as discussed above the conduction of ITQ-auctions is likely to reduce efficiency in the fishery and growth in other sectors of the economy. Added to that is the cost of conducting and participating in the auctions. Thus, the auctions are highly likely to reduce economic wealth in Chile. Due to the economic growth effects, this cost is likely to increase over time.

It follows that any initial gain in government revenues from ITQ-auctions are likely to be counteracted by reduced taxation income in the fishery and other sectors of the economy as the negative economic efficiency impacts discussed above materialize and accumulate. In fact, it is only a matter of simple calculation when the initial gains in revenues will have been completely offset by reduced taxation income from an economy that grows less fast than it would have without the auctions and, consequently, stronger private property rights.[17]

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[16] Non-uniform price auction where each bidder pays his bid will extract more than the resource rents.

[17] To indicate the essentials of this simple calculation let {y} be the path of gdp without auctions of ITQs and $\{\hat{y}\}$ the path of the economy with ITQ auctions. Moreover let, α be the average tax ratio out of gdp. Then, taxation revenue sat time *t* under the two regimes are $T(t) = \alpha \cdot y(t)$ and $\hat{T}(t) = \alpha \cdot \hat{y}(t) + A(t)$, where $A(t)$ is the auction revenue at time *t*. Given assumptions about economic growth with and without the auctions, it is a matter of

We conclude that any initial gains in government revenues form ITQ-auctions are likely to decline over time and at some data turn into reduced revenues.

9.4 Fairness

It is sometimes argued that allowing ITQ-holders to keep the resource rents made possible by the ITQ-system is somehow unfair. Therefore expropriation of these rents by means of taxation or auctions is fair.

This argument, however, is particularly strong. First why should it be fair to remove hard earned gains from members of the public for allocation to other members. It is not true that the ITQs as such automatically generate rents. ITQs only allow the members of the industry to make the necessary adjustments to their investments and operations to generate economic rents. To achieve these rents, the ITQ-holders normally have to endure a painful period of disinvestment, adjustments in their operations and, often, reduced harvests. In short, to rebuild stocks and adjust fishing effort and capital generally implies less profits than before. It is on the basis of this investment that the resource rents eventually emerge. So, the rents are earned. they are not windfall gains.

Second, if for the sake of argument we assume that ITQs-shares represent a windfall gain to a group of fishers. Why is it necessarily fair to harm the interests of this group to help some other groups? Is it more fair that groups not involved in the fishery gains from ITQs than the groups in the fishery?

Third, the resource rents are collected by the government in the form of auction price. The government will use these monies in some way. Even if the government uses them well from a social perspective, there is no guarantee that they will be allocated in a fair way. It is easy to argue that the odds are that they will neither be used wisely nor fairly. In any case, there is no a priori reason to believe that the way in which the government is going to use the funds collected from the fishing industry is going to be more fair than leaving them with the fishing industry.

Fourth, the efficiency aspect of auctions cannot be ignored. If, as seems likely, auctions of ITQs will lead to a reduced efficiency in the fishing industry and economic growth in the economy, at least some people's incomes will be reduced as a result. Is that fair or less unfair than the initial assignment of

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simple calculations when the initially increased government revenues under ITQ-auctions fall behind the revenues with no ITQ-auctions. For seemingly plausible assumptions, the number of years until this happens is quite low.

ITQ-shares? Are these people willing to pay this price for a redressing of a perceived unfairness of leaving ITQ-rights in the hand of the fishermen?

9.5 Conclusions

Auctioning ITQ-rights does not seem to be a good idea from virtually all major perspectives. They will almost certainly lead to a reduction in the economic efficiency of the fishery and, by their impact on property rights quality, are very likely to have a negative efficiency impact on many other industries as well not to mention the exploration and discovery (E&D) activity. Thus, auctions of ITQ-rights are likely to reduce the GDP and the real incomes of most members of the Chilean society in due course. ITQ-auctions are very unlikely to have any noticeable effect on possible monopoly power and monopolistic behaviour in the fishing industry. While ITQ-auctions will almost surely increase government revenues in the short run, they are likely to reduce the same revenues in the longer run as their negative economic impacts materialize. Finally, it is by no means clear that auctions of ITQs promote fairness compared to leaving ITQ-rights in the hands of the fishers (grandfathering).

In the Chilean situation it appears to be much more in the common interest to strengthen the property rights value of the ITQs by extending their term of duration, and preferably making them permanent, rather than weakening them by auctions. This will promote economic efficiency both in the fishery and, by strengthening property rights in general, many other sectors of the economy. For the same reason, limitations on ITQ-ownership and -trades to pre-specified groups should be relaxed to include, preferably, all Chileans.

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Appendix 7
Leading researchers

Ragnar Arnason: Short CV

Ragnar Arnason is a professor of fisheries economics at the University of Iceland. With a master's degree in mathematical economics and econometrics from the London School of Economics, he received his Ph.D in natural resource economics from the University of British Columbia in 1984. Since becoming a professor in fisheries economics in 1989, professor Arnason has primarily conducted his research in the area fisheries economics and fisheries management where he has a publication record of over 150 scientific articles and books. Professor Arnason has also been active in consultancy work on fisheries policy and fisheries management systems around the world.

Birgir Thor Runolfsson: Short CV

Birgir Thor Runolfsson is an Associate Professor of Economics at the University of Iceland a He received his Ph.D in Economics from George Mason University in Virginia, U.S.A. in 1991. Much of his research has been in the area of the economics of institutions, fisheries economics and economic performance of the Icelandic ITQ system where he is the author of several papers.