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NOTE

A Note on Market Power in ITQ Fisheries

LEE G. ANDERSON

College of Marine Studies and Department of Economics, University of Delaware, Newark, Delaware 19716-3501

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Individual transferable quotas, ITQs, in fisheries are analogous to transferable pollution permits in environmental policy. However, they are different in that the right to produce is for the final product, the fish, whereas pollution permits are for a non-market joint product (i.e., sulfur dioxide) of the good produced for sale. In both cases, the actual economic efficiency effects of creating the property rights depend upon the workings of the market for both the final product and the rights. There has been considerable work on market failures for pollution permits, and this paper extends the analysis to ITQs. It is shown that the difference between pollution permits and ITQs can change the type and occurrence of failure in the market for the final product, but it does not affect the potential for failure in the market for permits. © 1991 Academic Press, Inc.

INTRODUCTION

Individual transferable quotas, ITQs, in which transferable rights to harvest specified amounts of fish are granted to individuals, are being adopted in several fisheries throughout the world and are being considered for many others (Neher *et al.* [5]). The economic rationale for such a system is that individuals will be motivated to produce the fish as efficiently as possible, and, given market incentives, trades will take place such that the most efficient operators utilize the rights.

However, fisheries managers have been concerned that ITQs may pave the way for monopoly market failures. This was a question which was raised at every public hearing the Mid-Atlantic Fishery Management Council held for the ITQ program in the surf clam and ocean quahog fishery [3] and at meetings of other councils as they considered ITQ management [1, 6].

The purpose of this note is to analyze the potential effects of market power on both the market for ITQs (the rights to take a certain amount of fish) and the market for the final product (the fish). The analysis is based on earlier work on the market for pollution rights by Hahn [2] and Misiolek and Elder [4]. The former has shown that the allocation of permits will have an effect on the type and severity of market failure in the utilization of permits. The latter follow Hahn in describing failure in the permit market (called cost minimization manipulation, CMM) and in addition use the industrial organization literature to describe a type of failure in the market for the final output called exclusionary manipulation, EM. The current paper demonstrates that although the differences between ITQs and pollution permits will not affect the opportunities for CMM, they will affect the type and occurrence of failure in the product market.

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Fisheries ITQs are different than pollution permits because the right to produce is for the marketable product (fish) rather than for a waste product that is jointly produced with a market product. The difference provides for different results in the analysis of failure in the output market. Misiolek and Elder [4, p. 156] show that with pollution rights a dominant firm can force increases in market price by increasing the production costs of actual or potential competitors through strategic market manipulation of permit price. This is due to the jointness in production between the market product and the pollution causing residual. Both the amount of permits used by a firm and the price paid for them will affect total production costs. This is not simply because the total expenditure on permits goes up, but because the marginal cost of producing market output will vary depending upon the allowable level of the residual. The fact that market output, and hence cost, of a firm can vary with a given amount of pollution rights is an important distinction.

Because the ITQ is a right to produce a certain amount of the market product, manipulation in the final product market can be more direct. The dominant firm does not have to affect the cost curves of other firms to affect market price. It can simply not use some of its production rights. Total output in the market will fall and market price will increase. This can be called output price manipulation, OPM.

The model confirms the previous result that market power can cause an inefficient allocation of production among firms and demonstrates for the first time that with ITQs a specific type of market power inefficiency can occur in the output market, but only in certain circumstances.

THE MODEL

Assume that a fishery, the output of which faces a downward sloping demand curve, is managed by ITQs. Assume further that the fleet consists of one dominant firm and a competitive fringe of other firms that act as price takers. Under open access or traditional means of regulation, the ability of the dominant firm to set price is limited by the ability of other firms to enter if profits become large enough. With ITQs the total output of the fishery is limited and so, at least in theory, the dominant firm could restrict output to raise market price.

The analysis is static and it is assumed that $\bar{Q}$ is the number of ITQ units in the fishery each year. In terms of the traditional fisheries analysis, $\bar{Q}$ is the total allowable catch, the TAC. Let Q_1 represent the number of ITQ units the dominant firm uses to produce marketable output. In addition, let Q_2 represent the ITQ units the dominant firm holds off the market in order to raise the price of the marketable output. The amount of quota available to the competitive fringe will be $\bar{Q} - Q_1 - Q_2 = Q_3$.

Let the inverse demand curve for the final product be

$$P = P(Q). \tag{1}$$

This means that the base price $P(\bar{Q})$ will be determined by the size of the TAC. If the dominant firm elects to own ITQ units but not use them, then the market price will be $P(\bar{Q} - Q_2)$. If $\bar{Q}$ is fixed, the price function becomes

$$\bar{P} = \bar{P}(Q_2), \tag{2}$$

where

$$\frac{d\bar{P}}{dQ_2} > 0. \tag{3}$$

The equilibrium condition in the competitive fringe will be

$$\bar{P}(Q_2) - \mathrm{MC}_3(Q_3) = R, \tag{4}$$

where $\mathrm{MC}_3(Q_3)$ is the sum of their upward sloping marginal cost curves and R is the price of annual ITQ units which they take as given.

Equation (4) is the basis for the supply price of ITQ units for the dominant firm because, at the margin, it will have to bid ITQ units away from the competitive fringe. The difference between the price of fish and their marginal cost of obtaining it is the profit the competitive fringe will make on the marginal unit of output. Hence, it represents what the competitive fringe will be willing to pay for the right to produce a marginal unit. If the dominant firm is to purchase ITQ units, it will have to match their bids. The supply price is thus

$$R(Q_1, Q_2) = \bar{P}(Q_2) - \mathrm{MC}_3(\bar{Q} - Q_1 - Q_2). \tag{5}$$

The amount the dominant firm has to pay for ITQ units varies with the amount it purchases but there will be different effects for purchases of Q_1 and Q_2:

$$\frac{\partial R}{\partial Q_1} = -\overset{(-)}{\frac{\partial \mathrm{MC}_3}{\partial Q_1}} > 0 \tag{6}$$

$$\frac{\partial R}{\partial Q_2} = \overset{(+)}{\frac{d\bar{P}}{dQ_2}} - \overset{(-)}{\frac{\partial \mathrm{MC}_3}{\partial Q_2}} > 0. \tag{7}$$

Because the sum of dQ_1 and dQ_2 must equal $-dQ_3$, the marginal cost terms in (6) and (7) have the indicated signs. A change in Q_1 will increase R because the marginal unit available to the competitive fringe is more valuable, and so the dominant firm will have to pay more to bid it away. The same effect holds for an increase in Q_2, but in addition the increase in the price of output further increases the value of the marginal ITQ unit.

The analysis is different depending upon whether the dominant firm is a net purchaser or seller of ITQs and each is analyzed below. For simplicity the extreme cases are used, but the results are generalized.

Dominant Firm Initially Owns No ITQs

The profit function for the dominant firm which must buy ITQ units before it can produce is

$$\pi = \bar{P}(Q_2)Q_1 - \mathrm{TC}_1(Q_1) - R(Q_1 + Q_2)[Q_1 + Q_2], \tag{8}$$

where TC_1 is its total cost function for Q_1.

The first-order condition for Q_1 is

$$\frac{\partial \pi}{\partial Q_1} = \bar{P}(Q_2) - \mathrm{MC}_1(Q_1) - R - \frac{\partial R}{\partial Q_1}(Q_1 + Q_2) = 0. \tag{9}$$

This condition will guarantee that the cost of obtaining quota is minimized for the dominant firm. However, by comparing Eqs. (4) and (9) it can be seen that the ITQ units will not be allocated among all firms such that the cost of producing the TAC is as low as possible. $\mathrm{MC}_3(Q_3)$ (the cost of the marginal unit in the competitive fringe) will be greater than $\mathrm{MC}_1(Q_1)$ (the cost of the marginal unit in the dominant firm). The overall industry cost of producing the TAC could be lowered by shifting production to the dominant firm. The dominant firm has monopsonistic powers in the market for ITQ units and it will buy too few of them; there will be too much production in the competitive fringe. This is an example of cost minimization manipulation. (See Misiolek and Elder [4, p. 157].) Note that this result holds even if the price of output is fixed.

By translating Hahn's results from pollution permit models [2, p. 75], it can be shown that the same results follow when the dominant firm is only a net purchaser of ITQ units. If the initial allocations of ITQ units to the dominant firm, $\bar{Q}_1$, and the competitive fringe, $\bar{Q}_3$, are such the following condition holds,

$$P(\bar{Q}) - \mathrm{MC}_1(\bar{Q}_1) = P(\bar{Q}) - \mathrm{MC}(\bar{Q}_3), \tag{10}$$

then if each firm produces its initial allocation, the cost of producing the TAC will be minimized. Therefore, no trades will take place and CMM will not occur. Let $\bar{Q}_1^*$ and $\bar{Q}_3^*$ represent these optimal initial allocations to the dominant firm and the competitive fringe, respectively. If $\bar{Q}_1$ is positive but less than $\bar{Q}_1^*$, the profit function in (8) is changed because the dominant firm must purchase only some rather than all of the ITQ units it uses. Similarly, the first-order condition with respect to Q_1 will be different in that the change in R will only apply to those ITQ units which are purchased. Therefore, the monopsonistic increase in the price of ITQ units will have a smaller effect, but it will be positive nonetheless. As Hahn points out, the less the divergence between actual allocation and that described by Eq. (10), the lower the inefficiency loss from CMM.

Consider now the possibility of output price manipulation. The first derivative of the profit function with respect to Q_2, the ITQ units used to restrict market output, is

$$\frac{\partial \pi}{\partial Q_2} = \frac{d\bar{P}}{dQ_2}Q_1 - \frac{\partial R}{\partial Q_2}(Q_1 + Q_2) - R = 0. \tag{11}$$

If output price manipulation is to be profitable, the gain in revenue from the increase in market price must be greater than the increase in cost due to the increased purchase price of ITQs for all units utilized plus the cost of the last ITQ unit. Further, the purchase of ITQ to reduce market production should continue until the net benefit from doing so falls to zero.

Using Eq. (7), the above becomes

$$\frac{d\bar{P}}{dQ_2}Q_1 - \frac{d\bar{P}}{dQ_2}Q_1 + \frac{\partial \mathrm{MC}_3}{\partial Q_2}Q_1 - \frac{\partial R}{\partial Q_2}Q_2 - R = 0. \tag{11'}$$

Because the first two terms cancel out, it can be seen that the gain in revenue from the increase in product price is lost in the increase in ITQ unit price. The remaining three terms are all negative, and therefore there are no gains from reducing the production of the market product. The profit maximizing dominant firm which must purchase ITQs will not find it beneficial to withhold production to raise the price of the market output. The first-order profit maximizing condition for Q_2 is negative for all positive levels of Q_2. Purchasing Q_2 to restrict output and increase price will always result in decreased profits. In this case, it appears that fishery managers' fears about output price manipulation are ill founded.

Dominant Firm Initially Owns All ITQs

If the dominant firm owns all of the ITQ units, its profit function becomes

$$\pi = \bar{P}(Q_2)Q_1 - \mathrm{TC}(Q_1) + R(Q_1, Q_2)(\bar{Q} - Q_1 - Q_2).$$

The firm can earn revenue by using the ITQ units to produce fish or to restrict market output and by selling them to other producers. The first-order derivative with respect to Q_1 is

$$\frac{\partial \pi}{\partial Q_1} = \bar{P}(Q_2) - \mathrm{MC}_1(Q_1) - R + \frac{\partial R}{\partial Q_1}(Q_3) = 0. \tag{12}$$

Comparing (4) and (12) it is again obvious that the ITQ units will be misallocated among firms because $\mathrm{MC}_3(Q_3)$ (marginal cost in the competitive fringe) is less than $\mathrm{MC}_1(Q_1)$ (marginal cost in the dominant firm). This is the reverse of the previous situation. The dominant firm will have monopolistic powers in the market for ITQ units and it will sell too few of them; there will be too little production in the competitive fringe. As before, the same general results with respect to CMM follow if the firm is a net seller of ITQs, even if it does not own all of them. The severity of the market failures will be less, but they will be present nonetheless.

The first-order condition with respect to Q_2 in this case is

$$\frac{\partial \pi}{\partial Q_2} = \frac{d\bar{P}}{dQ_2}Q_1 + \frac{\partial R}{\partial Q_2}Q_3 - R = 0. \tag{13}$$

The increase in price of the marketable output caused by reducing production benefits the dominant firm in two ways. Revenue from market output and revenue from the sale of ITQ units will both increase. (In the previous case, these two effects worked against each other because the firm had to buy ITQs.) If the sum of these gains is greater than the profit earned from using a unit of ITQ, the firm will find it profitable to engage in output price manipulation.

SUMMARY

The conclusions of this analysis can be summarized quite succinctly. If there is a dominant firm in a fishery with ITQ management, market inefficiencies can result. If the initial distribution of the ITQs is such that the dominant firm is a net purchaser of quota rights, cost minimization manipulation in the market for ITQs will take place. The dominant firm will purchase too few ITQ units. However, because any increase in the price of the marketable output will be transferred into an increase in the purchase price of ITQs, output price manipulation in the output market will not be profitable.

If the initial distribution is such that the dominant firm is a net seller of quota, CMM will take place and the dominant firm will sell too few ITQ units. In addition OPM is possible because increases in output price will benefit both market revenue and the selling price of ITQ units.

These results are different from those in the case of exclusionary manipulation with pollution permits. Misiolek and Elder [4] show that that form of failure in the output market will occur whether the dominant firm is a net buyer or net seller of permits.

The results are interesting given the concerns expressed by policymakers. Although there is considerable concern about market failure in the fish market, it will only occur if the dominant firm is a net seller of ITQs. But although fishery managers show little concern for cost minimization manipulation, given a dominant firm, it will take place in one form or another unless there is a specific initial distribution of ITQs. Further, since in the real world initial quota distributions are normally based on historical catches and/or vessel size and not economic efficiency considerations, it is unlikely that the necessary distribution will occur.

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