Return on capital in the european fishery industry

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Abstract

This paper considers the level of Return on Capital of fishing vessels in Denmark, France, the United Kingdom and the Netherlands and an analysation of factors that influence this Return on Capital.

Samples of costs and earnings of fishing vessels in these four countries have been the basis for this profitability indicator.

Developments of the ROC are shown for the period 1991-1996. An analysation of the impact of other factors, such as prices and innovative techniques, on the economic performances and the profitability of the vessels is given.

This paper includes outcomes of inquiries among vessel owners, bankers and accountants to assess the perception in the industry with respect to the economic performance of fishing vessels.

Keywords: Economic performance/European fishery/Profitability indicator/Return on Capital

1. Objective

The main objective of this study is to consider the level of Return on Capital (ROC) of fishing vessels in Denmark, France , the Netherlands and the United Kingdom and to analyse factors influencing this return.

2. Introduction

This study has been carried out by four research institutes in: the Netherlands, France, the United Kingdom and Denmark:

- LEI-DLO: Agricultural Economics Research Institute, Fisheries Division, The Hague.
- ENSAR: Ecole Nationale Superieure Agronomique de Rennes, Dept. Halieutique, Rennes.
- SFIA: Seafish Industry Authority, Fisheries Economics Research Unit, Edinburgh.
- SUC: Sydjysk Universitetcenter, Danish Institute of Fisheries Economics Research, Esbjerg.

The study has been carried out with financial assistance from the Commission of the European Communities. The project was coordinated by W.P. Davidse from LEI-DLO.

3. Materials and methods

The information on the return on capital (ROC) and the costs and earnings in this study has been based upon samples of fishing vessels in the four countries and covers the years 1991-1996.

The samples contain 365 vessels totally, representing fleets totalling some 1700 vessels (1993).

Generally counts that the vessels in the several countries are of course fishing on different fishing grounds with different gear and on different species but they are comparable with respect to length, GRT's or horse power. Furthermore, every country may have particular national management measures but all four countries are subject to the same measures resulting from the Common Fisheries Policy. For example TAC's and technical measures with respect to mesh sizes, closed areas etc.

An earlier study 'Costs and Earnings of fishing fleets in four EC countries' is used as a basis for this study 'Return on Capital'. Costs and Earnings was focused on harmonisation of the profit calculations in the four countries (Denmark, France, the Netherlands and the United Kingdom). The methodology of calculating the return on capital for all four countries is done in the same way.

The Danish sample concentrates on the port of Thyboron and contains trawlers, seiners and gill netters. The French sample regards the ports of Concarneau, Lorient and Le Guilvinec and covers the (semi) industrial fleet. Beam trawlers are the most important vessels in the Dutch sample, but also shrimpers and multi purpose vessels are represented. Scottish vessels form the main part of the UK sample. Demersal trawlers, seiners and nephrop trawlers are included. Beam trawlers are represented in the English sample.

All amounts in this study are in ECU so that the level of costs and earnings can be compared between the four countries.

Some costs need to be explained.

Labour, shares and wages

Costs of all labour is included. For the skipper-owner an imputed amount is calculated in cases a salary is not paid to him. This imputed amount equals the share of a crew member.

A common depreciation system

Depreciation allowances are often a major component of a fishing vessel's financial accounts. Different systems may lead to big differences in net results per vessel. Therefore uniformity in this respect is very important to get comparable returns per vessel in the four countries involved in this project. The basis of the system is the replacement value of the vessel, this is the current building costs of a similar new vessel.

The hull of the vessel is depreciated in 25 years, 4% per year on the basis of the replacement cost and after this period 2% of the replacement value is depreciated as an estimate for improvements on these older vessels.

Engines with heavy use are depreciated in ten years, 10% per year and 4% after this period. In case of more light use the depreciation period is 15 years, 6.7% per year and 2.5% after this period; all percentages based upon the replacement cost.

Interest

Interest costs per vessel will differ widely in practice due to differences in the level of loans. To eliminate these differences an imputed interest has been calculated.

The basis for the calculation of the imputed interest is the nominal book value of the vessel, which is derived from the previous mentioned replacement value and the depreciation system described above.

Gross cash flow

This is the residual balance after the deduction of all operating expenditures from gross earnings. This indicator shows the amount available for interest payments and repayment of loans.

The key-indicator in this study is the Return on Capital (ROC). It is represented by a percentage, resulting from the formula:

$$\frac{\text{net profit + imputed interest}}{\text{insured value of the vessel}} \times 100$$

It should be kept in mind that the value of available fishing rights is not included in this return on capital figure. This concerns mainly Dutch and UK fishing vessels, owning more or less individualised fishing rights. The value of these rights is not included in the insured value of the vessel so that this measure of the capital value might be a low estimate in relevant cases. No costs of fishing rights (such as depreciation and interest) are included in the total annual costs of the vessels.

4. Developments of the Return on Capital

Calculating a return on capital seems a useful measure since fishing is a rather capital intensive activity. Though the indicator is hardly used in the industry, it is useful to compare the economic performance of fleet segments and to identify economic trends in the fisheries.

An adequate ROC requires a level of 8% or more, depending on the interest rate for borrowings.

From this viewpoint, the ROC has been very low for the fleetsegments involved in this study.

Only smaller Danish seiners and gill netters and some Dutch beamer groups show this or a higher level of the ROC. This occured mainly in 1991 and 1992. On the whole the Danish and Dutch vessel groups had the least worse level of ROC in the period 1991-1995

Most of the UK and French vessel groups had a negative ROC in this period, whereby the values of the French (semi)industrial vessels from Lorient seem to be disastrously low.

The avarage ROC per size group has developed differently in the period 1991-1995 in the four countries. The Danish trawlers improved their profitability in 1994/1995, whereas a deterioration occured for the seiners and gill netters in these two years.

For the French (semi)industrial vessels the ROC indicates a low point in 1993 and improvements for the trawlers of Guilvinec and Concarneau afterwards. The ROC decreased in most cases for the Dutch beam trawl groups after the relatively high level in 1991 and 1992.

The very low negative ROC of the British demersal fleet shows marginal improvements in 1993.

In the case of Scottish samples estimated ROC s in 1995 are above the corresponding levels in 1991-1994. There are also indications of a similar trend in the case of the English beam trawlers.

In figure 1, the average ROC in 1995 for (smaller) vessels (50-125 GRT) is shown. The outcomes vary between +7% and -4%.

In this case the investigated fleetsegments were; the Danish trawlers from Thyboron, fishing for consumption and industry, the French 24 meter trawlers from Le Guilvinec, two Dutch Eurocutter-groups and two groups of Scottish trawlers and seiners.

For the Danish vessels cod, plaice and sandeel are important. The French vessels depend on valuable flatfish and nephrops and the Dutch vessels on sole and plaice. The earnings of the two Scottish fleetsegments, with homeports Peterhead and Fraserburgh, depend on the catch of cod and haddock.

Both Scottish groups had a distinctly negative ROC in 1995. The French vessels performed as the best with a 7 percent ROC. As said before, ofcourse this is a comparison of only one year. In other years the results can be completely different.

Remarkable is that there are big differences between the countries concerning the earnings and costs. The French trawlers reached the highest earnings (593000 ECU). That was about 70 percent higher than the Dutch Eurocutters with the lowest earnings (348000 ECU).However, the French trawlers were rather new and therefore also the costs (depreciation and interest) were high.

The return on capital of bigger vessels (250-650 GRT) is shown in figure 2.

Results of the Danish trawlers from Thyboron, the French trawlers from Lorient, two Dutch beamer-groups and beamers from the United Kingdom are reflected for the years 1995 and 1993.

Both Dutch beamer-groups appeared to be the most profitable of the investigated vessels. The return on capital for the French trawlers was very bad.

5. The impact of public policies and other major factors on the return on capital

Analysis of the impact of different management measures on the profitability of the fleets could provide valuable information.

The following aspects have mainly influenced the ROC:

a. quota changes/catches of fish;
b. prices of fish;
c. decommissioning;
d. the horsepower licence scheme;
e. conservation measures;
f. innovations (technical and organizational).

The decrease of cod quota in the period 1991-1993 has depressed the returns of the *Danish* gill netters and the seiners. The cod price development could not compensate these lower quota.

Quota increases of this specie brought the availability again at the 1991 level, but the nominal cod price has decreased by nearly 30% for the period 1991-1995.

Plaice is most important for the Danish seiners and this quota decreased by 29 and 7% in 1995 and 1996, after a stable patern in 1991-1994. An investigation of the effect of quota changes in 1996 on the ROC, through a vessel model, learns that mostly the gill netters and the seiners show positive developments. The ROC could increase in 1996 from 4.9-10.4% for the gill netters and from a level of 4% to 6.5% for the seiners. The trawlers are more sensitive to changes in abundance of 'reduction' fish. A 5% increase of this abundance may increase the ROC for the largest trawlers from 4.3% in 1995 to 6.1% in 1996, all else equal.

The Danish seiners and smaller trawlers decreased in number by more than 50% in the period 1990-1995 by decommissioning. Decommissioning has had on one hand a statistical effect on the average ROC in that an imoprovement arises since the vessels with the lowest ROC mostly have left the fleet. A decommissioning of e.g. 5% causes an increase of the ROC of 0.2-0.3%. On the other hand, decommissioning has more impact on the longer run since there is less competition between the remaining vessels for yhe quota species.

Danish vessels are mostly very old and a less harder depreciation system than the commom one in this study seems to be more suited for the Danish situation. Such a depreciation which follows the decrease of the insured value, would higher the ROC by 2-4% for rhe Danish vessels.

Major impacts on the decreasing ROCs of the *French* industrial fleet have been:

- the lower prices in the period 1991-1994, 20-30% for the most important species, which seem to have the most important determinant of the ROC deterioration;
- quota changes for cod, saithe and anglerfish which species became less available in the period 1991-1993 and had an upward trend afterwards. The doubling of the haddock quota in the period 1991-1996 meant a positive factor for the ROC of the industrial vessels. A sensitivity analysis turned out that 5% quota increase of the main species results in a ROC improvement, varying from 0.9-3.8%.

The more specialized 33 meter vessels of Lorient are most sensitive to such a quota increase; A decommissioning of 33% in number of French industrial stern trawlers will have an important positive structural effect on the profitability. The decommissioning of

the vessels with the lowest ROC turned out to have a minor statistical effect on the average ROC.

For the *Dutch* beam trawlers public policies have had the following impacts on the ROC:

- decreases of the flatfish quotas have depressed the profitability of this fleet in 1995 and 1996. A sensitivity analysis for the most important size grop, 1101-1470 kW, turned out that the lowe plaice and sole quotas in 1996 will lower the average ROC of these vessels from 5.6% (1995) to 0.8%, all else equal. However, substantial increases of the sole and plaice prices may improve this ROC again to 3.6%;
- decommissioning has removed some 90,000 kW from the cutter fleet, which has resulted ion better catching possibilities for the remaining fleet. I has to be emphasized that higher catches do not accrue for free to the operating vessels. The vessel owners have to pay a high price for the ITQs, if they purchase them from other owners who leave the fishery;
- the horsepower licence scheme, implemented in 1985, has stopped the investment mechanism that resulted in capacity increases (10-20%) after profitable years. In particular, this scheme has prevented such increases after the profitable years 1991 and 1992. Investments in ITQs even exeeded the investments in vessels in these years.

The fuel price for the Dutch vessels came at such a higher level (some 50% compared with 1995 average price) in the second half of 1996. Such a cost increase will have a major impact on the profitability of the beamers. This means a cash flreduction by 75, ECU on an annual basis for a larger beamer, whereas the ROC effect would contain a decrease from the expected 3.6% in 1996 to 1.8%, all else equal.

6. Perceptions in the industry on the return on capital

Interviews with vessel owners, accountants and staff members of banks have been held in the four countries to:

- identify financial indicators that are used by vessel owners and to investigate if the ROC is of importance in the industry;
- investigate if the applied methodology of calculating profits does result in financial returns that correspond to out-turns as perceived by the industry itself;
- learn which factors are considered to have mainly affected the returns;
- investigate which have been the main technical innovations implemented by the industry over the survey period and thereafter.

Staff members from banks and accountants in *Denmark* concluded that:

- the ROC is theoretical relevant but they do not use this indicator. A problem is that the invested capital is difficult to measure;
- the net profit and the ROC resulting from this study mean an underestimation of the economic performance of the Danish vessels. In particular the depreciation costs ac-

cording to the common methodology cause this difference with the perception of the industry;
- the available fish quotas and the abundance of fish seem to have the major importance for the level of returns;
- the re-financing reform, implemented by the Danish government in 1993, positively affected the return of the vessels;

Conclusions from the *French* interviews are that:
- the level of returns in this study correspond roughly with the perception in the industry on profitability;
- a kind of ROC , a return on investment is annualy calculated by fishing companies. Apart from this, numerous indicators are periodically used since the beginning of the nineties;
- a major change has occured in the investments behaviour of the fishing companies in that the policy of replacing a vessel every ten or fifteen years has stopped.

Vessel owners, staff members from banks and accountants have been interviewed in *The Netherlands*. The main conclusions from the interviews are:
- the ROC indicator is not known under vessel owners and not used by accountants and bankers;
- the perception of vessel owners, accountants and bankers on the returns are rather in line with the outcomes in this study, wherby vessel owners seem to be somewhat more positive than the other two types of respondents;
- the amount of weekly gross earnings is the main financial indicator for skipper owners.

Beside that, a statement with a weekly survey of quota uptake is used as a supplement.Behaviour off skipper owners is changing from hunters for fish towards managers of quotas:
- returns of vessels are mainly influenced by quotas and prices. A new influencing factor thereby include speculative decisions about leasing and hiring of ITQs. The speculative element contains the moment of leasing/hiring (price differences over time) and the quantity to lease/hire (uncertainties about catchability);
- a minority of the vessel owners had implemented innovations on board;
- vessel owners, accountants and bankers emphasized that a kind of freeze of the fleet had arisen in the nineties as a result of all the regulations.

Conclusions from *UK* interviews are:
- the role of financial indicators is related with ownership structures. At one extreme there are few public companies who maintain a sophisticated regime of financial monitoring, including terget ROCs. At the other extreme there are large numbers of individual fishermen have no idea of ROC as such and whose indicators are related to cash flows;

- banks do not use ROC. They seem to be content with cash flow projections in relation to investments;
- the perception in the industry with respect to gross earnings/cash flows has been broadly in agreement with the trend indicated in this study;
- an interview with the most important British Insurance Company for fishing vessels learned that there is a rather close relationship between the actual market value of a vessel and its insured value, apart from time lags in adjustment of the latter one.

7. Conclusions and future work

1. Fishermen do not require an adequate reward for their labour since the ROC of the vessel groups in the four countries is mostly (far) below the actual costs of capital.
2. A very low or even negative ROC does not suggest that the enterprise has to be stopped within a short time. Owners of family enterprises, like most fishery firms are, can continue their activities for a rather long time, consuming their depreciations and accepting a low reward for their labour. Many farm holdings and fishery enterprices are an example of such a development. The consequence of this is that it may be very difficult to reduce the fleets by imposing limiting measures.
3. Calculating a ROC is useful to:

- identify trends in the economic performance of fishing vessels;
- compare the profitability in the fishery sector with profitability levels in other sectors;
- get more insight in the behaviour of fisherman.

This study provides detailed costs and earnings of fleet segments of four countries, based on sample vessels. Some of the results have been used for one of the reports of the STECF sub-group.

Continuation of studies on the economic performance of fleet segments is recommendable and even necessary in view of the basic Regulation for Fisheries management (REEC nr.3760/92).

This Return on Capital study has established a useful network for data collecting and processing. Continuation can result in buildingstones for future issues of e.g. an Annual Economic Report (AER).

A well developed data network in the EU fisheries countries is required when a representative Annual Economic Report (AER) is to be established. In this respect, the EU Farm Accountancy Data Network (FADN), in operation in the agricultural sector already for a long time , may serve as an example for future AERs.

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Integrated economic, social and ecological perspectives of herring fishery in the southern baltic sea. Risks and chances

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Abstract

The German catch quota of the western herring stock of the Baltic Sea is under-exploited. Only few fishermen, using trap nets and gill nets, catch herring in the spring-spawning season around the Island of Rügen (northeast Germany). Due to low prices for raw herring, only the use of the passive methods with low running costs remain. With severe economic problems because of low profits many fishermen retired and few new one started a fishing carreer. The build up of a processing plant for herring should solve these problems and the use of ecological friendly passive fishing methods can generate a sustainable fishery.

Key words: Sustainable fishery, Baltic Sea herring fishery, Fishing Sector Mecklenburg-Vorpommern (Northeast Germany), Processing Industry

1. Introduction

In most regions of the world, fisheries are in a severe crisis. The stocks decline, many fishermen got unemployed. In contrast the herring stock of the western baltic sea is in a very good condition. One reason might be that German fishermen have using up to 15% of last years quotas.

A new processing plant is to be built in Neu - Mukran (Rügen). Consequences of this new plant for local fishermen and the sustainability of German fishery in the Baltic Sea are discussed from an ecological and economical viewpoint.

2. The area

Being Germany's largest island, Rügen is a part of the German coast at the Baltic Sea. Several fisheries have a long tradition, because the island is surrounded by shallow water areas with brackish water. These waters are populated by specific fish communities including fresh- and saltwater species. Some of them live there permanently, like pike, perch and zander, others migrate seasonally. So the Greifswalder Bodden in the southeast is one of the main spawning areas of the herring stock of the western part of the Baltic Sea.

3. Characteristics of Bodden herring fishery

In a document about the Slavs from the 12th century, an extensive herring fishery is described. In the following centuries many places along the coast were used as 'Vitten', places where herring was salted. The people of Rügen used to be farmers and fishers. Only very few were fulltime fishermen.

Traders have always had a strong position from the middle ages on. One of the main reasons for the constitution of the „Hanse' was the right to trade herring in these region. The strong position of the traders didn't change since the beginning of the 20th century. Around 1920, the fishermen joined in cooperations to get a better position. After the second world war all fishermen were forced to join one of the new fish production cooperations, which were mainly engaged in marketing the fish. Technically most of the fishermen remained independent and kept their own boats and equipment. The state guaranteed good prices and bought all of the landed fish. So the fishermen were well-off economically.

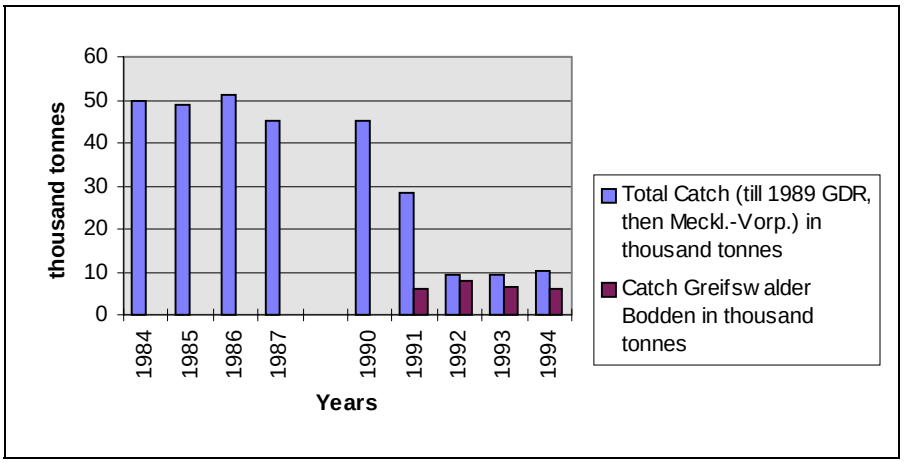
Due to the bad economic situation at the beginning of the century, the fishermen had no opportunity to buy big ships. They had to use the traditional fishing methods, trap nets, longlines and gill nets. But these fishing methods have some positive effects:

- they operate selectivly and protect the marine ecosystems;
- the running costs are low.

At the end of the 80ies, the fishermen caught 50.000 t of herring a year (see also table 1), of which 15% gill net herring and 21% trap net herring. The remaining 64% of the quota of the GDR was used by trawlers (17 m -Ships).

Table 1 *Herring Total Catch and Catch in the Greifswalder Bodden (source: Informationen über die Fischwirtschaft des Auslandes, p. 50 and Ministry of Agriculture and Nature Conservation of the Land Mecklenburg-Vorpommern (MANC) , Report about Agriculture, different years).*

Year	Total Catch (till 1989 GDR, then Meckl.-Vorp.) in t	Catch Greifswalder Bodden in t
1984	49,554	
1985	48,903	
1986	51,149	
1987	45,211	
1990	45,038	
1991	28,226	6,100
1992	9,338	7,890
1993	9,460	6,481
1994	10,026	6,126



4. Present situation

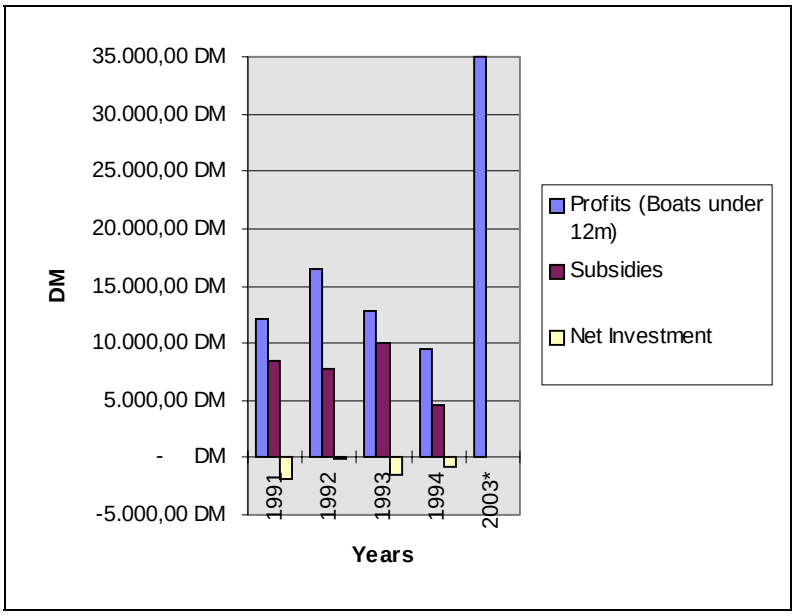
After 1989 low prices for herring caused big economic problems for the fishermen (Table 2 for boats under 12m). Only 10 to 15% of the German herring quota of 100.000 t was used during the last few years, and 88% out of it were fished with the traditonal, passive fishing methods. Because of the lower running costs, only the user of these techniques fished herring. The trawler used to catch cod and flounder.

A problem is, that the catch must be transported to Denmark for processing. The fishermen have to pay 0,10 DM/kg for the transport, the price for raw herring at the moment is 0,42 DM/kg.

During the last eight years many of the old fishermen retired and very few young people started a fishing carreer (see Table 3 for the job situation in the fishing sector). If these situation doesn't change during the next years, very few fishermen will be in practice within 10 or 20 years.

Table 2 Profits, Subsidies and Net Investment for Boats under 12m (see MANC, different years)

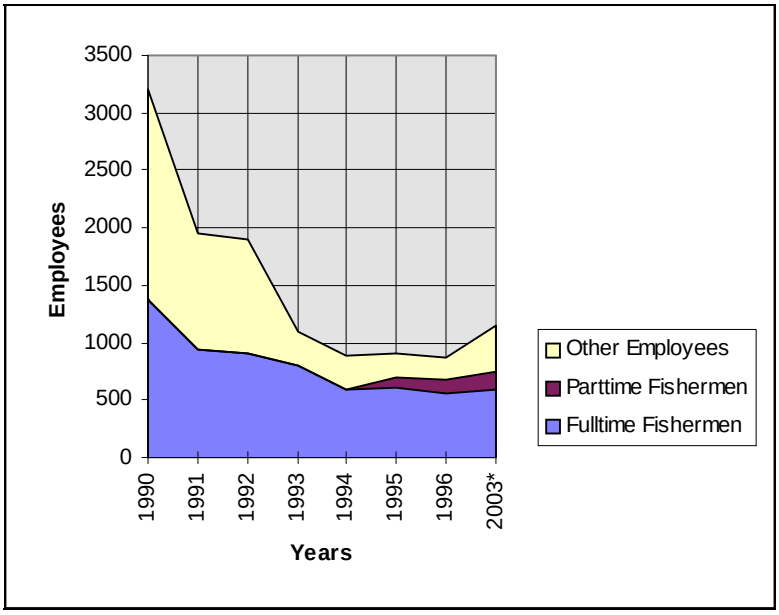
Year	Profits (Boats under 12m)	Subsidies	Net Investment
1991	12.166 DM	8.400 DM	- 1.800 DM
1992	16.496 DM	7.695 DM	- 144 DM
1993	12.857 DM	10.018 DM	- 1.465 DM
1994	9.510 DM	4.620 DM	- 800 DM
2003*	35.000 DM		



*) Expectation: Investments in the net-fishery are possible.

Table 3 Job Situation in the Fishing Sector (see MANC, different years)

	1990	1991	1992	1993	1994	1995	1996	2003
Fulltime Fishermen	1380	948	900	800	593	615	565	600
Parttime Fishermen						79	106	150
Other Employees	1817	1002	1000	300	300	220	200	400
Total	3197	1950	1900	1100	893	914	871	1150



*) Expectation: Expansion of the passive fishing technics and the new processing plant.

5. The new processing plant in Neu Mukran

At the moment it seems, a solution for the economic crisis is in sight. A new processing plant for herring may be built in Neu-Mukran, a small village with a big ferry harbour. With a capacity of 50.000 t, this plant can process half of the german catch quota. The newest processing technology and an integrated fish oil and fish meal factory will be build up. In contrast to the present situation, the catch will be transported over sea and only for short distances over land - the investor hopes that the quality of the fish will be superior closer to the catch areas. The German fishermen near the processing plant are supposed to fish the herring - but it is not yet clear wether this is possible in the future.

6. Risks and chances for local fishermen

For me a development of a sustainable fishery seems necessary. This requires the government's and the investor's readiness to preserve the traditional fishing methods. One of the main demands of people involved in the discussion about the future of fisheries is that the fish stocks have to be used near the coasts by means ecological friendly fishing techniques (McGoodwin, J.R. (1990), p. 107). In this area this mean gill nets and trap nets.

Risks and chances for local fishermen.

Risks

- large investments in new boats and fishing equipment are necessary, so that the net- and trap-fishermen can catch an adequate quantity of fish;
- parts of the german herring quota of 100.000 t can left to other states in the future, providedd Germany's catches do not rise. As already mentioned, under-use of quotas might however be responsible for the good herring stock (see figure 1);
- if that is so what happens;
    - if the rest of the quota will be used; and;
    - if the herring stock will be submitted to industrialized fishing for fish-meal and oil in the future?

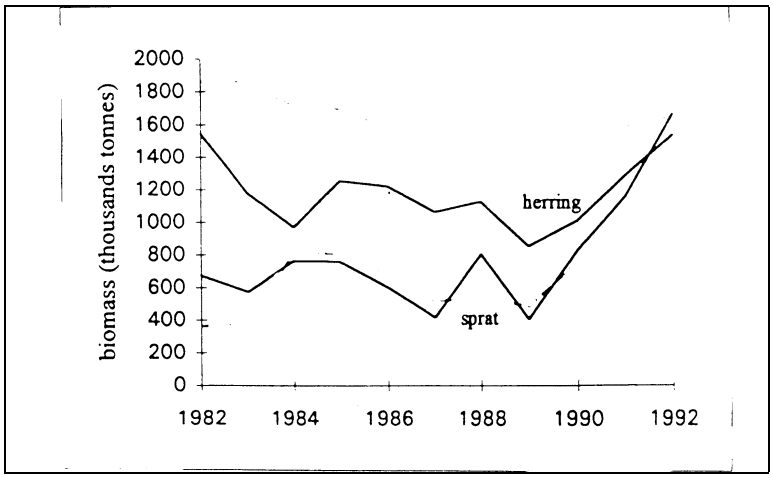


Figure 1 Biomass of herring and sprat in the Baltic Sea (see Harbowy, J. (1996), p. 2119)

Chances

- the government could grant property rights on a share of the quota to fishermen using passive fishing techniques which enables them to catch around 25.000 t in the future;
- the use of passive fishing techniques;
  - guarantees/creates more jobs than the big ships;
  - are ecologically sustainable (see to the question of destructive gear Berrill, M. (1997), pp. 62 and Dahm, E. (1994), pp. 23);
- in the cod-fishery a very low stock is involving severe problems at the moment. Better prices for herring might persuade owners of larger ships to catch herring instead of cod. So, the rest of the 50.000 t could be caught by german fishermen;
- the remaining 50.000 t of the german catch quota should not be used but kept as a buffer for a good herring stock in the future.

7. Conclusion

With the new processing industry for herring in Neu-Mukran there is a great chance for the development of a sustainable fishery in the Baltic Sea. If it is possible to preserve traditional use systems with passive fishing methods, the ecological consequences for the ecosystem and the stock are presumably not very severe. The most effective fishing techniques destroyed a lot of big fish stocks and brought high unemployment to many regions of the world (Canada's east coast e.g.). A buffer in the catch quotas can be expected to mitigate adverse consequences on fish stocks, caused by the new processing plant. Perhaps this can be a positive example for the use of a big pelagic fish stock in the future, I hope so.

8. Acknowledgement

I would like to thank John Couwenberg, Hans Joosten and Prof. Dr. Ulrich Hampicke for helpful comments and linguistic advice. Also I would like to thank the German Federal Environment Foundation for a scholarship to search for possibilities for sustainable fisheries in the Greifswalder Bodden.

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Sleeping in separate beds: a comparative analysis of the economic and social sciences in their approach to fisheries research

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Introduction

In their original statement introducing the session on 'Economics within multi-disciplinary research', the organisers stated that

- in fisheries-related research, marine biology has played a leading role for many decades. Economics has appeared gradually on the scene over the past 5 to 10 years (EAFE). Other social sciences have manifested themselves even more recently (ESSFiN);
- often a certain amount of antagonism exists between scientists who represent the established fields and those who also feel that they have something worthwhile to contribute but have to 'struggle' to receive some attention. There are many reasons for such frictions: a threat to vested interests, lack of mutual appreciation, insufficient personal and professional contact, etc.'

A social scientist could take exception to this statement both in terms of its historical inaccuracy - the interest of economic and social sciences in fisheries related research is far older than the emergence of the two organisations referred to by their acronyms - and in the positioning of the social sciences on the margin of applied research. Accordingly, the social scientist might detect a touch of arrogance in this statement and, in line with this interpretation, be tempted to locate both fisheries economics and fisheries science as established and privileged elite players in the policy community. The social sciences may prefer to be seen as mere bystanders, able to enjoy the game of fisheries management as spectators and vociferous critics (Fig. 1), unburdened by any share in the responsibility for the ensuing defeat. Or could it possibly be that this invitation to share in a moment of introspection is prompted by the fact that the fisheries economists themselves feel somewhat unnerved by recent attacks from social scientists directed at the palpably false assumptions - shared with fisheries scientists - underlying the bio-economic model which have structured the approach to fisheries management over the past three decades (Smith, 1990; Wilson and Kleban, 1992; Holm, 1996)? Is it even possible that fisheries economists themselves feel threatened with marginalisation as a result of past trends and future prospects? Might we be witnessing the acting out of the parable of the prodigal son in which fisheries economics, having enjoyed their misspent youth in the company of fisheries scientists, return chastened, wiser and repentant to their original home in the social sciences?

Putting aside such waspish and unworthy thoughts, there clearly are some serious questions facing the future development of research and expert advice on fisheries management and policy. These questions are in part engendered by the apparent failure of existing management systems to achieve their primary objective of sustainable resource development, in part stimulated by the growing awareness of a need to widen the scope of management objectives to include a socio-cultural dimension, and in part precipitated by a likely shifting of the goalposts in terms of the pressure to integrate fisheries management within a more broadly structured framework of management for the marine ecosystem as a whole (Svelle *et al*., 1997). This synoptic review of the current situation calls for a reappraisal of the roles of the economic and social sciences and of the relations between the two in a multidisciplinary approach to fisheries management. The aims of this paper are fourfold: first, to define the nature of the economic and social sciences; secondly, to distinguish their separate foci of interest and their contrasting approaches to regulation theory; thirdly, to outline an agenda for social science research; and finally, to comment on the scope for co-operation between the economic and social sciences in a multi-disciplinary approach to problem solving in fisheries management.

Getting to know the contestants

The social sciences are a broad church - a loosely structured federation of cognate disciplines. As such it would be inappropriate to refer to fundamental schisms within the social sciences, but there have been some significant breakaway sects - including both economics and law - leaving behind a more or less coherent body of 'softer' social sciences which share a common agenda of research interests in the realm of fisheries management. There is, however, a danger of falsely 'collectivising' the social sciences: each individual discipline is characterised by a distinctiveness of underlying theoretical constructs and research methodologies. Intrinsically different in detail but with no major language barriers intervening, they tend to complement each other quite effectively.

What is it then that sets the economic sciences apart from the social sciences? Apart from obvious differences of methodology and - for most social scientists, at least - the impenetrable language of econometrics, the key differences would appear to revolve around their intellectual aspirations and their assumptions concerning human behaviour. From the standpoint of a social scientist, fisheries economics is perceived as a clearly defined, well structured but relatively narrow science which tends to abstract from the particularities and contingencies of time and space. By contrast, the social sciences see themselves as very much broader in outlook, concerned to understand the social, cultural and political contexts within which management decisions are made. These specific contextual conditions influence not only the outcomes of management decisions but the very formulation of the decisions in the first place.

But it is the underlying assumptions of the neo-classical paradigm of modern welfare economics which drive the biggest wedge between the economic and social sciences. The claims of value neutrality, the focus on self-interested rational behaviour of individual economic actors and the belief in the role of competitive markets, real or simulated, which can

optimise the allocation of resources in society, are all challenged by the postulates of the social sciences (Jacobs, 1994). Economics is not a value neutral science: its persistent prioritisation of economic efficiency is akin to the assertion of a particular value. The assumptions of rational behaviour are not borne out by reality: within family firms, both in farming and fishing, decisions are made by individuals with different perspectives and values, where the intrinsic values of independence and the strategies of entrenchment in the quest for social and cultural survival compete with economic profitability to create the bounded rationality of the satisficer. Competitive markets, as for example in quota transfers, lead to an inequitable distribution of resources within society and even the claim for economically efficient distribution can be questioned on the basis of evidence from Iceland. No wonder, then, that artisanal fishermen are concerned by the apparent drift of opinion towards the privatisation of property rights in the corridors of power of many European countries.

While the economic sciences attempt to explain how things should work out if the social actors involved were to behave rationally, the social sciences explain why it is that the social actors - individuals, organisations and agencies - will almost invariably appear to behave irrationally and why the ideal world of economics is an illusion. To a degree, therefore, the social sciences attempt to counteract the time/space indifference of economic science. They argue for the need to enter the real world of enormous social, cultural and political complexity and to recognise the burden of history and geography.

The approaches of the economic and social sciences to management issues may also be differentiated according to their choice of temporal and spatial scales. As a universalising science, economics will tend to focus on the large scale and to trivialise or ignore local variations. By contrast, although aspiring to reach general conclusions, many of the social sciences will be extremely sensitive to the significance of local variation. Paradoxically, perhaps, the temporal preferences of the two groups are often reversed, with the economic sciences more concerned with short term futures while the general thrust of the social sciences is for a consideration of a longer term, intergenerational future. Just how well these different perspectives mesh with those of the social actors involved in fisheries management is an interesting question. The fishermen may share with the economists a preoccupation with short term futures in respect of their strategic economic behaviour - conditioned by the need to put food on the table today, to meet the demands of their bank managers over repayment of loans on a monthly basis etc. But their social and cultural aspirations, in terms of the survival of the family enterprise, may well be intergenerational. One of the problems of fisheries management lies in mediating between these differences in time horizons.

While the economic sciences may lay claim to value neutrality, the same could never be said of the social sciences which have become tainted with value laden perspectives and popularly endowed with radical agendas. The social sciences may also lack the 'purity' of the economic sciences as a result of a long standing 'common market' in theoretical concepts and methodologies. My own discipline - human geography - is renowned for its compulsive kleptomania in seeking to incorporate both social and economic theories into its essentially spatial perspective. Most other social sciences, except perhaps anthropology,

have shown a tendency towards eclecticism and plagiarism in pursuit of a more holistic framework of explanation.

Economists will tend to feel uncomfortable if saddled with the more radical agendas of their social science cousins. Most social scientists are, however, not so naive as to believe that their radical agendas will be incorporated into a new establishment position. But they do believe that it is important to enliven the debate by challenging the establishment position through the introduction of radical alternative projects in the hopes that these may reveal weaknesses in the current system and lead, at least, to incremental change rather than entrenchment of the *status quo*.

There has been a tendency for the social sciences to avoid engagement in the debates over the optimal designs of regulatory tools, either individually or as a policy package, while feeling free to comment critically upon the distributional effects of such measures. The one major exception to this rule of disengagement has been the ITQ debate where a fairly clear disciplinary division has emerged between the protagonists (economics) and the antagonists (social services) principally over the merits of rational structures *versus* the equitable distribution of resources.

Regulation theory

Within fisheries management the focus of research interest - consciously or unconsciously - for both the economic and social sciences is the system of regulation. Three broad regulatory regimes can be identified (figure 2): state, market and social regulation - ideally complementary, but potentially contrary forces. Whereas neo-classical economics is preoccupied with the system of market regulation and its relationship to state regulation, the attention of the social sciences is centred on the systems of social and state regulation and their interactive behaviour.

Where fisheries have, in the past, suffered has been the overriding dominance of state regulation, the instability of market forces and the weak and fragmented systems of social regulation. One focus of attention for the social sciences in recent years has been the ways in which alternative regulatory systems alter the position and balance of power between the various social actors within the policy system. For many areas of policy making - but much less so in the case of fisheries - recent trends have favoured a process of 'deregulation', involving the partial surrender of the state's pre-eminent position and the contracting out of management responsibilities to non-state institutions either in the market or the social sectors (Symes, 1997). However, according to Ayres and Braithwaite (1992):

- 'we have not, and are not, experiencing an era of deregulation so much as an era of regulatory flux - an era where dramatic regulatory, deregulatory and re-regulatory shifts are occurring simultaneously'.

In fisheries, to date, such trends have not been particularly marked. Where they can be observed, they have tended to favour increasing market regulation - as in the case of the handful of states which have embraced an ITQ system of management - and the strength-

ening roles of the processing and retail sectors, as in the Marine Stewardship Council project which offers a more radical example of this regulatory shift.

The weakness of the system of social regulation has been exposed. According to Cox *et al* (1985), the success of user group organisations within the policy community depends on the degree to which they are capable of self-regulation and effective discipline over their constituency. Doubts are raised over the capacity of user group organisations in the fishing industry to manage the essential balance between the corporate and individual ambitions of their members and to maintain effective control over their behaviour (Phillipson, 1996; forthcoming). The fisheries sector has not so far been able to emulate the (former) model of agriculture corporatism: in the UK, the National Farmers' Union (NFU) for long enjoyed a special relationship with central government in policy making, whereas the National Federation of Fishermen's Organisations has persistently grumbled at their exclusion from the policy community and the lack of regular, meaningful consultations over policy matters. Maybe their time will never come. The NFU has been increasingly marginalised, first by the transfers of decision making from Whitehall to Brussels and, more recently, as consumer and environmental interests have come to dominate the political agenda. The same trends are evident in fisheries. Moreover, the formal fishermen's organisations are increasingly being undermined by the challenge from more radical pressure groups operating outside the formal policy process.

Regulatory dissonance, resulting from the interplay of the state, market and social regulation systems, has become increasingly common within the fishing industry. It occurs within state regulations (quota rules and discards), at the interface between state and market regulation (black fish landings) and at the interface between state and social regulation where there are pressures to disregard the formal rules in order to maintain the viability of the social enterprise.

Theoretical contradictions

Although the regulatory model (figure 2) may suggest a partially overlapping set of research interests, the separation of the economic and social sciences is intensified through the distinctive theoretical approaches to regulation theory. Four different approaches can be identified: the first two adhere to the economic sciences and the third and fourth to the social sciences. The economic science approach would appear to have its origins in Hardin's 1968 'tragedy of the commons' thesis in which common property resources are portrayed as a 'free good', unanswerable to effective management - a thesis vigorously contested by the social sciences (Berkes, *et al*, 1989).

A property rights approach has clearly made its impact in the field of fisheries economics. Property rights are perceived as the central set of relationships defining the roles of the state, the market and the individual in the allocation of scarce resources; and the privatisation of property rights is seen as the only way of ensuring that society is able to optimise the use of scarce resources and that individuals can internalise the full costs of resource use. The property rights theory presumes that the only necessary action of government in the management of resources assets is to assign property rights and estab-

lish a free market for the exchange of those rights. Thereafter, the optimal allocation of rights and 'management' of the resource will be assured by the operation of the market, eliminating the need for further state intervention and greatly reducing the level of transaction costs.

The neo-classical approach to resource management follows much the same rationale, asserting that where natural resources are regarded as a 'free good' they will be overexploited, degraded and depleted. The point of departure from the property rights school of thought is that welfare economists are concerned to create hypothetical rather than real markets and are committed to the use of a variety of interventionist instruments in order to achieve the desired allocation of resources at any one point in time (Jacobs, 1994).

Both these approaches are essentially reductionist in style, relying upon rational economic behaviour acting in a self-interested way to maximise the utility of the resource. Several important aspects, including the role of institutional factors and the behavioural characteristics of the principal social actors are disregarded and treated as exogenous to the economic system (see figure 3). These 'exogenous variables' in their turn become the central features of the social science approach, which focuses on the distortions of the economists' rational world caused by socio-cultural and political processes. Political science literature provides insights into the processes which transform the relationships between state, market and social regulation, emphasising the role of institutions, policy styles and processes of interest group mediation. The outcomes of policy making are interpreted as the result of power politics and both state and market regulation are seen as susceptible to manipulation by powerful vested interests. Mediation of conflicting interests will lead to sub-optimal, compromise 'solutions'. According to Jannicke (1990), inappropriate state intervention may perpetuate and deepen many of the world's environmental problems. This 'state failure' thesis would surely include the handling of fisheries policy in Europe and the apparent willingness on the part of the EU to condone, if not actually plan for, 'sustainable overfishing' in Community waters.

Finally, the behavioural approach, adopted principally by social anthropologists, sociologists and human geographers, examines in much greater detail the decision making processes of the social actors in a search for greater understanding of why these actors do not always behave 'rationally' i.e. in accordance with the assumptions of the regulators. In terms of fisheries research, there has been relatively little emphasis on the internal social structures of the 'family firm' and its external linkages or on the socially and culturally constrained decision making within these important micro-institutions. This dearth of understanding is in marked contrast to the analogous situation in agricultural sociology which boasts a copious literature on the sociology of the family farm and its complex decision making processes (see for example, Gasson and Errington, 1993). One potentially fertile area for behavioural research in fisheries is an understanding of the human response to the risks of resource depletion. 'Hazard response' research has indicated a tendency of populations to return to the *status quo ante* following a natural disaster - to rebuild their homes in earthquake zones and on active flood plains - largely based on their individual perceptions of risk and their lack of knowledge of alternative options. In similar fashion, we need to understand more thoroughly the reasons why fishermen continue to reject scientific advice, to ignore their own empirical evidence of overfishing and to flout state

regulation designed to protect them from further depletion of the resource base and the risk of stock collapse. Simplistic 'explanations' rooted in the 'tragedy of the commons' thesis are wholly inadequate.

Outlining an agenda for social science research

The second task of this paper is to outline some key elements of a social science agenda for fisheries research and to comment, where appropriate, on their relevance to fisheries economics. In many cases, the research topics will fall quite clearly within the area of discrete concern for the social sciences; but in others they may be judged to occupy an area of common ground shared with the economic sciences (Fig. 4). Initially, we can simply list five key areas of social science research interest as:

- processes of social and cultural change within fishing communities, engendered by global:local interactions and by the impacts of fisheries policy;
- definition of social objectives for fisheries policies;
- institutional restructuring;
- social outcomes of different property rights systems and management regimes and;
- socio-economic development of fisheries dependent areas.

Of these five areas, three are worthy of further elaboration in the context of the present discussion: the social objectives for fisheries policy; institutional restructuring; and fisheries dependent areas.

Social objectives

The 1991 Review of the Common Fisheries Policy (CEC, 1991) recognised that the social parameters had been scarcely considered within the existing policy. This is not a problem unique to the European Community. Social objectives tend to form a 'hidden agenda', unstated at the outset of the policy process but likely to be introduced covertly in the final stages of decision making when the political acceptability of the policy proposal is assessed. The absence of explicit social dimensions to fisheries policy becomes more crucial as the social consequences of the policy become ever more acute. To date these problems are viewed essentially as externalities to be dealt with by other policy areas rather than internalised within the fisheries policy itself. Thus, rather unlike agriculture policy which commonly exhibits a strong concern for the social outcomes of its policy measures by providing special assistance to low income farmers and less favoured areas, fisheries policy is seen essentially as an unalloyed economic policy. Part of the problem for the economist is the incompatibility of social objectives - seen as subjective, value laden, political goals - with the scientifically defined biological and economic objectives. Social objectives, whether defined in terms of social recognition or social justice, are undoubtedly controversial and problematic: they are complex, internally conflictive and usually difficult of precise measurement - but they are not impossible to define, as the much vaunted Norwegian fisheries policy demonstrates.

Institutional restructuring

One of the conclusions from recent research in the social sciences is that the failure of fisheries management is due less to the content of fisheries policy than to the inappropriate institutional frameworks within which the policy is formulated. Hanna's (1998) diagnosis of the institutional pathologies of fisheries management on both sides of the Atlantic has pointed to two particular problems: an unstable policy scope with inconsistent and poorly defined objectives which renders fisheries policy susceptible to political manipulation, on the one hand, and inert policy institutions which reduce the flexibility of response to the changing conditions of the fisheries, on the other. Over the past decade or so, problems of institutional restructuring have become a relatively well established area of social science research developed around the analysis of policy process, definition of policy community and the tendencies towards decentralisation and delegation of management powers and responsibilities, which have featured prominently in 'deregulation' strategies in other policy areas. The concept of 'integrated fisheries management' (Svelle *et al*., 1997), in which the objectives of ecosystem sustainability and marine wildlife conservation are integrated with those of conventional fisheries management, provides an even more formidable challenge: how to restructure the institutional frameworks in order to accommodate the new stakeholders, their different scientific methodologies and their distinctive policy agendas without risking information chaos and communicative dissonance.

Socio-economic development of fisheries dependent areas

The socio-economic analysis of fisheries dependent areas is not only a field of common interest for the economic and social sciences but also, as the term 'socio-economic' would seem to suggest, an area which favours a commonality of approach. The broad aims of such a project are to define the structural characteristics, diversification strategies and infrastructural needs of these areas. To achieve this, a more closely defined set of objectives is required, *viz*:

- to identify areas where fishing related activities assume a significant level of importance within the local/regional economy;
- to analyse the structural characteristics of such areas in terms of economic and social factors;
- to assess the impacts of fisheries policies on the economic and social structures of such areas;
- to evaluate the opportunities and constraints for diversification of fisheries dependent areas, including *inter alia* the development and transfer of skills;
- to examine the role of economic and social institutions in the adaptation and diversification of fisheries dependent areas.

The term 'socio-economic analysis', which features quite frequently in the literature, confers the impression of a convergence of methodology between the economic and social sciences. But the term 'socio-economic' is one that I have come increasingly to distrust. It is used widely in agricultural sociology where it has come to mean the ways in which social factors (the structural characteristics of farm households, division of labour, gender and generational relations, social networks etc.) conspire to affect the economic perform-

ance of the farm business. Clearly, in this case, the term has been hi-jacked by the social sciences. By contrast, in fisheries, discussion of socio-economic factors has been left mainly to the economists and the concept therefore has been simplified in terms of social costs, income distribution and opportunity costs for labour, with a view to incorporating such factors into the bio-economic model (Charles, 1988). In view of the risk of appropriation of the term, it seems wiser to abandon it and to replace it with the less contentious 'social and economic analysis'.

Concern for the development of fisheries dependent areas - as a policy matter - is quite recent. It was triggered in Europe by the series of *Regional Socio-Economic Studies in the Fisheries Sector*, commissioned by the European Commission in 1991 and undertaken principally by economists. From a social science standpoint, this was a somewhat unpropitious start for the studies adopted an unambiguous, economics centred approach - in line with their terms of reference - to the exclusion of the social variables. The result was a useful, though narrowly constructed, geographical representation of the significance of the fishing industry throughout the European Community.

Although, for some, concern for the development of fisheries dependent areas may be something of a distraction from the central purpose of policy related research, it remains a very relevant field of analysis for both the economic and social sciences. It should serve to highlight the economic and social impacts of fisheries policy and help in constructing appropriate social and regional policies for the amelioration of any adverse impacts, as well as providing valuable data for the recalibration of the fisheries policy itself. As the socio-economic studies made clear, there is a dearth of statistical data describing the conditions in these areas; a prerequisite for the detailed analysis of fisheries dependent areas is the development of appropriate databases. In this connection, the continuing work of LEI-DLO (Dol *et al,* 1996) and of ESSFiN (Otterstad *et al,* 1996) could point towards a fruitful area of collaboration.

Conclusion

In so complex and dynamic a field as fisheries, no one discipline or school of thought can claim intellectual hegemony. The question is not whether a multi-disciplinary approach is appropriate, but in what form it should be promulgated in order to ensure that synergy rather than dissonance is the outcome. The main thrust of this paper has been to demonstrate that the economic and social sciences are distinct intellectual entities. While they may share common interests, they are nonetheless separated by their purpose, philosophy and methodology. This recognition of their separate intellectual identities and their distinctive roles in policy related research is an essential prerequisite for successful collaboration.

Much was made earlier in the paper of the 'common market' that existed within the social sciences. Disciplinary boundaries are, for the most part, no longer vigorously defended; the social sciences share several paradigms, speak broadly the same language, work with similar methodologies and combine a number of complementary skills. The same cannot be said for the relationship between the economic and social sciences. But this is not necessarily a barrier to meaningful collaboration. I am certainly not arguing that the

boundaries between the economic and social sciences should be dissolved; but they should become more permeable. Both groups of disciplines need to be more receptive to the ideas originating outside their own disciplinary boundaries. This should not prove too much of a problem for the social sciences already ensconced in the traditions of a 'common market' in theoretical constructs and methodologies. It may be rather more of a challenge for the economic sciences, especially where they are embedded in a reductionist approach.

The time is not quite right for a common, fully integrated research strategy embracing the economic and social sciences. The marriage, if there is to be one, needs to be prefaced by a period of courtship during which each partner becomes more thoroughly aquainted with - and tolerant of - the virtues and vices of the other. It must also be a 'modern marriage' based on equality rather than domination.

The collaborative model that I would favour is therefore not based on a spurious integration of research agendas but upon the pursuit of parallel trajectories in economic and social research, the complementarity of research findings and the continuation of an interactive dialogue.

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The effect of individual quota on the catch composition of the Dutch beamtrawl vessels.

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Part I: differences between the dutch beamtrawl fishery and dutch quota hoppers

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Introduction

Often it is assumed that a decrease in the catch per unit effort (CPUE) is caused by a decrease in stock size. To secure a minimal stock size (MBAL) a decreasing CPUE should lead to management actions (reduction of quota etc.). This is correct if fishermen would

- go to the same fishing areas as they did before;
- fish the same period of the year as they did in the years before;
- fish on the same species as they did before.

The pressure on the quota of one species could lead in a multi species fishery (e.g. beamtrawling) to reactions of the fishermen in the sense that they shift their effort in time and space and that they shift their target species. If this is the case, the CPUE gives a distorted picture of the true catchability of the fish. For instance the last two years we have seen that the quota of plaice is such that Dutch beamtrawl fishermen can easily catch their plaice quotum, but are not able to fish their sole quota. This resulted in a shift in behaviour of the Dutch fishermen in a sense that they target more on sole and shifted their effort to locations (location and period) where the catch composition is in favour of sole. If fishermen start to target explicitly on sole the CPUE of plaice will be lower than if they would fish as they did the year before. On the other hand the CPUE of sole would be higher as expected. We also have observed that other species (i.e. dab, see figures 1a,b,c) have become a more important part of the catch and that fishermen explicitly target on these species. Targeting on other species results is lower CPUE's for plaice and sole. Since many ICES advices are based on (relative changes in) the CPUE it is important to investigate the magnitude of the problem stated above.

Another problem is how the international effort is calculated. In many scientific calculations the effort of several countries is added to get a total. Doing this to get a time series there are two potential problems:

1. if the different countries would not change their fishing behaviour in the same way, one can not add the effort of all the countries to get a total effort that can be compared with effort data of other years;
2. if the target species would change over time it becomes more and more important to be able to split the effort into effort on all the separate species. For example for the beamtrawl fleet it would become important to be able to split the total effort in plaice effort, sole effort, other species effort.

In this report there will be an comparison between Dutch beamtrawl fishermen and Dutch quota hoppers. We use these groups since detailed data on catches and effort of other countries are not available. Comparing these two groups, not only the magnitude of the differences in CPUE is of interest. The differences between these two groups in time is important, since these differences are an example to motivate the importance of the effort problems as stated above and stresses the urgent need for effective methods to be able to divide effort into effort targeting on a specie.

Method

To investigate the problems above one needs very detailed data. Since 1995 the Dutch Ministry of Agriculture, Nature management and Fishery collects the logbooks of all the vessels that land their fish in the Netherlands and store the complete logbook in a database (called VIRIS: FIsh Registration and Information System). This data contains landings of several quota species but also the ICES rectangles where fish is caught. Using the time away from port and the assumption of constant CPUE when several rectangles are fished during one trip, one can do effort and CPUE calculations on a trip/rectangle basis. Since many Dutch quota hoppers land their fish in the Netherlands, the VIRIS database has the detailed data we need to compare the CPUE of the Dutch beamtrawl fleet with the CPUE of quota hoppers.

Using VIRIS some basic plaice and sole data of Dutch beamtrawlers and quota hoppers are presented in table 1. In table 2 some results are presented about the first half years of 1995-1997. Table 3 gives some insight in catches and effort per HP-group. The tables show enormous differences in CPUE between Dutch beamtrawlers and quota hoppers. From table 2 we see that the Dutch beamtrawl effort is almost the same in 1997 as in 1996, however the 1997 catches of plaice/sole are 18.53% resp. 40.75% less than in 1996. Quota hoppers also have lower catches but to a lesser extent. In 1996 the quota hoppers applied less effort than in 1995 but had higher plaice catches (11.14% more), this is in strong contrast with the Dutch beamtrawlers that saw decreasing catches with almost the same effort.

The CPUE depends on many factors, the most important ones are:

- fish stock sizes;
- vessel characteristics (i.e. engine power);

- period (in which month the effort is employed);
- location (in which ICES rectangle is fished);
- target species (plaice, sole or other...).

Since Dutch beamtrawlers and quota hoppers do not fish in the same area at the same time of the year, we have to filter out the vessel, period, and location effects before we can compare the two groups. This is done by estimating an ANOVA model. To limit the statistical analysis so we would not get too many parameters that had to be estimated we decided to look at two groups of vessels and limit the number of areas. When comparing the CPUE in table 3 is looks sensible to do statistical analysis on two groups of vessels:

1. vessels with an engine of 300 HP or less (about 160 Dutch vessels and 30 quota hoppers);
2. vessels with an engine of more than 300 HP (about 210 Dutch vessels and 40 quota hoppers).

One of the possible reasons for the difference between these two groups is the possibility to switch to shrimp fishing (small vessels).

Looking at the CPUE per ICES rectangle during the year we decided to choose 7 areas. Figure 2 presents the 7 areas. In the case that a vessel visited two areas in the same trip we took the whole catch and stored it into the area that had the highest catch (this is done to decrease the number of outliers in the ANOVA model). As a measure for CPUE we took the catch per day-at-sea, i.e. all the calculation are *not* done with HP-days and the days-at-sea are based on the total time away from port (so including steam time, search time etc.). In all the statistical analysis presented below data from 1 January 1995-30 June 1997 is used.

The ANOVA model used in the statistical analysis is:

$$\log CPUE = \text{constant} + {}_1 \log HP + {}_{2ij}\ month_i*area_j + {}_{3ijk}\ flag_i*month_j*year_k$$

with:

CPUE	Catch of plaice or sole divided by days-at-sea
HP	Engine power of the vessel
month	January, February, ..., December
area	areas as given by figure 2
flag	has value 0 if it is a Dutch beamtrawler and 1 if it is a quota hopper
log	the natural logarithm (applied to give outliers less effect)
*month*area*	the model is estimated for all months and all areas (12*7=84 coefficients)
*flag*month*year*	all groups, all months, and all years (gives 72 coefficients (2*12*3))

The variable *month*area* represents the period- and location effect. The coefficients of the *flag*month*year* variable indicate the differences in CPUE of Dutch beamtrawl vessels and quota hoppers after filtering out the vessel, period, and location effect. Looking at the differences of the coefficients of *flag*month*yea*r on can calculate the relative (percentual) differences in CPUE [1]. These (relative) differences can be plotted and show how the differences in time (i.e. January 1995-June 1997) are evolving.

The ANOVA model described above is estimated four times:

1. for plaice and for vessels with more than 300 HP);
2. for plaice and for vessels with 300 HP or less;
3. for sole and for vessels with more than 300 HP;
4. for sole and for vessels with 300 HP or less.

The results of the four ANOVA analysis are presented in the figures 3-14. For all of the four models three figures are presented:

1. the relative difference between the CPUE of Dutch beamtrawlers and quota hoppers for every month (January 1995-June 1997). If for a given month the difference is +20% this should be translated to: the CPUE of Dutch fishermen after filtering out the vessel, location, and period effect, is 20% higher than the CPUE of quota hoppers. A difference of -20% would indicate that quota hoppers have a 20% higher CPUE as compared to Dutch beamtrawlers. NB.: we do not present the CPUE in any of the three figures, we only show *differences* between CPUE;
2. to be able to see if the differences between CPUE is changing over time a figure of the differences as compared to 1995 is presented. For example for January 1995 the difference between Dutch beamtrawlers and quota hoppers is -11.94%, in January 1996 it is -17.07. This means that the difference in CPUE of Dutch beamtrawlers as compared to quota hoppers has increased by 5.13%. A negative value in the second figure hence indicates an increase in the relative difference of quota hoppers as compared to Dutch beamtrawlers, or if you want a decrease in CPUE of Dutch beamtrawlers as compared to quota hoppers;
3. the third figure is almost the same as the second figure, except that all changes are weighted by the size of the difference of 1995. This is done to better compare differences in time, i.e. when the difference in already high in 1995 is will become less dominant in the third figure.

[1] Using a multiplicative model (taking the logarithme) the differences in the coefficients of -1 between the Dutch beamtrawlers and quota hoppers means CPUE(NL)=exp(-1)CPUE(quota hopper), i.e. this means CPUE(NL)=0.3678 CPUE(quota hopper) and hence there is a difference in the Dutch CPUE as compared with the quota hoppers CPUE of 63.22%.

Results for vessels with more than 300 HP

For plaice the differences in CPUE is always negative (figure 3), this indicates that the CPUE of quota hoppers is always higher than for Dutch beamtrawlers. This is what one would expect since quota hoppers do not have a large sole quotum and target more on plaice than the Dutch beamtrawlers. Figure 6 shows that the CPUE of sole is always much higher for Dutch beamtrawlers than for quota hoppers. This difference can be very large: up to more than 300% and often more than 100%. The Dutch beamtrawlers clearly are experts in fishing sole. The figures 4 and 5 show an increase in the differences between the CPUE of plaice in benefit of the quota hoppers. Only the months May 1996, June and July 1997 have a positive effect for the Dutch beamtrawlers, in a sense that the difference between quota hoppers and Dutch beamtrawlers has decreased but is still in favour of the quota hoppers. For sole the figures 7 and 8 show that the differences in 1996 and 1997 have decreased (as compared to 1995), i.e. suggesting that the sole CPUE for quota hoppers have become better as compared to Dutch beamtrawlers. Only the months November an December 1996 are extremely positive. This can be explained by the fact that at the end of 1996 the Dutch quotum for plaice was full and fishermen were highly motivate to fish on sole and perhaps also did some high grading of plaice (in a sense that those who would get the highest price were landed).

After applying the ANOVA model the differences between Dutch beamtrawlers and quota hoppers do not contain vessel, location and period effects. The difference can only be explained by the target species or by high grading (applied by one group and not both). The shift in target species can be explained by the problems one has with his quotum. A good example is certainly the months November, December 1996 for plaice.

Since the relative plaice CPUE and sole CPUE have become better for quota hoppers this suggest that Dutch beamtrawlers shift to other species (e.g. dab). Since dab is not a quota species the landings can not be found in the logbooks and we can not apply an ANOVA analysis as above on dab.

Results for vessels with 300HP or less

From figure 9 one can derive that the plaice CPUE for quota hoppers is always higher than for Dutch beamtrawlers (only the month September 1996 the Dutch CPUE is higher). The differences as compared to 1995 (figures 10 and 11) show that there is sometimes a positive and sometimes a negative effect but over the total period 1996-1997 there is a positive effect, meaning that the CPUE of Dutch beamtrawlers has become better compared to the quota hoppers. The question is wether this can be explained by the fact that the quota hoppers in Germany have since 1996 some catch restrictions in the plaice box.

Figure 12 shows that in the period January 1995 to May 1996 the sole CPUE for quota hoppers is better than the CPUE of Dutch beamtrawlers. After May 1996 the CPUE of Dutch beamtrawlers is better. The figures 13 and 14 show that the differences in CPUE has become better for the Dutch fleet as compared to the quota hoppers.

The results of the 300 HP or less group is opposite of the more than 300 HP group. It looks as if the Dutch Eurocutter fleet performs a better job as compared to the quota hoppers. With the more than 300 HP group the quota hoppers perform better. Looking at the results it is difficult to say if the Dutch Eurocutter fleet changed to other target species (dab).

Conclusions and remarks

The differences in CPUE between Dutch beamtrawlers and quota hoppers is high, even if one filters out the vessel, location and period effects the difference is still high and increasing over the last few years. The increasing differences are the result of quota restrictions that have more effect on the larger Dutch beamtrawlers than on the quota hoppers. This leads to effects like "high grading" and shifting effort to other target species. The results of this report motivates further research how international effort should be calculated. Also one should be careful how to interpret the international effort time series since the behaviour of Dutch beamtrawlers changed drastically the last 2.5 years. The possible solution lies in splitting effort to effort on separate target species. A first attempt is presented in part II of this research: "calculation of directed effort on plaice and sole".

From the results presented above it is clear that fishermen change their behaviour due to restrictions on their quota. This reaction does not take years and the magnitude of the reactions can be quit large (shifting location and target species).

This research is completely about CPUE. The differences in CPUE can by no mean be directly translated into differences in income (costs and earnings). Further research is needed if one is interested in the costs and earning effects due to decreasing quota on the different groups of vessels.

Table 1 Some plaice and sole statistics over the period 1995-1997

Catches (live weight tons)			
1995	NL	Quota hoppers	% QH/NL
plaice	44100	13536	30.69
sole	20900	1747	8.36
1996	NL	Quota hoppers	% QH/NL
plaice	35206	14585	41.43
sole	15523	1194	7.69
Effort (HP-days)			
1995	NL	Quota hoppers	% QH/NL
plaice	84393810	12803489	15.17
sole	81400550	11393095	14.00
1996	NL	Quota hoppers	% QH/NL
plaice	70904260	12429670	17.53
sole	70056300	9976300	14.24
CPUE (x10^6)			
1995	NL	Quota hoppers	% QH/NL
plaice	522.5502	1057.21183	202.32
sole	256.755	153.338491	59.72
1996	NL	Quota hoppers	% QH/NL
plaice	496.5287	1173.40203	236.32
sole	221.5789	119.68365	54.01

Table 2 Some catch and effort data plaice and sole over the first half year of 1995-1997

Netherlands

Plaice	catch	%	effort	%	CPUE
jan-jun 95	23780		42731		556.50
jan-jun 96	19640	-17.41	36118	-15.48	543.77
jan-jun 97	16000	-18.53	35900	-0.60	445.68
	(TONs)		(1000 HP-days)		(*1000)

Sole	catch	%	effort	%	CPUE
jan-jun 95	10094		40458		249.49
jan-jun 96	9012	-10.72	34816	-13.95	258.85
jan-jun 97	5340	-40.75	34494	-0.92	154.81
	(TONS)		(1000 HP-days)		(*1000)

Quota hoppers

Plaice	catch	%	effort	%	CPUE
jan-jun 95	6617		6256		1057.70
jan-jun 96	7354	11.14	6357	1.61	1156.83
jan-jun 97	6272	-14.71	5880	-7.50	1066.67
	(TONS)		(1000 HP-days)		(*1000)

Sole	catch	%	effort	%	CPUE
jan-jun 95	888		5496		161.57
jan-jun 96	753	-15.20	5344	-2.77	140.91
jan-jun 97	479	-36.39	5092	-4.72	94.07
	(TONS)		(1000 HP-days)		(*1000)

Table 3 Some plaice and sole statistics per HP-groups over the period 1995-1996

Catch plaice Netherlands

HP-group	1995	1996	%growth	
1 - 100 HP	5	7408	148060.00	*
151 - 200 HP	606	0	-100.00	
201 - 260 HP	12399	21510	73.48	
261 - 300 HP	1943219	1875265	-3.50	
301 - 400 HP	38	73	92.11	*
401 - 600 HP	8766	1433	-83.65	
601 - 800 HP	272441	86704	-68.18	
801 - 1100 HP	483816	353106	-27.02	
1101 - 1300 HP	1213497	783596	-35.43	
1301 - 1500 HP	1024272	420532	-58.94	
1501 - 2000 HP	21928808	17674820	-19.40	
2000 + HP	17212623	13981638	-18.77	

Catch plaice Quota hoppers

HP-group	1995	1996	%growth	
1 - 100 HP	0	0		
151 - 200 HP	0	0		
201 - 260 HP	0	0		
261 - 300 HP	2921546	2454345	-15.99	*
301 - 400 HP	0	0		
401 - 600 HP	0	0		
601 - 800 HP	320699	412205	28.53	
801 - 1100 HP	755340	1006438	33.24	
1101 - 1300 HP	1648638	1709295	3.68	
1301 - 1500 HP	2342404	2355394	0.55	
1501 - 2000 HP	3776979	4038509	6.92	
2000 + HP	1770137	2609309	47.41	

Effort Netherlands

HP-group	1995	1996	%growth	
1 - 100 HP	61	4063	6560.66	*
151 - 200 HP	7012	0	-100.00	
201 - 260 HP	38834	35740	-7.97	
261 - 300 HP	2601524	2331442	-10.38	
301 - 400 HP	1400	7610	443.57	*
401 - 600 HP	75531	57802	-23.47	
601 - 800 HP	293288	158800	-45.86	
801 - 1100 HP	770287	526401	-31.66	
1101 - 1300 HP	2112604	1367264	-35.28	
1301 - 1500 HP	1915239	737427	-61.50	
1501 - 2000 HP	37716631	31626927	-16.15	
2000 + HP	38861393	34050780	-12.38	

Effort Quota hoppers

HP-group	1995	1996	%growth	
1 - 100 HP	0	0		
151 - 200 HP	0	0		
201 - 260 HP	0	0		
261 - 300 HP	1262582	1085342	-14.04	
301 - 400 HP	0	0		
401 - 600 HP	0	0		
601 - 800 HP	166700	160567	-3.68	
801 - 1100 HP	715498	669117	-6.48	
1101 - 1300 HP	1656854	1609862	-2.84	
1301 - 1500 HP	2321480	1920066	-17.29	
1501 - 2000 HP	4326474	3976464	-8.09	
2000 + HP	2353901	3008249	27.80	***

CPUE plaice Netherlands

HP-group	1995	1996	%growth
1 - 100 HP	0.0819672	1.823283	2124.41
151 - 200 HP	0.0864233	0	0.00
201 - 260 HP	0.3192821	0.601847	88.50
261 - 300 HP	0.7469541	0.804337	7.68
301 - 400 HP	0.0271429	0.009593	-64.66
401 - 600 HP	0.1160583	0.024792	-78.64
601 - 800 HP	0.9289197	0.545995	-41.22
801 - 1100 HP	0.6280984	0.670793	6.80
1101 - 1300 HP	0.5744082	0.573112	-0.23
1301 - 1500 HP	0.5348011	0.570269	6.63
1501 - 2000 HP	0.5814095	0.558854	-3.88
2000 + HP	0.4429235	0.410611	-7.30

CPUE plaice Quota hoppers

HP-group	1995	1996	%growth
1 - 100 HP			
151 - 200 HP			
201 - 260 HP			
261 - 300 HP	2.3139455497	2.2613563282	-2.27
301 - 400 HP			
401 - 600 HP			
601 - 800 HP	1.9238092382	2.5671837924	33.44
801 - 1100 HP	1.0556842926	1.5041285754	42.48
1101 - 1300 HP	0.9950412046	1.0617649215	6.71
1301 - 1500 HP	1.0090132157	1.2267255396	21.58
1501 - 2000 HP	0.8729924183	1.0156030584	16.34
2000 + HP	0.7520014648	0.867384648	15.34