EFFECTS OF FORESHORTENING OF TRANSFERRED QUOTA IN AN ITQ MARKET

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ABSTRACT

This paper models and investigates the foreshortening of transferred quota which is applied in the Norwegian fisheries management. This reduction in the transferred quota amount by 20% is then redistributed amongst all vessels in the relevant vessel group. It is shown that fishing units can be expected to be operated longer, and capital renewed at a slower rate under foreshortening than if foreshortening is not used by the government. Foreshortening will most likely also reduce the value of the quotas. However, foreshortening may increase the value of the quotas if unit costs of fishing increase fast compared to the discount rate used by quota holders.

Keywords:

ITQs, Norwegian fisheries policy

Introduction

Foreshortening of transferred quota is a tool used in Norwegian fisheries management. A buyer of quota will only receive 80%, say, of the quota a seller sells. Hence the seller only receives payment for 80% of the quota sold. The 20% accrues to the general pool allotted all remaining quota holders in the vessel group, including the quota buyer. This form of transfer taxation bears some resemblance to the Tobin tax discussed in international finance literature. The difference is that the “income” accrued by the foreshortening rule is diverted back to quota owners while the income from the Tobin tax would be used to finance supply of global public goods. The purpose of this note is to map the economic effects of foreshortening in an individual transferable quota (ITQ) setting. How does foreshortening affect entry and exit of firms in the industry? How does foreshortening affect the social cost of fishing? How should a social planner fix the foreshortening parameter?

Though one would expect that any reduction or taxation of transferred quota would reduce the value of the said quota, our results surprisingly show that this is not necessarily the case. Under conditions of high rate of cost increase relative to the discount rate of the firms, foreshortening may increase the value of individual quota.

The paper is organised as follows: First we present how foreshortening is applied in Norwegian fisheries, followed by a model of individual firm behaviour given foreshortening. The next section presents the social planner’s behaviour, with a conclusion summing up the paper.

Foreshortening in Norway and other places

Foreshortening of transferred quota was first introduced in Norway for the offshore fishing fleet in the mid nineties and for the coastal vessel fleet in 2004, and has varied in size from 5 to 40% of the transferred quota. Many different types of foreshortening have been and are currently used in Norwegian fisheries, depending on political or societal motives. Foreshortening may also have a geographical element, where for instance offshore vessel quota sold *from* a northern county in Norway to a county further south, results in a greater foreshortening than if the quota is sold from south to north. This is motivated by a political will to secure the fisheries dependent northern counties.

The motivation for the 20% foreshortening of sold quota in the coastal vessel group was twofold. One motivating factor was to compensate for the loss of so called "over-regulation" in the non-transferable individual vessel quota system that existed earlier (Anon, 2002). "Over-regulation" was the regime that allotted each vessel a higher individual vessel quota than the group total allowable catch (TAC) justified, based on the fact that many vessels never harvested their full quota right (Hersoug, 2005). As the implementation of ITQs resulted in the transfer of these vessels' quota to more active vessels which depleted the possibility to "over-regulate", foreshortening was introduced to partially compensate those who did not sell out, and who also did not buy extra quota. This was a justification that secured the acceptance of transferability amongst fishers. The second motivation for foreshortening was directed towards the more general political scepticism to transferability. Foreshortening was here (mistakenly) used as a solidaric argument that transferral of quota would partially return to the common pool.

Originally the transferred quota in the offshore vessel segment had a limited life span. Once the quota was transferred, it was only the buyers' property for a given number of years, varying from 13 to 18, depending upon whether the vessel which relinquished quota was taken out of the fishery or not. After this given period of time, the quota was returned to the common pool and was divided equally between the remaining vessels in the group. When the debate for quota rights in all perpetuity emerged in the coastal vessel group, foreshortening was introduced as way to bring a limited amount of quota to the vessel group at an early date, rather than a large amount of quota later, when the life span of the transferred quota was over. Hence, in the offshore vessel segment an additional motivation for foreshortening was that it became a way to introduce everlasting transferred quota rights. The Ministry of Fisheries made it clear that there was a trade-off between the size of the foreshortening, and the amount of quota that would return to the common pool of the vessel group (Anon, 2002). This since the larger the foreshortening, the less attractive transferral of quota would be, making for less quota going into the common pool via foreshortening. This is of course familiar from all discussion regarding the extent of taxation.

To our knowledge there is no similar foreshortening used in other countries with ITQs. A method of attrition is however common many other places, and is a way of securing that quota is returned to some "common pool" over time. Many countries, such as Iceland, Australia and New Zealand, do not have any return of quota upon transferral.

Dynamics of a fishing firm

In the following we adapt a model proposed in Weninger and Just (2002). A firm uses a single unit of capital to produce a single unit of output. The firm must have a permit in order to produce. Permits can be bought and sold in a quota market. Unit operating costs depend on the age of capital. As a simplification we ignore uncertainty regarding development of operating cost, and assume that the latter increases with time reflecting the fact that maintenance of old fishing units is much more costly than maintenance of newer units. We ignore possible effects of learning by doing, and technological development. A firm that leaves the industry can sell its capital at some price *s* and its fishing permit at a price *R*. In the real world, the fisher or firm will not necessarily sell both capital and quota, but only capital, reinvesting in more cost-efficient capital. It is not unusual, however, to exit a fishery for a period of time, and re-enter with a new and more modern vessel. In this model both an "old" fisher and a "new" fisher face the same conditions upon entering the fishery. In a sense we are studying the turn-over of capital, given that the quota price is an opportunity cost that the fisher who chooses not to leave also faces.

When the firm sells its permit, a part of the permit, *k*, is retained by the authorities and distributed back to the pool of active permit holders. Number of permits (firms) is *Y*. As unit costs are increasing as time passes, each firm will find it optimal to go out of business at some point in time. The remaining time span that a firm has to "live" is τ_* The number of firms that exit the industry in each time period is *Y* over $\bar{\tau}$, where the latter is the average time a firm stays in business. In steady-state we have that $\bar{\tau} = \tau_*$. It is assumed that the age of the capital in the industry is evenly distributed. Hence, the current value of an active firm is given by the following equation:

$$
\begin{aligned}
F(c) &= \int_0^{\tau_*} \left[p - c(t)\right] e^{-\rho t} dt + \int_0^{\tau_*} \left[\frac{Y}{\bar{\tau}} R \frac{k}{Y} \sum_{j=0}^{\infty} k^j \right] e^{-\rho t} dt + \left[R + s\right] e^{-\rho \tau_*} \\
&= \int_0^{\tau_*} \left[p - c(t)\right] e^{-\rho t} dt + \left[\frac{R}{\bar{\tau}} \frac{k}{1-k} \right] \int_0^{\tau_*} e^{-\rho t} dt + \left[R + s\right] e^{-\rho \tau_*} \qquad (1) \\
&= \int_0^{\tau_*} \left[p - c(t)\right] e^{-\rho t} dt + \left[\frac{R}{\bar{\tau}} \frac{k}{1-k} \frac{1}{\rho} \right] \left[1 - e^{-\rho \tau_*}\right] + \left[R + s\right] e^{-\rho \tau_*}
\end{aligned}
$$

Here ρ is the discount rate utilized by the fishing firms. The first element on the RHS describes the firm's discounted profit over time from fishing, where *p* is the fixed harvest price of a unit of quota, and *c*(*t*) is the cost of harvesting a quota unit, which increases over time as described above. The second element is the income accruing the firm from the sale of its share in the foreshortenened quota, that is, *k*/*Y*. In each time period, $Y/\bar{\tau}$ firms leave, the amount of quota remaining is therefore $k/\bar{\tau}$, adjusted by the parameter *k* since each permit share sale made by the firm is foreshortened. The latter element on the RHS is the sales value of the quota and capital, *R* and *s* respectively, discounted from the sales time period τ_* back to the present. Note that in the case that there is no foreshortening, so that *k*=0, then (1) reduces to equation (2) in Weninger and

Just (2002). Note that total average operation time of other firms, $\bar{\tau}$, is not a choice variable for the firm under investigation, but note also that this variable is equal to τ_* in steady state as already alluded to.

Assume as do Weninger and Just (*op.cit*) that cost of firm *i* is determined by:

$$\frac{dc_i}{c_i} = \mu dt \quad \Rightarrow c_i(t) = c_i(0)e^{\mu t} = c_e e^{\mu t} \tag{2}$$

Hence, if all firms start out with the same average unit cost when first engaged in fishing, as assumed above, then old firms will experience higher average unit cost than do newer firms, reflecting the effect of increasing maintenance costs etc.

An old firm will have to consider each period whether to sell the quota right and the capital or rather continue operations one period more. A prospective operator will have to consider whether he is able to acquire capital and fishing rights at a price that is low enough to justify entrance. Thus the equilibrium conditions are:

$$\begin{aligned} F\left(c^{exit}\right) - s &= R \\ F\left(c^{entry}\right) - \phi &= \frac{R}{1-k} \end{aligned} \tag{3}$$

Here ϕ is the start-up cost of a new firm (fishing unit) in the industry. Optimal exit is determined by the first order condition for equation (1):

$$c_i\left(\tau_*\right) = p + \frac{R}{\bar{\tau}}\frac{k}{1-k} - \rho\left(R+s\right) \tag{4}$$

Again, equation (4) reduces to a corresponding equation in Weninger and Just (2002) if k=0. Note that the effect of foreshortening seems to depend on the average length of time a firm will stay in the industry at any point in time, and also the size of the foreshortening rate k, as well as on the going rate for quotas. Equation (4) implicitly defines the optimal time until exit for firm *i* as

$$\tau_* = \frac{1}{\mu}\ln\left[\frac{p + \frac{R}{\bar{\tau}}\frac{k}{1-k} - \rho\left(R+s\right)}{c_e}\right] \tag{5}$$

Assuming that c_e and ϕ are exogeneous variables and defining $c_i\left(\tau_*\right)_{k=0} = c_{0*} = p - \rho(R+s)$ we can establish the following equation[i]:

$$\left(\frac{R}{1-k}+\phi\right)(\rho-\mu)\rho=\rho\left(p-c_e\right)-p\mu+\mu c_e^{\rho/\mu}c_{0*}^{1-\rho/\mu}+(\rho-\mu)\frac{R}{\overline{\tau}}\frac{k}{1-k}\left\{1-\left(\frac{c_e}{c_{0*}}\right)^{\rho/\mu}\right\} \quad (6)$$

Here, as in that paper, the left hand side of the equation equals the value of a firm entering the fishery times $(\rho-\mu)\rho$. Based on (6) we can derive the following relationship between the forshortening parameter and the market value of quotas:

$$\frac{dR}{dk}=\frac{R}{(1-k)^2} \times \frac{-\rho+\frac{1}{\overline{\tau}}\left(1-\left(\frac{c_e}{c_{0*}}\right)^{\rho/\mu}\right)}{\rho\left[\frac{1}{(1-k)}-\left(\frac{c_e}{c_{0*}}\right)^{\rho/\mu}\right]+\frac{1}{\overline{\tau}}\frac{k}{(1-k)}\left[\left(\frac{c_e}{c_{0*}}\right)^{\rho/\mu}-1+R\frac{\rho^2}{\mu}\left(\frac{c_e}{c_{0*}}\right)^{\rho/\mu}c_{0*}^{-1}\right]} \quad (7)$$

Now, for the sake of simplicity lets ignore all parts of the equation that contain the factor $\left(\frac{c_e}{c_{0*}}\right)^{\rho/\mu}$, which we can postulate will be some small number.[ii] Then (7) can be rewritten as:

$$\frac{dR}{dk}=\left[\frac{R}{(1-k)}\right]\left\{\frac{\frac{1}{\overline{\tau}}-\rho}{\rho-\frac{k}{\overline{\tau}}}\right\} \quad (8)$$

Though one would expect *dR*/*dk* to be negative, note that (8) may be either positive or negative depending on the size of the parameters. In cases where $1>\rho\overline{\tau}>k$ then $dR/dk>0$. Otherwise this derivative is less than zero. Now, assume that a piece of capital wears out at a rate of $100\cdot\gamma\%$ each period and that a new part has to be added (think of a clock with a finite number of movable parts and that a given percentage of the original parts is replaced every period). It can be shown that the original capital-unit will be fully replaced in $1/\gamma$ periods, see Gittleman et al. (2006). Assume that the rate of decay of capital invested in a fishing vessel is equal to the rate of increase in unit cost so that $\gamma=\mu$. Our case differs from the case of Gittleman et al. in that a owner of a fishing vessel may scrap his vessel before all the orignal parts have been renewed. Hence, we can state that the higher limit of the effective economic lifetime of a capital unit is $1/\mu$.[iii] In other words, if *k* is small, $\rho<\mu$ and if $c_*\approx ec_e\approx 2{,}72c_e$, then we have that $dR/dk>0$. Hence, if costs are increasing at a rate that is faster than the rate used for discounting future income, then foreshortening can increase the value of the fishery. In a setting where costs increase at a slower rate, foreshortening reduces the value of the fishery.

The intuition for the possible positive effect of forshortening on quota value is as follows: Introducing foreshortening affects the value of the quota both positively and negatively.

Positively as the foreshortening rule implies that the holder of a quota will be receiving additional quota each time someone else quits. Hence, if the lifetime of the unit is longer than the effective economic horizon of the owner, then the owner will be better off the higher is the forshortening parameter as more income is coming his way each time someone leaves the industry and sells off his/her quota.

Implicit derivation of (5), assuming that $\frac{\partial \tau_i}{\partial k} = \frac{\partial \bar{\tau}}{\partial k}$, yields:

$$\frac{\partial \tau_i}{\partial k} = \frac{\frac{dR}{dk}\left(\frac{1}{\bar{\tau}}\frac{k}{1-k} - \rho\right)}{\mu c_* + R\frac{k}{1-k}\frac{1}{\bar{\tau}^2}} = \frac{\frac{dR}{dk}\left(\frac{1}{\bar{\tau}}\frac{k}{1-k} - \rho\right)}{\mu\left(p - \rho(R+s) + \frac{kR}{(1-k)\bar{\tau}}\left(1 + \frac{1}{\mu\bar{\tau}}\right)\right)} \qquad (9)$$

The denominator of (9) is positive by our assumptions.. If k is small, $\rho > \mu$ and if $\mu \simeq 1/\bar{\tau}$ then both dR/dk and $\left[(1/\bar{\tau})(k/1-k) - \rho\right]$ will be negative. Hence, in this case the numerator will be positive. The implication is that if the parameters of the problem are such that foreshortening reduces the market value of quotas then foreshortening will also induce that capital is used longer. We can not, however, rule out the possibility that introduction of or increase in the foreshortening parameter could shorten the time that capital is in use, but it would involve a high rate of increase in unit costs compared to rate of discounting (in the case of negative relationship between price of quota and foreshortening), or a very low rate of increase in unit costs compared to rate of discounting (in case of positive relationship between price of quota and foreshortening). Furthermore, the foreshortening percentage in the offset must be small.

The problem for a social planner

The goal of a social planner differs from fishery to fishery and from country to country. Assume that quota holders are discounting income at a faster rate than the growth of unit costs. Then, if the goal of a social planner is to maximize the market value of the resource, which in our model is equal to *YR*, the planner should set the foreshortening parameter as small as possible as already alluded to, i.e. k equal to 0. Such a policy may however induce more rapid renewal of firms than seen as optimal from the social planner point of view. The reason might be that a rapid renewal induces externalities not accounted for by the fishing firms[iv]. Foreshortening may be one option open for fishery managers seeking ways to correct such an externality.

If however, the costs of quota holders are increasing at a rate higher than their discount rate, a social planner wishing to maximise the market value of the resource may surprisingly enough optimally introduce or increase an already small foreshortening parameter. This even if there are no externalities connected with rapid renewal of capital.

Conclusions

The model shows that it is most probable that foreshortening reduces the value of permanent quotas in an ITQ fishery, and that foreshortening increases the time each fishing unit is operated and thereby reducing capital renewal or the number of exits in the industry each year. Foreshortening increases the time each firm decides to stay in business, making for fewer openings for new entrants. Foreshortening is hardly an optimal policy for government in this case unless there is some externality tied to capital renewal or exit of firms from the industry. The model also shows, somewhat unexpectedly and paradoxically, that foreshortening can increase the value of quotas. This may happen if unit costs of fishing increase fast compared to the discount rate used by quota holders.

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Endnotes:

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[i] Equation (6) is derived in same manner as equation (A1) in the Weninger and Just (2002) paper.

[ii] Note that $\left(c_e/c_{0*}\right)^{\rho/\mu} = e^{-\rho\tau_*}$. Hence, the longer the economic lifetime (τ_*) of the capital unit, the smaller is $\left(c_e/c_{0*}\right)^{\rho/\mu}$.

[iii] From equation (5) we have that $\tau_* = (1/\mu)\left[\ln(c_*) - \ln(c_e)\right] = (1/\mu)$ for $c_*/c_e = e$. Cnf. also earlier assumption about the relative size of c_{0*} and c_e.

[iv] This could be due to inefficient investments as described in Hannesson (2000).