IMPLICIT AND EXPLICIT PRICES OF QUOTAS IN THE ICELANDIC FISHERIES

Thorolfur Matthiasson, University of Iceland, toimatt@hi.is
Olafur Klemensson¹, Central Bank of Iceland (E-mail: olafur.klemensson@sedlabanki.is).

ABSTRACT

The paper documents the discrepancy between prices of permanent quotas traded directly between fishing firms and implicit price of quotas as reflected in the price of fishing firms that are publicly traded. An overview of earlier attempts to explain the discrepancy is given. It is suggested that price formation in the market for permanents quotas and in the stock market is based on different principles. Finally it is observed that fishing firms that have been publicly traded are now being bought up and made private again. It is concluded that this is in line with the basic thesis of the paper and that ultimately no fishing firms will be publicly traded.

Keywords: quotas, Iceland

Introduction

Iceland introduced Individual Transferable Quotas (ITQs) as a method of implementing fishery management in the early 1980s, see (Matthiasson 2003). Transferability and tradability has been central to the Icelandic implementation of the ITQ system. The ITQ system forced the fishing firms to streamline their operation. Many firms merged and others expanded their share of ITQs. Hence, their need for capital increased. A handful of fishing firms solved their capital needs by going public during the 1990s. That trend has now turned and majority of the formerly publicly traded fishing firms are now withdrawing from the stock market. ²

Who holds the title to the quotas has been a matter of heated dispute in Iceland since the inauguration of the ITQ system, see (Matthiasson 2001). Recently, a governmentally initiated committee has suggested a declaration in the constitution that the fish stocks of the Icelandic Economic Zone belong to the Icelandic nation, see (Auðlindanefnd 1999). Experience in other markets has shown that such uncertainty depresses trade in permits and slows the expected increase in efficiency anticipated when such programs are initiated, see (Weninger and Just 2002). Weninger and Just also find that uncertainty depresses permit values. Contrary to this experience in other countries permanent fishing quotas have been the objective of trade in Iceland, sometimes lively, sometimes sluggish. The price of ITQs has been seen as high by practitioners and observers of the industry.

(Benediktsson 1999) finds a positive correlation between stock-market value of publicly traded Icelandic fishing firms and the value of ITQs but the relationship is far from one to one as might have been expected. Other observers of the industry have noticed that price of quota-holdings have not been well reflected in the stock-market value of fishing firms, see (Matthiasson 2000). This observation square badly with a simple application of the law of one price: One would have expected that low price

¹ Klemensson is a senior economist at the Economics Department of the Central Bank of Iceland. The views expressed in this paper are those of the author and do not have to reflect the views of the Central Bank of Iceland.

² Over 30 fishing firms were publicly traded at one point. Only 8 remain as of July 2004. The most recent examples of withdrawal are: Þorbjörn-Fiskanes withdrawn April 2, 2004; Hraðfrystihúsið Gunnvör, withdrawn March 31, 2004; Eskja, withdrawn February 16, 2004 and Fiskiðjusamlag Húsavikur, withdrawn November 28, 2003.
of quotas in one form would induce increased buying activity in that market and reduced buying activity
in the other market and hence a convergence of price of quotas in both markets.

Few other countries beside Iceland have adopted a fully fledged ITQ system. Very few ITQ holding
firms in these countries are traded publicly (Sharp 2003), but sporadic observations indicate similarity to
the Icelandic situation, (Foss 2003). Hence, it is possible that this apparent abnormality is not specific for
Iceland. But is it inherently connected to the ITQ system? Some information might be gained by looking
at firms operating in other industries where transferable and tradable quotas are also used. Tradable
pollution quotas spring to mind. An intense search of human as well as non-human sources revealed that
no studies seem to exist on the connection between price of pollution quotas and the stock-market value
of pollution-quota holding firms.

The objective of this paper is to shed some light on the connection between the ITQ price and stock-
market price of fishing firms in a theoretical model. Furthermore to map the empirical facts as carefully
as possible.

The reminder of this paper is organized as follows: A model is presented in section 2, the empirical
evidence is accounted for in section 3 and conclusion and discussion is offered in section 4.

The model

The model is a simplification of (Grafton 1992). Assume that use of effort in a typical fishing firm
\((e_i)\) depends on catch \((q_i)\) and abundance of fish at the fishing ground as measured by the indicator, \(b\), in
the following manner:

\[
e_i(s, \pi, q) = \begin{cases} 
\frac{1}{s^2 b^2} q_i^2 & \text{with probability } \pi \\
\frac{1}{b^2} q_i^2 & \text{with probability } 1-\pi 
\end{cases} \quad (1)
\]

Here the parameter \(s\) is a productivity factor common to all firms, \(s \leq 1\). The bigger is \(s\) the less
effort is needed in order to bring a given quantity of catch a shore, cet.par. Decisions regarding the size
of the operation in terms of intended catch are taken prior to the revelation of \(s\). The fishery is regulated
by a yearly Total Allowable Catch (TAC) and Individual Transferable Quotas (ITQs). Hence, the
manager of the fishery firm must decide how much quota to buy before the true productivity of the fishery
technique available is known.

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

In a steady state situation the discounted value of the profit of representative first unit firm can be
written as:

\[
H_1 = \frac{1}{r} \left[ P q_i - c E e_i(s, \pi, q) - r \Gamma q_i \right] 
\]

Here, \(H_1\) denotes the expected discounted value of the steady state profits from operation of the
fishing unit. The variable \(r\) denotes the discount rate, \(P\) is the unit price of output, \(E\) is the expectation
operator and \(r \Gamma\) is the rental value of quotas utilized by the fishing unit. The variable \(c\) denotes the unit
cost of effort. The steady state value of profits in the second unit can be written as
Here, $A_i$ is the initial allotment of quotas to the firm and $\alpha_i$ is the share of Total Allowable Catch allotted to the firm for free. We have that $0 \leq \sum_i \alpha_i = \alpha \leq 1$. Should the fishery manager auction the ITQs to the highest bidder, then $\alpha = 0$. That parameter would be one if current vessel owners were grandfathered into the system at the outset. Any form of rent-recovery or politically orientated allotment of quotas on behalf of the fishery manager would result in the parameter being somewhere in between the extreme values zero and one.\(^3\) Steady state catch and steady state TAC are given by:

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

Equation (4) is the equilibrium condition for the fishing stock and is similar to equation (3) in (Grafton 1992). The right hand side of (4) describes (annual) growth of the fishing stock under consideration. The variable $b$ is an index of size of the stock, $B$ is a scalar while $\bar{b}$ is sometimes referred to as a measure of the carrying capacity of the environment. The form of the function implies that growth is fastest for stocks that are neither too small nor too large. Small stocks might not produce enough recruits to sustain the size of the stock while large stocks might endure low fertility due to high use of energy for basic survival.

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

$$\Gamma = \frac{P}{r} - \frac{2c}{rb^2}\left(1 - \pi\left(1 - \frac{1}{s^2}\right)\right)q_i$$

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

$$\Gamma = \frac{P}{r} - \frac{2c}{rb^2}\left(1 - \pi\left(1 - \frac{1}{s^2}\right)\right)\sum_i q_i$$

Taking the equilibrium condition (4) into account further yields:

$$\Gamma = \frac{P}{r} - \frac{2c}{rb^2}\left(1 - \pi\left(1 - \frac{1}{s^2}\right)\right)TAC$$

Aggregated profit in the fishing operation can now be written as:

$$H1 = \sum_i H1_i = \frac{c}{rb^2}\left(1 - \pi\left(1 - \frac{1}{s^2}\right)\right)TAC^2$$

Aggregated profit in the quota holding part of the fishing sector can be written as:

$$H2 = \sum_i H2_i = \alpha \frac{P}{r}TAC - \alpha \frac{2c}{rb^2}\left(1 - \pi\left(1 - \frac{1}{s^2}\right)\right)TAC^2$$

Aggregate profit in fishing and quota holding is simply given as:

\(3\) Owners of vessels regulated by ITQs in Iceland (the owners of “large” vessels) claim that owners of small boats have used their political clout in order to increase their share. That effect could be accounted for in the present model by assuming that the share of TAC available for the big vessel owners would be equal to $\alpha$.\(^3\)
\[ H = H_1 + H_2 \]  

(10)

We are now ready to proof the central propositions of the paper:

**Proposition 1:** The value of the fishing operation part of the fishing enterprise is reduced as the likelihood of cost-saving technical progress increases.

**Proof:** Differentiate \( H_1 \) with respect to \( \pi \):
\[
\frac{\delta H_1}{\delta \pi} = -\frac{c}{rb^2} \left( 1 - \frac{1}{s^2} \right) TAC^2 < 0. 
\]
The reported result is a consequence of the fact that the production function of each fishing firm exhibits decreasing returns to scale and the influence of uncertainty with respect to technical progress. Technical progress will bring the production function closer to constant returns to scale. Hence, increased technical progress gives lesser scope for intramarginal rents. Lower marginal cost drives up the price of quota permits.

**Proposition 2:** The value of the quota-holding part of the fishing enterprise increases as the likelihood of cost-saving technical progress increases.

**Proof:** Differentiate \( H_2 \) with respect to \( \pi \):
\[
\frac{\delta H_2}{\delta \pi} = \alpha + \alpha c \frac{c}{rb^2} \left( 1 - \frac{1}{s^2} \right) TAC^2 > 0. 
\]
The economics of this result are identical to the economics explaining Proposition 1. Note that if \( \alpha > 0 \) then the fishing firm will only enjoy part of the increase in quota values. The other gaining party is the “rent-collector” be that the fishery manager or some other party.

**Proposition 3:** If \( \alpha < 1 \) then the value of the overall operation of a fishing enterprise will decrease as the likelihood of cost-saving technical progress increases.

**Proof:** Differentiate \( H \) with respect to \( \pi \):
\[
\frac{\delta H}{\delta \pi} = (\alpha - 1)\left( \frac{c}{rb^2} \right) \left( 1 - \frac{1}{s^2} \right) TAC^2 < 0. 
\]
Note that the value of the overall operation will be unchanged should \( \alpha = 1 \). Hence, the reduction in fishing-firm value is identical to increase in the value of rent collected by the rent collector.

**Corollary 1:** If \( \alpha = 1 \) then the value of the overall operation of a fishing enterprise will not be affected when the likelihood of cost-saving technical progress changes.

**Proof:** Consult proof of proposition 1.

**Proposition 4:** Assume that stock-size and sustainable TAC increases. Then value of quota permits will increase

**Proof:** Insert (4) in (7) and differentiate with respect to \( b \):
\[
\frac{\delta \Gamma}{\delta b} = \left\{ B \left( \frac{c}{rb^2} \right) \left( 1 - \frac{1}{s^2} \right) \right\} \left( 1 - \pi \right) Bb \frac{b^2}{b^2} - b. 
\]
We require that
\[
\frac{\delta TAC}{\delta b} = B(b - 2b) > 0 \implies b < \frac{B}{2}. 
\]
Hence, if the TAC is increased because of increase in stock size and the stock is “small” at the outset, then the overall effect will be to increase the quota price. Note that the conclusion would be reversed if the size of the stock is in excess of maximum sustainable yield (MSY).

**Proposition 5:** Assume that stock-size and sustainable TAC increases. Then value of the fishing operation will be reduced
Proof: Insert (4) in (8) and differentiate with respect to $b$:

$$\frac{\delta H_1}{\delta b} \bigg|_{TAC=bb(\bar{b}-b)} = -\frac{2cB^2}{r} \left(1 - \pi \left(1 - \frac{1}{s^2}\right) \right) (\bar{b} - b)$$

As before, we require that $\frac{\delta TAC}{\delta b} > 0 \Rightarrow \bar{b} - 2b > 0$ and $\bar{b} - b > 0$. Hence, $\frac{\delta H_1}{\delta b} \bigg|_{TAC=bb(\bar{b}-b)} < 0$.

Proposition 6: Assume that stock-size and sustainable TAC increases. Then value of the quota-holding part of the fishing firm will be increased.

Proof: Insert (4) in (9) and differentiate with respect to $b$:

$$\frac{\delta H_2}{\delta b} \bigg|_{TAC=bb(\bar{b}-b)} = \frac{\alpha P}{r} (\bar{b} - 2b) + \frac{4\alpha cB^2}{r} \left(1 - \pi \left(1 - \frac{1}{s^2}\right) \right) (\bar{b} - b)$$

As before, we require that $\frac{\delta TAC}{\delta b} > 0 \Rightarrow \bar{b} - 2b > 0$ and $\bar{b} - b > 0$. Hence, $\frac{\delta H_2}{\delta b} \bigg|_{TAC=bb(\bar{b}-b)} > 0$.

Proposition 7: Assume that stock-size and sustainable TAC increases. Then value of the overall operation of the fishing enterprise will increase or decrease depending on the size of the rent-collection parameter $\alpha$.

Proof: Combine the proofs of Propositions 6 and 7 and note that

$$\frac{\delta H}{\delta b} \bigg|_{TAC=bb(\bar{b}-b)} = \frac{\delta (H_1 + H_2)}{\delta b} \bigg|_{TAC=bb(\bar{b}-b)} > 0 \text{ if } \alpha = 1 \text{ and that } \frac{\delta H}{\delta b} \bigg|_{TAC=bb(\bar{b}-b)} < 0 \text{ if } \alpha = 0.$$

Proposition 8: The value of quotas increases as the likelihood of technical progress increases.

Proof: Differentiate (7) with respect to $\pi$.

A stock-market analyst/trader and a quota-market trader may have differences of opinion regarding the probability of technical progress as well as the likely development of future TAC. Furthermore, some stock-market analysts might be more interested in future income-earning potential of a fishing firm than in its asset value. Following scenarios might produce the pattern of implicit and explicit quota prices observed in Iceland.

Proposition 1 indicates that a careful analyst would see cash-flow from the fishing-operation of the fishing enterprise reduced in time of unexpectedly rapid technical progress. Proposition 2 indicates that the value of the quota-holding part of the enterprise and thus the value of quotas would be rising fast. The increased value of the quotas might well be considered to be capital gains. Now, assume that the careful analyst keeps capital gains out of the equation when valuing fishing enterprises. Assume that other analysts do likewise. Then rapid technical progress in the fishing sector would be accompanied with reduction in fishing-firm stock values! Under these circumstances one would find that the implicit value of quotas (calculated from the stock-market value of quotas) differed from the explicit quota-market value of quotas. That difference is not sustainable in the long run. Hence, as stock-market shopping of quotas is more cost-effective than quota-market shopping one might suspect that well-informed actors with easy access to capital would utilize their knowledge and buy lesser informed fishing-firm stock-owners out.
Propositions 4-7 suggest that expectations regarding the future value of the TAC may be instrumental in the valuation of quotas and fishing firms. Hence, even if actors at the stock-market and actors at the quota-market used identical models to guide their evaluation efforts they might come to different conclusions regarding the future size of the TAC. Permit systems are usually introduced at times of crises, see (Mattisson 2003). Hence, TACs are usually far below their assumed long-term value initially. Thus, participants in the industry must base their valuation of quotas and firms on expected future values of TACs. Assume for sake of argument that traders at the quota-market are more optimistic than traders at the stock market. The reason for this difference could be that quota market traders had better knowledge of the marine biological facts and factors which are affecting the stock size of fish species or that the traders at the stock-market would hold the belief that politicians would not have the guts to pursue a conservation policy necessary to establish the long term goals of TAC. Such difference of opinion may seem unreasonable at the outset. The same person can change part from being a quota-market trader to being a stock-market trader in relatively short time assuming that s/he has good access to capital. This condition may seem trivial. But in a thin market with relatively few actors it may be less so. It should be kept in mind that the relevant markets, i.e. the stock market and the quota market are by law, to a certain degree, closed to firms that are not Icelandic. The implication of the fact that the markets in question are thin is that the law of one price will work slowly.

As indicated above it is likely that actors in the quota-permit market become actors in the stock-market. That is, that owners and/or managers of fishing firms buy other owners out. There is strong evidence that this is happening in the Icelandic market now, see (Arnason 2004).

To summarize it may be instrumental to envision three types of actors or possible actors. Firstly, think of a Fishing Firm Operator (FFO) who is optimistic regarding probability of technical progress in the fishing sector and also optimistic that the fishing stock and the TAC will be increased. Secondly, think of a Stock-Market Analyst (SMA) that takes the asset value of the fishing firm into consideration when considering the attractiveness of fishing firm stocks. The SMA is more pessimistic regarding the likelihood of technical progress than is the FFO. S/he also puts less faith into the effectiveness of fishery policy with regard to rebuilding stocks than would the FFO. Thirdly, think of a Stock-Market Analyst (SMI) that takes the future income potential of the fishing firm into consideration when evaluating fishing firms. S/he shares the opinion of the SMA in other respects. Further, assume that fishing rights were grandfathered so that \( \alpha = 1 \). Then, utilizing Corollary 1 and Proposition 7 we find that the FFO would be willing to value the fishing firm higher than both the SMA and the SMI. Furthermore, the SMA would be willing to value a fishing firm higher than a SMI given the scenario that has been envisioned. We also find, utilizing Propositions 4 and 8 that the FFO would value quota rights more highly than the stock-market analysts. Presumably the Fishery Firm Operator spends his days securing inputs for the fishing firm and selling its outputs. Securing inputs implies trading at the ITQ market. The Stock-Market Analysts would either be traders or advisors to traders at the stock-market. Given imperfections in the financial markets the above scenarios support the possibility for a temporary discrepancy between valuation of quotas at ITQ market and the implicit valuation of quotas as given by analyzing stock-market values of fishing firms.

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4 Only Icelandic citizens and Icelandic legal persons may conduct fishing operations within the Icelandic fisheries jurisdiction and Icelandic legal persons engaged in fisheries in Iceland must be controlled by Icelandic entities and are not under more than 25% ownership of foreign residents.
Empirical evidence

The National Economic Institute and later the Central Bank of Iceland have collected information about the price of permanent quotas. We have had access to this information. Should fishing rights be the only form of un-booked asset controlled by a fishing firm one could calculate the market value of that asset by finding the difference between the market value of the company and the value of stockholders equity (as stockholders equity represents the difference between the value of booked assets and liabilities). When collecting information from the financial statements of the publicly traded Icelandic fishing firms we encounter two problems: First, there can be non-booked assets other than fishing rights controlled by the firm. Examples of such assets are: Management know-how and strategy, development prospects, vision and style, geographical position, political goodwill etc. Secondly, the firms count quotas they have bought from other firms among other productive assets. We have taken care of correcting stockholders equity for booked ITQs. We are unable to correct for value of other non-booked assets but note that the existence of such assets should imply that our estimates of implicit price of quota is too high. Implicit price of quotas have to be calculated using the corrected market value of fishing firms (market value minus stockholders equity plus book value of purchased quota) and the quota units in kilos that the firm has at its disposition. Most of the above mentioned information is readily available from the financial statement of the fishing firms. Purchased quota can in some instances be included in the book value of a fishing vessel. This may happen if vessel and quota are bought and sold jointly. Care has been taken to correct for this.

The Directorate of Fisheries publishes kilos of allotted quotas per firm per species. Furthermore, an aggregated measure, cod-equivalence kilos is also published. The Directorate defines the cod-equivalence kilos in accordance with ex-vessel price of a given species relative to ex-vessel price of cod. We do not find this definition adequate for our purposes as this method assigns high cod-equivalence value to a hard to get and valuable species regardless of the value-added involved in hunting and on-vessel processing. Hence, we have re-defined cod-equivalences to be the relative price of within-the-year lease price of quota of a given species relative to the within-the-year lease price of cod quota. Thus, we assume that the within-the-year lease price reflects value-added related to each fishery. Our method will yield high cod-equivalence parameter to species that earn high first-hand price and are cheap to harvest. Species that are costly to harvest relative to first-hand price will be allotted a lower cod-equivalence parameter. Our method yields considerable lower cod-equivalence parameters than the Directorate of Fisheries method does in all cases but one. Confer Figures 1 and Table 2.
Figure 1: Cod-equivalences re-estimated using price of within-the-year lease price of quota relative to within-the-year lease price of cod-quota, selected species

Figure 2: Implicit price of kg of cod-equivalence for publicly traded Icelandic fishing firms, firms with high content of pelagic quotas and fabric trawlers
Figure 3: Implicit price of kg of cod-equivalence for publicly traded Icelandic fishing firms, traditional firms

Figure 4: Implicit price of kg of cod-equivalence for publicly traded Icelandic fishing firms, average
The difference between the market value of a fishing firm and (corrected) shareholder equity reflects the value of non-booked assets controlled by the firm. These assets can be of different origin: Management know-how, favorable geographical position, political good-will and the value of allotted fishing quotas. We can measure the size of the allotted fishing quota but not the size of the other potential sources of non-booked wealth. The results, shown as the implicit price of a kg of cod-equivalences in Figures 2 to 4 and Table 1, should be viewed with that caveat in mind.

The difference between the highest and the lowest price fluctuates from 60% in 1996/1997 to 230% in 2000/2001. It should be noted that stock-prices in general were highly inflated in 2000/2001 in Iceland. Thus the big difference between the highest and lowest implicit price of quotas might just reflect “irrational exuberance”. A common factor for the firms yielding high implicit quota values seems be that pelagic species are overrepresented in their quota-portfolio, a) they enjoy good cash-flow and high EBITDA as compared to the other firms, b) they use fabric-trawlers to catch and process their demersal and pelagic quota to large extent, c) they are more diversified, d) they have a management style that is considered to be successful by outside observers and e) they have relatively large pelagic quota. The last point implies that our method of estimating cod-equivalences yields lower estimates of allotted quotas for these firms than the method used by the Directorate for Fisheries. A common factor for the firms yielding low implicit quota values is that cod and other demersal species are the main stable of their quota-portfolio. They use “traditional” on-shore facilities to process the catch. It may also be pointed out that correlation between levels of implicit and explicit quota-market prices is low or negative!

We are thus lead to belief that investors do value fishing firms based on cash-flow, management strength and vision rather than portfolio of productive assets especially quota holdings. As indicated the stock-market value of a firm can easily become much lower than the accumulated value of its assets or the liquidation value. As expected we have seen both management buy-outs and take-over at price far over the stock-market value of stocks. And as the other side of the coin we have seen mergers and acquisitions at a price far below the value of the accumulated assets. One does expect that in the long run this process will eliminate or diminish the discrepancy between the implicit and explicit value of quotas. But that process seems to take very long time. It should be pointed out that the ceiling that has been put on quota-holding by a single firm can halt the process and also slow the drive towards increase in efficiency that was hoped that the quota system would stimulate.

Discussion and conclusion

We have shown that the implicit and the explicit price of ITQs in the markets for fishing-rights and for public stocks do not match. The theoretical model developed in the first part of this papers suggests that differences in expectation formed by stock traders and fishery managers with respect to the future development of the fishing firms may be the driving force behind the observed difference. This discrepancy will ultimately disappear if the present trend of withdrawal of fishing enterprises from the stock-market is continued until total withdrawal of fishing firms from public trade! Such a process would re-invoke the law of one price in the markets for quotas by eliminating the possibility of shopping for quotas at the stock-market!

---Figure 3 about here---

Recently, UA in the north of Iceland, one of the large fisheries companies, was sold at a price estimated to be 50% of the liquidation value. At the same time HB in Akranes, also one of the largest fishing firms in Iceland was merged with Grandi plc in Reykjavik at a price assessed to be one-half of the liquidation value.

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There is therefore reason to raise and seek answer to much wider question than the one addressed in this paper. Is it so that fishing firms are non-tradable at the stock-market when fisheries are managed by ITQs? Is it so that seeking capital through the stock-market will be much more costly than using other avenues? If those questions are answered in the affirmative it seems clear that fishing firms must yield higher than average return on invested capital than other firms. That is hardly welcome news to an industry facing bigger and bigger need for capital.

References:

Table 1: Implicit price of cod-equivalence permanent quotas, kronur per kg, by firm and by period

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Table 2: Re-estimated cod-equivalences, based on lease-price of quotas

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