Tilburg University

Open access, common property and scarcity rent in fisheries

Bulte, E.H.; Folmer, H.; Heijman, W.J.M.

Published in:
Environmental and Resource Economics

Publication date:
1995

[Link to publication in Tilburg University Research Portal](#)

Citation for published version (APA):
Bulte, E. H., Folmer, H., & Heijman, W. J. M. (1995). Open access, common property and scarcity rent in fisheries. *Environmental and Resource Economics*, 6(4), 309-320.

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Open Access, Common Property and Scarcity Rent in Fisheries

ERWIN BULTE, HENK FOLMER and WIM HEIJMAN

Wageningen Agricultural University, Department of General Economics, P.O. Box 8130, 6700 EW Wageningen, The Netherlands

Abstract. Open access resources are frequently not managed efficiently, resulting in falling stock levels and a declining income for fishermen. In the late 1970's, the policy response to this problem was the implementation of 200-mile fishing zones, which enabled the European Union to formulate and implement the Common Fisheries Policy, aimed at (among other things) conservation and distribution of available stocks. In Germany, this shift from an open access regime towards a common property regime had favourable outcomes. The trend of falling prices was reversed. The conclusion was that intertemporal efficiency had increased as a result of (inter)governmental policy. Apparently, a wedge was formed between price and marginal harvesting costs, implying that scarcity rent had returned as a component of prices.

Key words: Renewable resources, open access, common property, scarcity rent, rent dissipation, Common Fisheries Policy

1. Introduction

For a long time, marine fisheries in Europe and elsewhere in the world were managed as open access¹ resources. The outcome of open access management, however, was far from sustainable and efficient. Although global fish catch in tonnes did not decline until 1990, the composition of species changed substantially. Valuable species, such as herring and flounder, were replaced by less valuable ones such as skates and dogfish. In addition, the catch declined in several major fishing areas and fishermen's incomes were depressed.

Economic theory predicts that under conditions of open access, a natural resource will be exploited at such a pace that the scarcity rent dissipates completely and that, eventually, total costs equal total revenues (Gordon, 1954; Schaefer, 1957; Bjorndal and Conrad, 1987). Open access implies that, as long as there is an excess profit, new entrants are attracted, thereby reducing overall profits. The rationale for rent dissipation is that no fisherman is willing to 'invest' in stock maintenance since the expected benefits are likely to be reaped by others.² Also, other drawbacks of open access resource management have been documented. First, the fish stock is often severely depleted, and extinction may be the result. For instance, Spence (1973) found that the stock of blue whales was reduced to undesirable levels because of the open access character of the species.³ Second, in addition to lost profit and possible stock

extinction, open access fisheries usually result in an inefficient structure of the fishing industry, as is argued by for instance McKelvey (1983) and Lipton and Strand (1989).

It is now widely recognized that open access results in biologically and economically suboptimal outcomes. That is why nowadays fisheries are regulated. Iceland and Norway were the first European countries to declare a substantial exclusive fishing zone. In 1977 the European Union followed this initiative and declared sovereign rights within a 200-mile zone, thereby anticipating the 1982 Law of the Sea Convention.⁴ By establishing exclusive zones, it was expected that the open access characteristics of marine resources would be reduced. In fact, the open access regime was replaced by a common property regime, under which a group of owners was expected to regulate exploitation. This exclusive zone has been very important to the European fishery. The nine Atlantic E.U. member states produce more than 5 million tonnes of fish every year, over 80% of which are harvested in the exclusive zone (Saltz, 1991).

To be effective, a conservation policy must be pursued for the entire area inhabited by the fish stocks concerned. Since 1977 such an area has existed for the European Union. It was, however, not until 1983 that the Common Fisheries Policy (CFP), which aimed at both the distribution of fish stocks among member states and the maintenance of the stocks, was implemented.⁵ Total Allowable Catches (TACs) were determined, based on biological considerations, and then divided among member states. These states in turn allocate the national quota to their fishermen. There are differences, however, in how individual countries do this. In some countries, fishermen are allowed to harvest until the national quota is reached, while in other countries fishermen are allotted individual quotas, possibly transferable ones. It should be observed that there are no exclusive zones within the European Union zone, and that in principle each member state has access to any area within this zone. Initially the TACs were fixed at levels which corresponded with existing catches. The levels of the catches have been reduced in a stepwise manner. Likewise, there has been a shift in the structural policy from stimulating vessel construction to reducing fishing capacity in Union waters (Holden, 1994).

According to Schmidt (1993), measures taken to halt overfishing and make fisheries efficient have been largely unsuccessful. Recent research has provided evidence for this proposition. According to estimates of the F.A.O. of the United Nations, the global revenue loss because of inefficient fisheries is in the order of US\$ 15–30 billion per annum. The income foregone because of suboptimal fisheries management in the European Union alone amounts to about US\$ 2.5 billion annually (Schmidt, 1993). Holden (1994) argues that the CFP suffers from four major defects. First, the CFP has not been conceived as a coherent, integrated policy. Conflicting objectives arose, for instance, between the structural and conservation policies. Second, the policy has no specific objectives which hampers effective implementation. Third, the

fundamental basis has been biological rather than economic, and fourth, the policy suffers from the decision-making processes of the Union where every decision is a political compromise.

In this paper, we discuss a small aspect of the CFP. The effectiveness of regulation in terms of the return of rent in Germany is analyzed. The main objective was to test whether shifting from an open access management regime to a common property regime enhanced intertemporal efficiency. It should be observed that, in contrast to most of the analyses of rent dissipation, this paper on rent return was based on empirical data.

The paper is organized as follows. In section 2, the notion 'scarcity rent' is explained briefly. In addition, the method applied to test the main hypothesis is described. Section 3 is a case study of German fisheries. The results illustrate that government policies produced some beneficial effects. In section 4 conclusions are drawn.

It should be borne in mind that this paper fits in the Schaefer (1957) tradition (as opposed to the age-class approach) since the biological processes driving the fish population are not explicitly considered here. Furthermore, no attempt was made to model processes of production and consumption of the resource. Instead, resource scarcity issues were dealt with exclusively by regarding the outcomes of the underlying processes. Observations of prices (which reflect the outcome of harvesting and demand) were combined with assumptions regarding harvesting costs, in order to draw conclusions about scarcity rent over time.

2. Scarcity Rent in Fisheries

Under the assumption of constant extraction costs per unit of fish and constant demand for fish, implementation of effective policy in the case of marine fisheries will result in a U-shaped price path. First, in the absence of governmental control and with abundant stocks, a pure profit is made. Then, as more and more new entrants appear, dissipation of rent occurs until price per unit equals harvesting costs per unit (phase 1 in Figure 1). For a certain period of time, prices are expected to equal marginal costs. During this period possible future benefits of harvesting are completely disregarded and 'over-fishing' is likely to occur (phase 2). If the government intervenes successfully, prices will go up and rent may return (phase 3). Finally, the rent increase will tail off and settle at a level determined by marginal costs and government regulation (this phase is not included in Figure 1). Under these (strong) assumptions, testing of effective government policy is straightforward, and essentially comes down to analyzing whether such a U-shaped pattern actually exists.

The assumption of constant marginal harvesting costs, however, may be too simple. First, it can be expected that technological developments constantly reduce the cost per unit of catch (bigger trawlers, new technologies for

Fig. 1. Constant marginal harvesting cost and a U-shaped price path implies increased efficiency as a result of government regulation. The shaded area indicates scarcity rent.

detecting and harvesting). Second, it can be expected that as the stock of fish declines, the costs of harvesting a unit of fish go up. These are thus countervailing effects. Therefore some additional assumptions are needed to empirically analyze policy effects.⁶ They are discussed below.

In fisheries theory, it is common to distinguish between schooling fisheries and searching fisheries. Some fish populations have a propensity to school in large numbers during the course of migration or reproduction activity, or as a defence against predators. Well-known examples are salmon, mackerel, anchovies and herring. The widespread use of modern fish-finding devices makes locating schools easy and cheap, even when (because of overfishing) the stock is small. From this follows that in the case of schooling fisheries, the marginal harvesting costs decline over time, though at a decreasing rate.

In the case of searching fisheries the stock of fish (the population level) contributes significantly to the harvesting costs. Examples are cod, plaice and sole. In this case there are two opposing tendencies. First, ongoing innovations constantly reduce the cost of effort⁷ (although possibly at a declining rate), which lead to a constant downward pressure on marginal harvesting costs.

Fig. 2. Marginal harvesting cost for searching and schooling fisheries.

Second, there is the increase in harvesting costs owing to increased scarcity. The resulting marginal harvesting cost curve is likely to be U-shaped. The marginal harvesting costs of both schooling and searching fisheries are depicted below in Figure 2.

The assumptions made so far about marginal harvesting costs enable us to say something about the price path. For searching fisheries, it is U-shaped because of the U-shaped pattern of marginal costs. If scarcity rent returns because of successful policy intervention, the rate of price increase must be sharper than can be expected on the basis of the 'naturally' increasing marginal costs, since the rent drives a wedge between price and (rising) marginal harvesting costs. This is illustrated in Figure 3, where the moment of policy intervention is indicated as t^* . If the parameters of the harvesting cost function are assumed to be constant over time,⁸ the policy effect can simply be measured by comparing the actual price increase in the common property period with the price increase on the basis of the 'natural' development (as estimated for the open access period).

For schooling fisheries, increased scarcity is expected to have a minor effect on harvesting costs. Therefore prior to policy implementation, the price is expected to fall constantly, although possibly at a declining rate, implying a convex, downward price path. Because of shifting from open access towards common property, policy intervention, if successful will drive a wedge between price and marginal harvesting costs. The resulting price path can thus be

Fig. 3. Price and marginal harvesting cost for a searching fishery.

convex downward, horizontal and U-shaped, but it should be upwardly biased compared with the pre-policy period (see Figure 4 for an example).

The most general function describing a U-shaped price path is (1), where α_1 is negative and α_2 positive.⁹

$$P_t = \alpha_0 + \alpha_1 t + \alpha_2 t^2 \quad (1)$$

The simple model is applied to both schooling (herring, mackerel) and searching fisheries (cod, haddock, plaice and flounder). Based on the above-mentioned considerations with respect to marginal harvesting costs, α_2 is expected to be smaller for the schooling species.

3. Case Study: German Fisheries

The hypotheses formulated in the previous section were tested for Germany, which was selected because of the availability of data.¹⁰ The analysis was confined to six important commercial species: herring, mackerel, plaice, flounder, haddock and cod. Annual national statistics for the period 1967–1991 served as sources of data. The German fishery sector experienced some major changes in the 1980's. More specifically, the sector shrank by about 60%, partly

Fig. 4. Price and marginal harvesting cost for a schooling fishery.

because harvesting in the Northern Atlantic was restricted after implementation of the 200-mile exclusive zone.

The period considered might seem strange at first sight. After all, open access has long existed, which would support the hypothesis that a substantial part of the rent had vanished before 1967. A closer examination of the history of fishing, however, shows that global fish catch really increased from the fifties onward (see World Resources Institute, 1993). This also holds for Germany. The short period under consideration might thus be justified by the fact that large scale fishing operations are a relatively recent phenomenon. In addition, the increase of global fish catch from 1967 to the late eighties indicates that marine fisheries were profitable and attracted new capital continuously. This implies that in particular in the beginning of the 1967–1991 period, it must have been possible to capture a rent (although it should be taken into account that European subsidies in the framework of the structural policies may have had some distortionary effects).

The policy effect will be analyzed by estimating model (1) on the basis of the data set for the open access period (1967–1982) and by comparing the actual p_t and predicted $\hat{p}_t$ for t after 1983 in terms of the studentized residuals. $\hat{p}_t$ is predicted on the basis of model (1) estimated for the open access

period only.¹¹ A studentized residual smaller than 2 in absolute value is taken as an indication of no policy effect. Since there was no clear-cut moment of policy intervention and because of possible time lags for biological reasons (see Holden, 1994), policy effects were not expected to materialize immediately after 1983 when the CFP took shape. This uncertainty about the timing of the policy effects will be dealt with as follows. For each observation beyond 1982 with a studentized residual smaller than 2 in absolute value, it is assumed that the policy effect has not yet materialized. The observation is added to the open access data set and the procedure is repeated for the next observation. If from a given year onward a sequence of studentized residuals larger than 2 shows up, we will conclude that significant policy effects have materialized in that particular year.

The following results were obtained. First, estimating model (1) for the entire period gives significant negative coefficients for α_1 and significant positive estimates of α_2 for all the species selected. The expected U-shape as described in the previous sections is thus found. (The model is not presented here.)

Second, Table I shows the estimated quadratic price paths for the selected fish species in Germany. Figures in brackets below the coefficients are t -values. A t -value larger than two in absolute value is considered to be significant.

Table I. Regression estimates for the price paths of selected fish species in Germany.

	Herring	Mackerel	Haddock	Cod	Plaice	Flounder
α_0	0.51 (7.56)	0.54 (8.37)	0.12 (15.5)	1.53 (11.2)	1.18 (14.1)	1.16 (13.7)
α_1	0.03 (2.35)	0.005 (3.60)	0.002 (1.24)	-0.099 (-3.35)	0.025 (1.28)	-0.026 (-1.31)
α_2	-0.002 (-3.71)	-0.002 (-3.91)	-0.002 (-1.91)	0.004 (2.72)	-0.002 (-1.91)	0.0005 (0.56)
ρ	0.34 (1.32)	-0.023 (-0.91)	0.18 (0.65)	0.09 (0.33)	0.25 (0.96)	0.29 (1.25)
Log.lik.	41.9	30.8	19.8	92.4	36.0	29.2
SR(83)	0.29	1.94	0.33	0.30	0.73	-1.42
SR(84)	0.03	0.53	0.59	0.04	0.25	0.69
SR(85)	0.76	-0.40	2.57*	0.95	2.02*	0.46
SR(86)	2.70*	0.35	6.01	2.73*	5.17	3.28*
SR(87)	4.68	3.13*	8.52	3.80	8.96	6.14
SR(88)	4.04	5.68	7.88	3.16	7.16	4.87
SR(89)	4.58	5.07	6.28	3.38	6.38	5.03
SR(90)	4.34	5.69	6.85	3.98	6.23	3.79
SR(91)	3.70	6.91	6.70	3.40	8.96	N.A.
DW	1.7	2.0	1.9	1.7	1.7	1.8

Log.lik indicates the value of the log likelihood function, which is a goodness of fit indicator, SR is short for studentized residual, and the figure in brackets following SR is the year concerned. ρ indicates the autocorrelation factor of the original data set, and * indicates the year that a significant SR showed up for the first time.

The models shown in the upper part of Table I relate to the pre-invention period and hence need not follow a U-shaped pattern which, as argued in section 2, is expected to hold for the period as a whole. All models given in Table I show a downward sloping trend for the pre-invention period. This is in conformity with the arguments spelled out in section 2.

The results for all the species concerned described in the lower part of Table I are clear: price development in the common property period was 'upwardly biased'. For haddock a number of outliers showed up starting in 1985. For herring, cod, plaice and flounder the starting point was 1986. For mackerel a number of outliers were found from 1987 onward. Hence, for all species a wedge was developed between actual price and expected marginal harvesting costs, implying that rent had returned as a component of prices. The analysis clearly indicates that there was a time lag (because of several reasons mentioned above) before policy became effective.

Conclusions with regard to policy effectiveness, however, should be drawn with caution. Since policy intervention and other relevant variables are not explicitly included in the model, factors other than policy may have contributed to the U-shaped price path. The price of gasoline, for instance, is a factor that has great influence on marginal harvesting costs and hence the price of fish. Gasoline price, however, did not rise in the period in which the increase in price was most profound. On the contrary: real prices fell, especially from 1987 onwards (Salz, 1991). This is additional support for the conclusion that policy has been effective since falling gasoline prices result in an underestimation of the true increase of the rent. Another factor that should be taken into account in the context of rent underestimation is increasing stock levels (as a result of the quota system) that could possibly mitigate the stock effect on harvesting costs. Since the analysis explicitly assumed constant coefficients for the harvesting cost function, the true increase in marginal harvesting costs was overestimated, which automatically implies that the true increase in rent was underestimated.

Another factor that should be taken into account is product specific capital and non-salvageable costs. Product specific capital implies capital that can be used only for one or a limited number of activities. If these activities cease, the fixed costs associated with the capital cannot be salvaged by shifting these to other activities (see Munro and Scott, 1985). If applied to fisheries, and if non-salvageable fleet costs exist, fleet redundancy becomes important. This might imply that implementing a quota system results in a temporary excessive capacity and hence excessive costs. These might be reflected in a rise in the price (higher costs/unit of fish). However, because of the earlier-

mentioned stepwise reduction in quota which made structural fleet adjustments possible, this effect is likely to be small. Harvesting costs could also rise in the short run because of investment in new technologies and power capacity as a consequence of more time spent idle in the harbour, thereby possibly increasing harvesting costs in the short run. One way to investigate both claims is to analyze the net returns of German fisheries. Under the assumption of excessive harvesting costs because of product specific capital or new investments, one would expect a falling, or at best a stable net income. It appears, however, that net income has developed positively in recent years (Salz, 1991). In addition, Salz (1991) argues that the size of individual vessels has been relatively constant, thereby further reducing the validity of the second claim. Once again, the claim that government and Union policy has resulted in more efficient harvesting does not seem to be invalidated by this second category of factors.

4. Conclusion

In this paper effects of policy in terms of the return of rent in German fisheries were investigated. The paper differs from previous work because its focus is empirical. The method employed consisted of estimating a model on the basis of a time series of prices for the open access period and to estimate studentized residuals for the following common property period. Studentized residuals larger than 2 were taken to imply significant policy effects.

The results show that for all six species selected, studentized residuals exceeded 2 for a series of observations. Scarcity rent was found to have returned as a component of prices. There are even reasons to expect that the true increase in rent was underestimated in this analysis.

Despite this finding of increased intertemporal efficiency, there is evidence that the outcome achieved is not yet fully efficient. Large potential gains in income can be made by more radical changes of the sector (see section 1 and Schmidt, 1993). According to a report from the Commission to the Council and the European Parliament on the Common Fisheries Policy (cited in Schmidt, 1993), the income foregone through sub-optimal fisheries management in the E.U. has been calculated at around \$2.5 billion annually. In addition, it can be severely doubted whether over-fishing has been successfully halted.

An interesting topic for further research may be to analyze whether similar results also hold for other member states of the European Union. According to Salz (1991), the fisheries sector in many countries (Belgium, Ireland, United Kingdom, Spain, Portugal, France, The Netherlands) has performed well in recent years, at least those sectors that are not dependent on fisheries rights in other parts of the world.¹² On the other hand, there have been great differences among countries in species harvested, techniques applied,

organization of the sector and national policy, so some differences are expected to arise.

Acknowledgement

The authors owe thanks to Olli Tahvonen, Kees van Kooten, Dick Brazee, and two anonymous referees for their comments and suggestions. They are of course absolved from the responsibility for remaining errors.

Notes

¹ In an open access regime each potential user has complete autonomy in utilizing the resource. Under a so-called common property regime a group of owners can control the resource and exclude others from using it.

² Which implies that the future is discounted at an infinite rate.

³ Likewise, Bjørndal and Conrad (1987) argue that North Sea herring was saved from possible extinction by the closure of the fishery at the end of the 1977 season. Wilen (1976), however, studied the dynamics of fur seal hunting and found that rent dissipation may well be compatible with stock survival.

⁴ Already at the third United Nations conference on the Law of the Sea in 1977 a document called the Informal Composite Negotiating Text was produced with the recommendation that coastal ocean states may have exclusive economic zones where appropriate.

⁵ The CFP consists of policies for structures, markets, external fisheries and conservation (for more information the reader is referred to Holden (1994)). There are two reasons why formulation and implementation of the CFP did not immediately follow the establishment of the "Community" sea. There was a time-consuming debate between the UK and France about an exclusive zone for England and it took several years before matters concerning the determination of TACs and their allocation were settled in a politically acceptable way for all member states.

⁶ Note that marginal harvest costs will only be constant under stock depletion if technological change exactly offset the increasing difficulty of harvest as the stock shrinks.

⁷ Note that as a result of regulation, ships will spend more time idle in the harbour, which will enhance the opportunities for investment.

⁸ This issue will be discussed in section 3.

⁹ The simple quadratic model was also applied by Slade (1982), who attempted to reconcile the theoretical predictions of exponentially rising prices with empirical findings of falling prices of exhaustible resources. It should be observed that in contrast to Slade, the purpose of this paper was not to demonstrate the possibility of an exponentially rising rent path accounted for by a U-shaped price path, but rather that the time path of scarcity rent was U-shaped itself.

¹⁰ This does not imply that the conclusions drawn relate to Germany only. They may also apply to European developments if trade in fish is free, and prices equalize. A more appropriate approach to test the success or failure of the European policy would be to do a similar analysis for each of the Atlantic European member states or by pooling cross section and time series data for all these member states. Lack of data makes this impossible.

¹¹ Analysis of the autocorrelation indicated a first order autoregressive model (AR(1)). Maximum-likelihood was used to handle this problem.

¹² Spain, for instance, lost the right to fish near Namibia and Norway.

References

- Bjorndal, T. and J. M. Conrad (1987), 'The Dynamics of an Open Access Fishery', *Canadian Journal of Economics*, 74–85.
- Clark, C. W. (1990), *Mathematical Bioeconomics*, Wiley & Sons, New York.
- Clark, C. W. and G. R. Munro (1975), 'The Economics of Fishing and Modern Capital Theory', *Journal of Environmental Economics and Management* 2, 92–106.
- Deacon, R. T. (1989), 'An Empirical Model of Fishery Dynamics', *Journal of Environmental Economics and Management* 16, 167–183.
- Gordon, H. S. (1954), 'The Economic Theory of a Common Property Resource: The Fishery', *Journal of Political Economy*, 124–142.
- Holden, M. (1994), *The Common Fisheries Policy: Origin, Evaluation and Future*, Fishing News Books.
- Lipton, D. W. and I. E. Strand Jr. (1989), 'The Effect of Common Property on the Optimal Structure of the Fishing Industry', *Journal of Environmental Economics and Management* 16, 45–51.
- McKelvey, R. (1983), 'The Fishery in a Fluctuating Environment: Coexistence of Specialist and Generalist Fishing Vessels in a Multipurpose Fleet', *Journal of Environmental Economics and Management* 10, 287–309.
- Munro, G. R. and A. D. Scott (1985), 'The Economics of Fisheries Management', in: *Handbook of Natural Resource and Energy Economics*, vol. 2, edited by A. V. Kneese and J. L. Sweeney, Elsevier Science Publishers B.V., Amsterdam.
- Salz, P. (1991), *De Europese Atlantische Visserij: Structuur, Economische Situatie en Beleid*, Landbouw-Economisch Instituut (LEI-DLO), Afdeling Visserij, Onderzoeksverslag 85, Den Haag.
- Schaefer M. F. (1957), 'Some Considerations of Population Dynamics in Relation to the Management of Commercial Marine Fisheries', *Journal of the Fisheries Board of Canada* 14, 669–681.
- Schmidt, C. C. (1993), 'The Net Effects of Over-Fishing', *The OECD Observer* 184, 9–12.
- Slade, M. E. (1982), 'Cycles in Natural Resources Prices: An Analysis of the Time Domain', *Journal of Environmental Economics and Management* 9, 122–137.
- Spence, A. M. (1973), *Blue Whales and Applied Control Theory*, Technical Report 108, Stanford University, Institute for Mathematical Studies in the Social Sciences, Stanford, Calif. Processed.
- Wilén, J. E. (1976), *Common Property Resources and Dynamics of Overexploitation: The Case of North Pacific Fur Seal*, University of British Columbia Resource Paper no. 3.
- World Resources Institute, *World Resources 1992–93; A Guide to the Global Environment*, Washington.