

# **BENEFITS OF RESPONSIBLE FISHING: THE IMPACT OF AN INNOVATIVE TRIAL OF VOLUNTARY RESTRAINT**

Philip Rodgers, Erinshore Economics Limited, phil@cferltd.com  
Andy Read, North Sea Fishermen's Organisation, aread@dsml.co.uk

## **ABSTRACT**

Early in 2002, members of two Producer Organisations (POs), the North Sea Fishermen's Organisation in Britain, and the Dutch Cooperative Producentenorganisatie Oost Nederland, realised that their quotas of plaice and sole were insufficient to last until the end of the quota period. Vessels have in the order of 70-80% of their needs for sole but only 50-60% plaice. In response they voluntarily tied up their vessels periodically early in the year. This was repeated in 2004 and 2005.

The objective of this study, which was part-funded by the European Commission Directorate-General for Fisheries and undertaken by the two POs and a firm of economists, was to identify whether the expected improved price stability for plaice and sole on the Urk auction market where most of the fish is sold, was achieved, and to estimate the amount of the improvement in revenues and cost-savings for the fleet.

Inverse demand functions were calculated for lemon sole, dover sole, and plaice and the results suggest that revenue is maximised by spreading supplies evenly across any given time period. This was confirmed by simulations of the estimated model which were run to predict what would have been the revenue in the period that the tie up scheme was in force against an alternative scenario of the scheme not being in force. The aggregate gains in earnings are calculated to have been up to 18%.

From a sample of vessels' costs and earnings accounts statistical evidence emerged that the profitability was higher in the years when the tie-up scheme was in place, though no significant change in revenue and crew share was found. While individually the evidence of the econometrics and statistical tests is not conclusive (and that of the statistical tests need not be attributable to the tie-up scheme), combined, the two pieces of evidence do suggest that the tie-up scheme did result in the intended higher revenues and profits, and a more stable market.

**Keywords:** Fisheries Economics, Fishery Management, Responsible Fishing

## **Introduction**

Early in 2002, members of the North Sea Fishermen's Organisation (NSFO), in the United Kingdom, and of the Cooperative Producentenorganisatie Oost Nederland UA (CPO), in the Netherlands, realised that quotas of plaice and sole on their North Sea fishing grounds were insufficient to ensure a fishery until the end of the quota period and would be quickly exhausted. In response to this realisation, NSFO members agreed voluntarily to tie up their vessels for one week in four during the first three months of the year. Similarly, members of CPO limited their fishing to 40 days at sea during the first quarter, with at least 3 weeks without any fishing activity at all. The action was repeated under the same principle but slightly different terms in 2004 and 2005 but not in 2003.

The membership of CPO is made up of beam trawlers fishing for flatfish in the North Sea. They land almost exclusively to the markets at Urk and Harlingen. CPO membership in 2004 consisted of more than 100 vessels of widely varying sizes. The annual turnover of CPO members is approximately €15 million.

The NSFO is a Producer Organisation (PO) with a membership of some 25 active vessels representing mainly British and Anglo-Dutch beam trawlers, most of which originate in the Dutch port of Urk. Total income of the 23 North Sea beam trawlers in the NSFO, in 2004 was approximately €30 million. A further 7 Urk beam trawlers with similar fishing patterns work within other UK Producer Organisations. The Anglo-Dutch vessels land mostly into the fish auction at Urk, or Harlingen, also in the Netherlands and the next most important market.

The Dutch vessels operate under an Individual Transferable Quota (ITQ) management system where each fishing company originally had a quota given according to previous fishing practice and which could subsequently be traded. Under the UK's Fixed Quota Allocation (FQA) system each vessel has been allocated a share of the UK fish quotas also based on track record. The vessel quotas are allocated to a vessel's PO and administered by the PO. It is effectively very similar to an ITQ system since quota may be, and is, traded, both between PO members and between POs.

The average British North Sea beam trawler has access to significantly more annual plaice quota than average Dutch flagged vessels (approximately 400 tonnes compared to 175), and significantly less sole quota (15 tonnes compared to 50), leading to different fishing patterns evolving between what are physically very similar vessels.

Vessels each had (and still have) significantly less quota of sole and plaice than they are capable of catching; they have in the order of 70-80% of their needs for sole but only 50-60% of the plaice they could catch.<sup>1</sup>

The fish action at Urk is the leading fish auction in the Netherlands, taking a third of all Dutch sales, with a throughput of 35,500 tonnes in 2004.

## **Problems of Estimation**

Early work in estimating the relationship between the quantity of fish supplied and the price achieved at fish auctions concentrated on the market for fish in the USA, where Bell (1968), Nash and Bell (1969), and Waugh and Norton (1969) established the empirically the inverse linkage between the price obtained for fish and the quantity landed.

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<sup>1</sup> This should not be taken as evidence, *per se*, of over-capacity in the fleets and even less a measure of it. It is perfectly normal for an industry to work at less than full capacity. Operating at 35% less than full capacity is not at all uncommon in other industries and since these fleets both exist under efficient management regimes historic overcapacity is being shed and they can be expected to be approaching an industry optimum by economic means. That having been said, it is equally clear that the sharp falls in quota of recent years have left fleets needing a better quota to use their capital efficiently.

Gates (1974) confirmed the relationship and showed the importance of including the size of fish as an explanatory variable in the inverse demand function.

In Europe, a number of studies since Ioannidis and Whitmarsh (1987) estimated the demand relationship for plaice in the United Kingdom and found the market to be highly competitive. They supplied a theoretical underpinning for assuming that the supply of fisheries products at the quayside is indeed perfectly inelastic and that the demand function is therefore identified. A conclusion of their study was that the direction of causality ran from quantity to price, confirming that the supply of fish is exogenous in the short-run.

### **Cointegration of Price and Quantity**

Several papers have now established that fish prices and quantities sold at auction are often cointegrated. Ioannidis and Matthews (1995) showed that the prices and quantities of both cod and haddock in the British market were cointegrated and proceeded to estimate demand functions for those species accordingly.

However, the time period covered by the data is too short for the impact of shocks of the significance of, for example, 1970 oil prices, to be identified. Since these types of shock were intended to be accommodated by analysis for co-integration and the use of error correction mechanisms, there is no justification for pursuing this approach and testing and correction for co-integration has not been carried out.

### **Integration of Markets**

The American estimates of price elasticities are consistently lower than those estimated for the European market until the most recent. Stigler (1969) established the Law of One Price and Nielsen has shown that to ignore the Law of One Price may invite estimates of price elasticity of demand which are excessive (Nielsen 1999).

Thus the continental differences may be due to the fact that whereas both the American and European markets are each single integrated markets, empirical work has often treated the USA as a single market but European Union member states as a set of independent markets.

Neilsen (1999) is especially valuable in that not only does he show the importance of market integration, he also offers a simple method for correcting estimates made where an apparent market is in reality part of a sub-market.

Guillotreau *et al* (1998) concluded that the markets are integrated for roundfish in Belgium, Denmark, France, Germany and United Kingdom.

## Econometric Investigation of the Tie Up Scheme using the Inverse Demand Function

The data used cover the quantities and values of sales of plaice and sole at Urk on a daily basis. Data on daily landings and the prices achieved at Urk have been provided by Visafslag Urk – the Urk fish auction market. They include landings and revenues achieved for lemon sole, dover sole, and plaice by EU market size category (Council Regulation 2406/96) from 1<sup>st</sup> January 2002 to 31<sup>st</sup> March 2004, a total of 584 observations. Sales were also disaggregated by nationality of the vessel landing the fish; namely, Belgian, Danish, German, Irish, Dutch, Norwegian, and British.

Since this covers two periods when a collective agreement to tie-up was in force, the data proved adequate for the needs of the study. The data were not corrected for inflation. Obtaining an index for daily inflation is impossible, and to interpolate rates on inflation on a daily basis between monthly statistics would risk introducing more errors than it removed. The time period covered is short and inflation has not been a serious problem in the Netherlands.

The inverted demand curve for each of the three species confirmed the expected downward gradient of the curve in establishing the market price. However, tests on the data suggest the presence of heteroskedasticity, and outliers.

It became clear early on that the market has no memory. There are no lagged variables influencing the prices determined. This confirmed the belief that the use of a method which corrected for co-integration would have been inappropriate. The use of lagged dependent variables to represent seasonality on a weekly and monthly basis was not possible as days when there were no sales disrupt the series. Therefore dummy variables were used instead but they offered no indication of seasonality in prices for any of the three species and although they gave a markedly improved coefficient of correlation corrected for degrees of freedom, the temptation to accept them in preference to a model showing the cross-elasticities was resisted.

Functions of the form

$$P_{f,t} = \phi_0 Q_{f=1toF,t}^{\phi_f=1toF_1}$$

were estimated using Seemingly Unrelated Regression (SUR), where the  $P$  are the prices of the species,  $f=1$  to  $F$ , the  $Q$  are the quantities offered for sale. The estimated equations for the three species are set out in Tables 4.2a-c.

*Table 3a: Estimated inverse demand function for lemon sole*

Lemon Sole	Parameter Estimate	t-Statistic and Significance
Constant Term	9.0590	
Lemon Sole Own-Quantity	-0.9584	22.38**
Dover Sole Cross-Quantity	-0.0967	2.94**
R-bar-squared	0.763	

*Table 3b: Estimated inverse demand function for dover sole*

<b>Dover Sole</b>	<b>Parameter Estimate</b>	<b>t-Statistic and Significance</b>
Constant Term	9.2750	
Dover Sole Own-Quantity	-0.4586	16.70**
Plaice Cross-Quantity	-0.2426	9.79**
R-bar-squared	0.845	

*Table 3c: Estimated inverse demand function for plaice*

<b>Plaice</b>	<b>Parameter Estimate</b>	<b>t-Statistic and Significance</b>
Constant Term	8.3960	
Plaice Own-Quantity	-0.6998	52.37**
$\bar{R}^2$	0.826	

\*\* indicates significant at the 1% level.

The explanatory power of the estimates indicated by the  $\bar{R}^2$  is good, higher than is often the case for landings of fish. This is believed to be due to the quality of the data provided by Visafslag Urk and the fact that the data relate to auctions of fish through the market. There are no official statistics from any of the six countries whose vessels sold their catch through Urk which might have been corrupted by misreporting. The mean size variables did not prove significant.

### **The Simulation Tests**

The next stage was to compare, by simulation, what the model calculates were the earnings with the tie-up scheme in place to what it suggests would have been the earnings if it had not been. (It is necessary to let the model estimate the earnings under the scenarios of the tie up scheme being in place and not in place in order to be able to compare like-for-like when it is asked to estimate an alternative scenario.)

The alternative scenario chosen for this study has been to assume that the monthly sales of fish through the market by British and Dutch vessels in each month of the tie-up scheme's operation would have been put through in the first three weeks of each month. This was achieved by raising the level of actual landings proportionately. Supplies from other countries through the market were left unchanged.

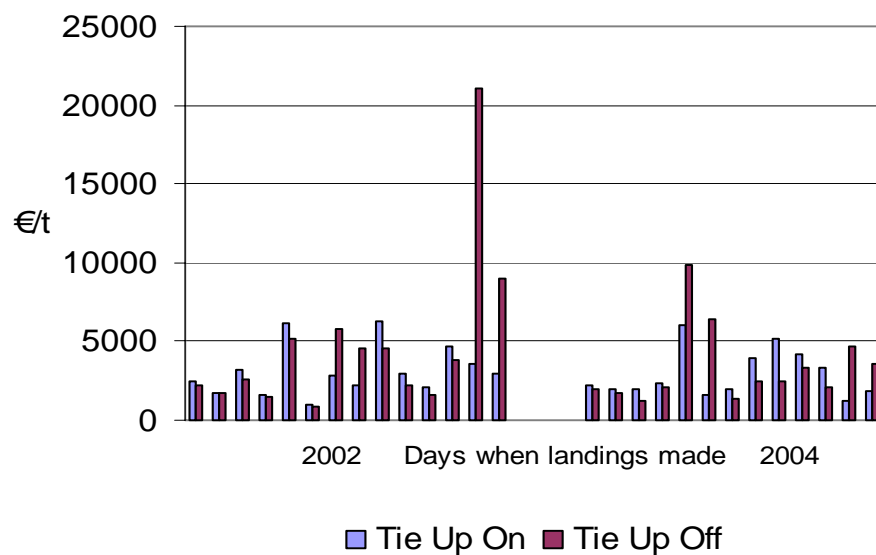
*Table 4: Aggregate Gains in Earnings Arising from the Tie-Up Scheme*

	<b>CPO</b>	<b>NSFO</b>
2002	16%	15%
2004	12%	18%

The prices for each of the three species estimated by the model both with and without the tie-up scheme in place are set out in Figure 5a-c.

*Figure 5a: Estimated prices of lemon sole with and without the tie-up scheme operating*

### Lemon Sole



*Figure 5b: Estimated prices of dover sole with and without the tie-up scheme operating*

### Dover Sole

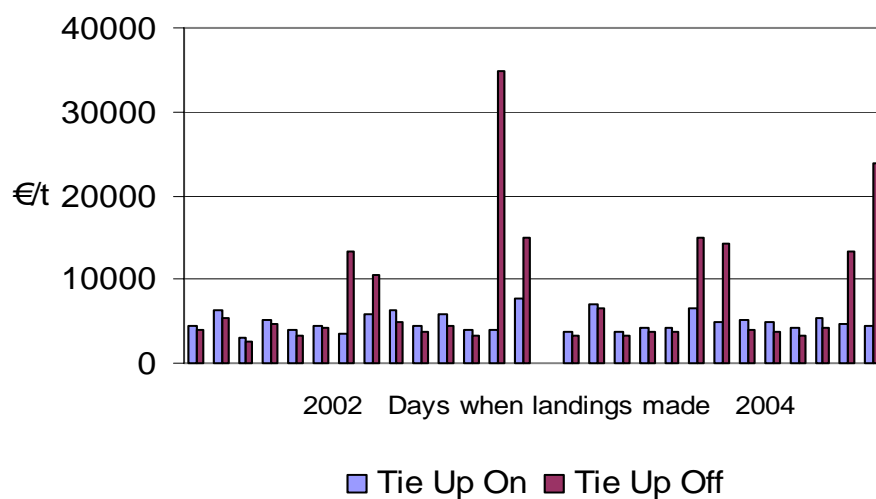
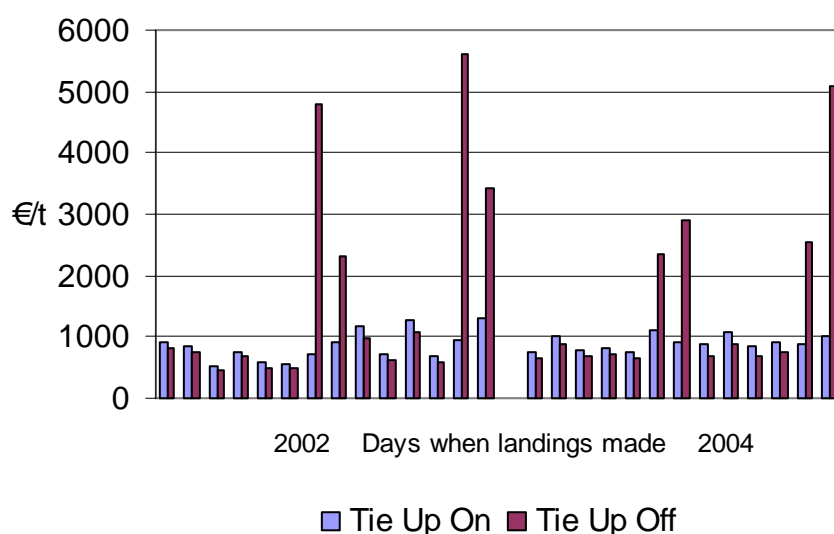


Figure 5c: Estimated prices of plaice with and without the tie-up scheme operating

## Plaice



In the case of all three species examined, it can be seen that prices are more volatile when the tie up scheme was not operating.

## Statistical Analysis of the Impact of the Tie-Up Scheme using Costs, and Earnings Data

To confirm whether profitability might have improved as a result of the scheme, it was decided to assemble costs and earnings data for a sample of vessels and to test whether a number of variables were significantly different when the scheme was in operation. The variables tested were revenue, costs, profits, profits as a percentage of revenue, crew share, and crew share as a percentage of revenue

Costs and earnings data were obtained for a sample of nine vessels for the years 1999 to 2003, the latest available. Eight vessels were members of CPO and the ninth a member of NSFO, all fishing from Urk. In 1999 one vessel was omitted because of missing data and in 2002 one set of observations was omitted as the vessel was replaced and there had clearly been an unusual impact on the costs and earnings for the year. Thus in the period 1999 to 2001 and 2003 there was a total sample of 35 observations and in 2002, the year when the tie-up scheme was in place, a sample of 8 observations.

The data were adjusted to correct for inflation using the EU Harmonised annual average consumer price index. One-tailed t-tests under the assumption that the variances were unequal were conducted on the means of the sample statistics, revenue, profits and profits as a percentage of revenue.

The alternative hypothesis,  $H_1$ , was that each was significantly higher at the 5% level in 2002 when the tie-up scheme was in place than in the remainder of the period 1999 to 2003 when it was not. The results are set out in Appendix 2.

For revenue, the t-statistic is not significant and we cannot reject the null hypothesis,  $H_0$ , that there is no difference between the revenue obtained in 2002 when the tie-up scheme was in force and in the other years.

This is not in conflict with the findings of the econometrics which estimated the impact on revenue had the tie-up scheme not been in force. Combined the two different methods of analysis suggest that if the tie-up scheme had not been in force in 2002 the level of revenue would have been noticeably lower than usual. This concurs with the impact of the bad weather experienced.

While the primary effect of the tie up scheme was expected to be on the stability of prices, a secondary effect may have occurred on the costs of the fleet. The impact could have been that the congestion cost experienced by the fleet was lowered. The tests suggest that costs although they were on average 12% lower in 2002 could not be considered statistically to be significantly below normal.

Profits are a sharper test as they represent the difference between the revenue and costs and are thus more volatile in the face of commercial pressures and, indeed, the t-test of profits confirms that the null hypothesis, that the level of profit in 2002 was the same as in other years, can be rejected. The evidence is quite strong with a likelihood of only about 1 in 30 of being incorrect. A similar result was obtained for profits as a percentage of revenue.

It should be noted that it does not necessarily follow that the finding, of significantly higher profits during the year in which the tie-up scheme was in place, was brought about by the tie-up scheme itself. However, we are not readily able to offer any coincidental cause.

A possibility might have been abundant stocks but neither plaice nor sole stocks were out of the 1999 to 2003 range in 2002, as shown in Figure 5.1. There was however, a slight upward trend in stocks of plaice, but no discernible trend in the biomass of sole.

It is possible that the bad weather in late 2002 had more influence in holding up prices but plaice and sole have not been reported as having elasticities which would increase revenue as a result of generally lower landings. The evidence from the econometrics is that improved stability of prices resulting from smoother landings has made the difference.

While these results suggest that profits were higher in 2002 than the other years tested, they do appear to support the view that the Dutch fleet was prevented from taking its quota owing to bad weather in the later part of the year. This conclusion is supported by the observation that revenue to the fleets was not found to be higher during 2002.



## **Discussion and Inferences**

The results found by the econometric testing corroborate the work of earlier studies that have found an inverse relationship between the amount of sole and plaice available and the prices achieved at auction. They also verify the finding that the price of both is fairly elastic but relatively low.

The value of the elasticities estimated and the subsequent simulation of an alternative landings pattern indicate that the fleet did indeed benefit from the collective restraint in supplying fish to the market in a more orderly fashion than might otherwise have occurred. However, there are some weaknesses indicated by the statistical tests of the data. It was disappointing that a relationship between the price achieved and the average size of fish being offered for sale was not found, and likewise that there appears to be no seasonal influence on prices at either a daily or monthly level.

The statistical test on the costs and earnings data also indicate some benefit from the collective action to smooth the pattern of landings. While the tests give quite a strong indication that profits in the year of the tie-up scheme were better than they would have been in a free-for-all, the question of causation is not proven.

Individually the evidence of the econometrics and statistical tests is not strong. Indeed, that of the statistical tests need not necessarily be attributable to the tie-up scheme at all. However, combined, the two pieces of evidence do suggest that the tie-up scheme did result in higher revenues and profits than would have been available to the fleets if the vessels had not collaborated in the tie-up scheme.

Nevertheless, despite some statistical problems with the data, it is the conclusion of this study that the collective behaviour of the two fleets of beam trawlers belonging to CPO and NSFO members did achieve the objective of making gains from more stable markets, and that the processors, caterers, retailers and consumers of flatfish will have benefited accordingly.

The collective behaviour of the beam trawl fleets is unusual in fisheries and has wider implications. Beam trawler owners have often been accused of being among the least responsible of fishing enterprises. This study suggests that if a good case can be made to them they are capable of leading the way if necessary towards responsible fishing.

There is a further inference that can be drawn that is of some importance throughout the fishing industry in Europe. This study suggests that in many fish markets, fleets could improve their own incomes by collective behaviour to stabilise markets through providing a steady supply rather than by racing to fish and then racing to the auction.

In many industries such collective behaviour might prove detrimental to the interests of the consumer, but in the particular circumstances in which fisheries are to be found operating, it appears to offer benefits to the fleets, processors, caterers, retailers and consumers alike, with no-one losing.

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## Appendix 1

### *Results of Econometric Estimation of Inverse Demand Functions*

#### **Method of Estimation: Seemingly Unrelated Regression**

Number of Observations 584

<b>Parameter</b>	<b>Estimate</b>	<b>Standard Error</b>	<b>t-statistic</b>
Constant Lemon Sole	9.059	0.1319	68.69**
Own-Quantity of Lemon Sole	-0.9584	0.0428	-22.38**
Cross-Quantity of Dover Sole	-0.0967	0.0329	-2.942**
Constant Dover Sole	9.275	0.1015	91.43**
Own-Quantity of Dover Sole	-0.4586	0.0275	-16.70**
Cross-Quantity of Plaice	-0.2426	0.0248	-9.798**
Constant Plaice	8.396	0.1210	69.37**
Own-Quantity of Plaice	-0.6998	0.0134	-52.37**

	<b>Inverse Demand Function for Lemon Sole</b>	<b>Inverse Demand Function for Dover Sole</b>	<b>Inverse Demand Function for Plaice</b>
Mean of dependent variable	4.415	4.984	3.221
Standard deviation of dependent variable	4.184	3.565	4.054
Sum of squared residuals	2430	1146	1671
Variance of residuals	4.161	1.963	2.862
Standard error of regression	2.040	1.401	1.692
$R^2$	0.7631	0.8453	0.8262
Durbin-Watson statistic	1.783	1.937	1.948

#### **Simulation Results**

<b>Year</b>		<b>Free for All</b>	<b>Tie-Up Scheme in Place</b>	<b>Tie-Up Scheme in Place versus Free for All as a percentage</b>
2002	Dutch Vessels	2901421	3375695	1.163
	British Vessels	1084602	1255004	1.157
2004	Dutch Vessels	3317044	3719132	1.121
	British Vessels	1270983	1511537	1.189

## Appendix 2

### *Results of the Statistical Testing of Data for 2002 when the Tie-Up Scheme was in force compared to 1999 to 2001 and 2003*

t-Test: Two-Sample Assuming Unequal Variances							
		Revenue	Costs	Profits	Profits as a Percentage of Revenue	Crew Share	Crew Share as a Percentage of Revenue
Variable 1	Mean	1,403,061	1,028,528	374,533	27.40	266,818	18.96
	Variance	145,454,953,338	132,754,451,018	34,476,508,440	202.05	10,359,091,848	23.72
	Observations	8	8	8	8	8	8
Variable 2	Mean	1,401,958	1,173,958	228,000	16.23	276,311	19.76
	Variance	101,115,525,596	92,061,090,481	28,927,148,888	123.41	9,098,670,232	31.09
	Observations	35	35	35	35	35	35
Variable 1 / Variable 2		1.001	0.876	1.643	1.689	0.966	0.959
Hypothesised Mean Difference		0	0	0	0	0	0
Degrees of Freedom		9	9	10	9	10	12
t Statistic		0.008	-1.049	2.045	2.083	-0.241	-0.410
P(T<=t) one-tail		0.497	0.161	0.034	0.033	0.407	0.345
t Critical one-tail		1.833	1.833	1.812	1.833	1.812	1.782
P(T<=t) two-tail		0.994	0.322	0.068	0.067	0.815	0.689
t Critical two-tail		2.262	2.262	2.228	2.262	2.228	2.179