Separating Resource Rents from Intra-marginal Rents in Fisheries' Economic Survey Data

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Economic surveys of fisheries are undertaken in several countries as a means of assessing the economic performance of their fisheries. The level of economic profits accruing in the fishery can be estimated from the average economic profits of the boats surveyed. Economic profits consist of two components—resource rent and intra-marginal rent. From a fisheries management perspective, the key indicator of performance is the level of resource rent being generated in the fishery. Consequently, these different components need to be separated out. In this paper, a means of separating out the rent components is identified for a heterogeneous fishery. This is applied to the multi-purpose fleet operating in the English Channel. The paper demonstrates that failing to separate out these two components may result in a misrepresentation of the economic performance of the fishery.

The purpose in managing fisheries is to ensure that the resource is exploited in an optimal fashion. Optimal exploitation is generally defined in the context of various economic, social and biological (conservation) criteria, the relative weightings of which varies from country to country. For example, in the U.S., the Magnuson-Stevens Fishery Conservation and Management Act (Public Law 94-265) specifies that fisheries managers shall aim to achieve the 'optimum yield' from each fishery. The Act specifies a number of national standards against which fisheries management must be assessed and requires that regional management councils monitor the performance of each fishery under their control with respect to these standards.[1] Similarly the Australian Fisheries Act (1994) requires annual assessment of the biological and economic status of Commonwealth managed fisheries. In Europe, the Scientific, Technical and Economic Committee for Fisheries (STECF) is similarly charged with assessing the biological and economic status of European fisheries.

Biologists have developed a series of reference points against which the biological status of the resource can be assessed (Mace 1994). These involve an assessment of the status of each stock for the fishery as a whole. The key indicator of economic performance is the level of resource rent generated in the fishery. Effectively managed, most fisheries are capable of earning substantial levels of resource rent (Arnason 1993). Resource rent is the return to the owner of the resource. For example, land rent is the return to the owner of the land representing the value of the land in the production process. The price of land reflects the capitalized value of all future rents in a perfect market. In fisheries, resource rent is the return to the owner of the fishery resource, and represents the value of the input generated by the fish stock in the production process.

In an unregulated fishery, resource rent is dissipated through excessive levels of effort being applied to the stock (Gordon 1954). Hence, resource rent can only be realized through fisheries management and for this reason is sometimes called management rent (Anderson 1989).[2] Consequently, the measurement of rent is important in terms of measuring the effectiveness of management.

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[1] See Sections 301, 402 and 404 of the Act.

[2] In this paper, the term resource rent and management rent (or returns to management) are assumed synonymous. However, the term resource rent is used in the analysis.

In practice, assessment of the economic performance of fisheries is derived from economic surveys of the individual fishers participating in the fishery. Regular surveys of economic performance are undertaken in Australia (e.g. ABARE 1998) and most European countries (e.g. Concerted Action 1998; Nautilus Consultants 1998; SJFI 1998; Smit and others 1998) in order to meet the monitoring requirements of their respective fisheries policies. Similar economic data will need to be collected in the U.S. either through surveys or other methods, under Section 404 of the Magnuson-Stevens Act which specifies the areas of research to be undertaken in support of the monitoring requirements of the Act.

However, average values derived from surveys of commercial fishers may be misleading indicators of economic rent in the fishery. A fishery is generally thought to be generating resource rent if the average economic returns to capital in the fishery are greater than normal economic returns. However, in a heterogeneous fleet, above normal profits of individual boats may arise through more efficient practice of the fisher rather than effective management by fisheries authorities. Even in the absence of fisheries management, boats with more highly skilled crew or skipper could be earning above normal profits.

In this paper, we demonstrate that the use of average performance measures will be misleading in fisheries with heterogeneous fleets. However, data collected in economic surveys can be used to separate the economic profits into resource rent and intra-marginal rent at the fishery level. This is examined in both a theoretical context and with reference to a heterogeneous multi-purpose fleet—the UK fishing fleet operating in the English Channel. This fleet has similar characteristics to those found in other multispecies fisheries (for example the Australian South East fishery and the New England groundfish fishery[3]). Hence, the method developed will be applicable to a wide variety of fisheries.

Resource Rent and Average Costs of Effort

The traditional economic model of a fishery (Gordon 1954) is based on the assumption of a competitive homogeneous fleet that has a common cost structure (i.e. the average cost per unit of effort is the same for all boats). Fishers maximize their individual profits based on the costs of the purchased inputs. It is assumed that fisher costs include an allowance for their own labor input and for normal profits representing the opportunity cost of the investment. However, the input generated by the fish stock has essentially a zero cost in the fishing process.

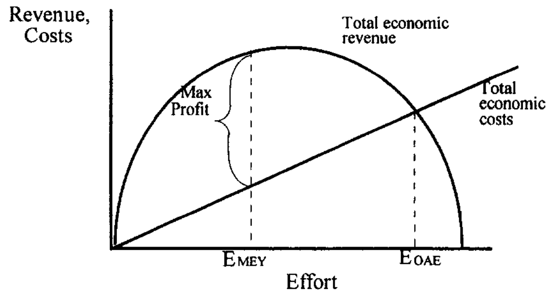

Figure 1. The Traditional Bioeconomic Model.

In a free and open access fishery where property rights are not defined, the existence of any positive economic profits (i.e. super normal profits) is assumed to attract new entrants to the industry, reducing the industry average revenue until all boats are earning zero economic profits (i.e. normal profits), the point of open access equilibrium (OAE). In figure 1, the level of effort (a measure of the total inputs used by the fleet) at this equilibrium is denoted as E_{OAE}. At this equilibrium, there are only normal returns being earned by the factors of production owned by the fisher (i.e. capital and labor). Since the fish input does not have an explicit cost, the potential return to the resource is dissipated.

The economic objective of management is to generate a return to the resource. This is achieved by reducing effort to a point below that of the OAE and ideally to the point that produces the greatest economic profits, or the maximum economic yield (MEY) (figure 1). As the factors of production owned by the fisher are earning normal returns, the economic profits in the traditional model represent the returns to the stock input (i.e. the resource rent). Hence, the level of economic profits of the fleet is an indicator of the performance of management in generating economic benefits from the fishery, given that the assumptions of the model are satisfied.

An implication arising from the traditional model is that average performance indicators are an appropriate description of the fishery since the average boat describes the marginal boat. Consequently, the economic performance of the average boat is equivalent to the economic performance of

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[3] For general descriptions of these fisheries see Pascoe, Robinson and Coglan (1997) for the English Channel fishery, Pascoe (1993) for the Australian South East fishery and Anthony (1990) for the New England groundfish fishery.

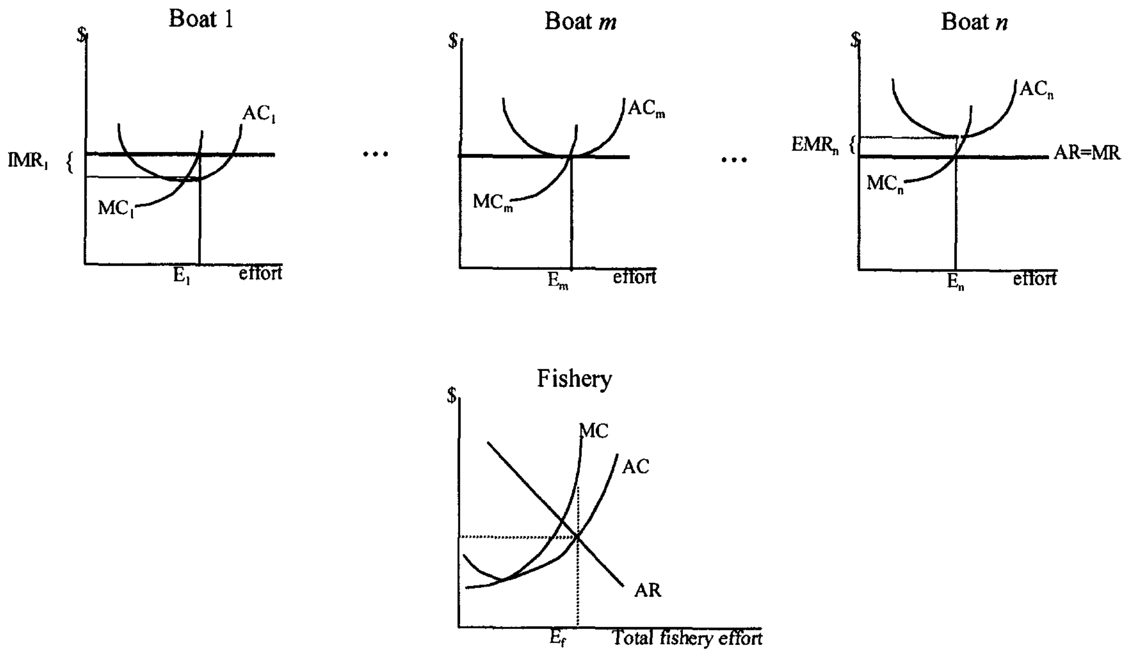


Figure 2. Heterogeneous Fishing Fleet in an Unregulated Fishery.

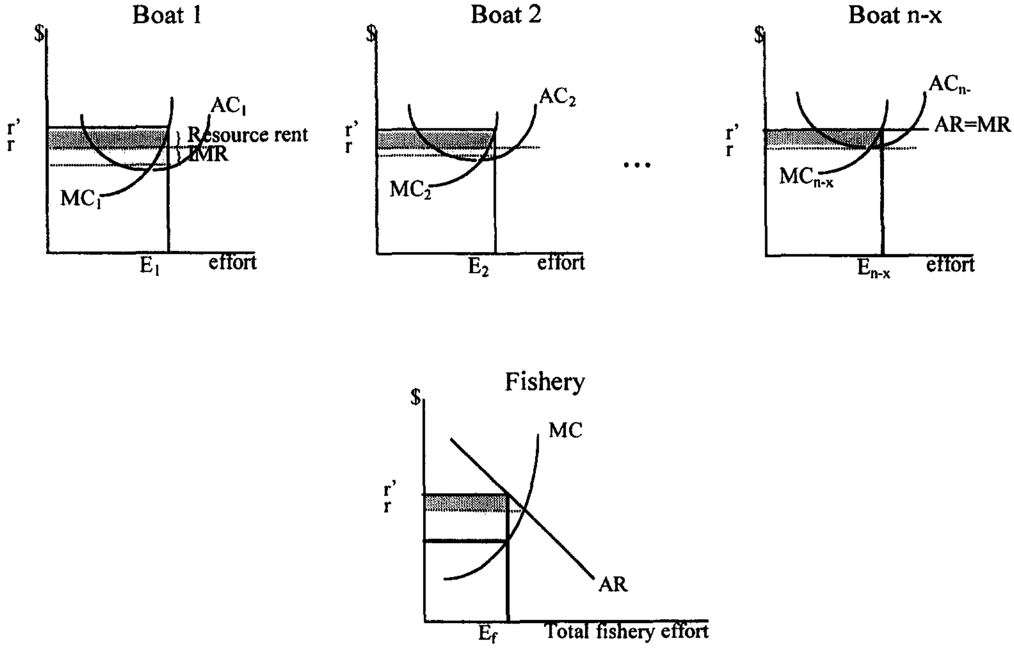
all boats. A survey indicating above normal profits on an average per boat basis would therefore indicate the existence of resource rent in the fishery.

Heterogeneity in cost structure (arising through differences in size, age, engine power and the skill of the skipper and crew) has implications for the definition of the level of rent in the fishery. In an unregulated fishery, an individual boat may be earning above normal profits accrued through efficiency gains, breaking even or be making an economic loss. Consequently any description of economic performance of the average boat will be the mean value of the entire distribution of the returns to all boats in the fishery. Hence, the average boat no longer equates to the marginal boat (Anderson 1989).

This is illustrated in figure 2 for the open access fishery with a heterogeneous fleet consisting of *n* boats. Given that the industry is competitive and that the individual boats cannot influence the price received, all boats face the same marginal revenue curves (equivalent to the industry average revenue). An individual boat's returns are maximized at the level of effort where its marginal costs equals its marginal revenue. Heterogeneity of the fleet is exhibited through the different cost structures facing each boat. At any one point in time (as would be observed from a sample survey), it would be expected that the fishery would be in disequilibrium rather than equilibrium, with some boats making economic profits while others make economic losses.

As some boats are likely to be making a loss in any one year in an unregulated fishery, the industry level of effort is likely to be greater than the theoretical open access equilibrium level of effort with a heterogeneous fleet. The latter level of effort is defined by the intersection of the industry marginal cost curve with the average revenue curve (Hannesson 1993). In figure 2, the total fishing effort is E_f, which is greater than the OAE level. Boat 1 is earning economic profits, boat *m* is earning normal returns and boat *n* (the least profitable boat) is earning an economic loss. Firms (boats) that made economic losses (e.g. boat *n*) are termed extra-marginal while those that earn economic profits (e.g. boat 1) are intra-marginal. The corresponding losses/profits may also be defined respectively as extra-marginal rent and intra marginal rents (Call and Holahan 1983). Provided that $m - 1 > n - m$ (i.e. more boats are intra-marginal than extra-marginal), the average economic profit of the boats would be positive.

In the long run, the expectation from economic theory would be for boat *n* to exit the fishery. However, in practice, the above normal profits being earned by boat 1 would attract additional boats to the fishery, potentially forcing currently profitable boats to become unprofitable (i.e. extra-marginal) (Whitmarsh 1998). As a result, it is unlikely that a true equilibrium could ever



Derived from Anderson (1989)

Figure 3. The Effects of Management on Economic Profits.

exist in an unregulated fishery with a heterogeneous fleet.

The model has further consequences for the attributes of an unregulated fishery with a heterogeneous fleet. Under the traditional model, open access equilibrium occurs when no resource rent exists in the fishery. However, as seen in figure 2, the marginal cost exceeds the average revenue at the total level of effort in the fishery (a consequence of some boats making a loss).[4] As a result, an open access fishery may be characterized by negative resource rents rather than zero resource rents.

The introduction of management into a fishery can (but will not always) reduce the level of effort below the open access level. For example, in figure 3, fisheries management has been assumed to have reduced effort below the open access equilibrium level through the removal of x boats. In addition, it is also assumed that new boats have been prevented entry to the fishery, for example through some license limitation scheme. The reduction in total fishery effort results in the average revenue increasing from r to r'. The remaining $n - x$ boats are again operating at the point where their marginal revenue (equal to the fishery average revenue) equals their marginal cost. As average revenue has increased, each boat increases individual effort. However, under this example, each boat is earning economic profits. The least profitable boat (boat $n - x$) would have earned zero economic profits when MR $= r$, but is earning positive economic profits given MR $= r'$ (as indicated by the darker shaded area). The other boats are also earning above normal profits. However this consists of both resource rent and intra-marginal rent,[5] with the latter being the economic profits over and above the marginal (or least profitable) boat, while the resource rent represents the economic profits of the least profitable boat that arose out of the management change.

From the above, positive economic profits in heterogeneous fisheries can be considered as consisting of two elements—resource rent and intramarginal rent. The disaggregation of the above

[4] For the sake of illustration, the industry level of effort in figure 2 is assumed to be at the point where average revenue equals average cost. This is not based on any theoretical reasoning, except that the existence of boats making a loss in a fishery would necessitate the marginal cost being greater than the average revenue in the fishery. Any effort level to the right of the open access equilibrium level (where average revenue equals marginal cost) would have been suitable to demonstrate this.

[5] In the absence of management, this would be considered only as intra-marginal rent. However, as a result of management, part of the intra-marginal rent becomes resource (or management) rent. This has implications for extracting resource rent as in some cases, extracting the full rent may make some efficient producers worse off under management than under open access (Anderson 1989). This, however, is a separate issue.

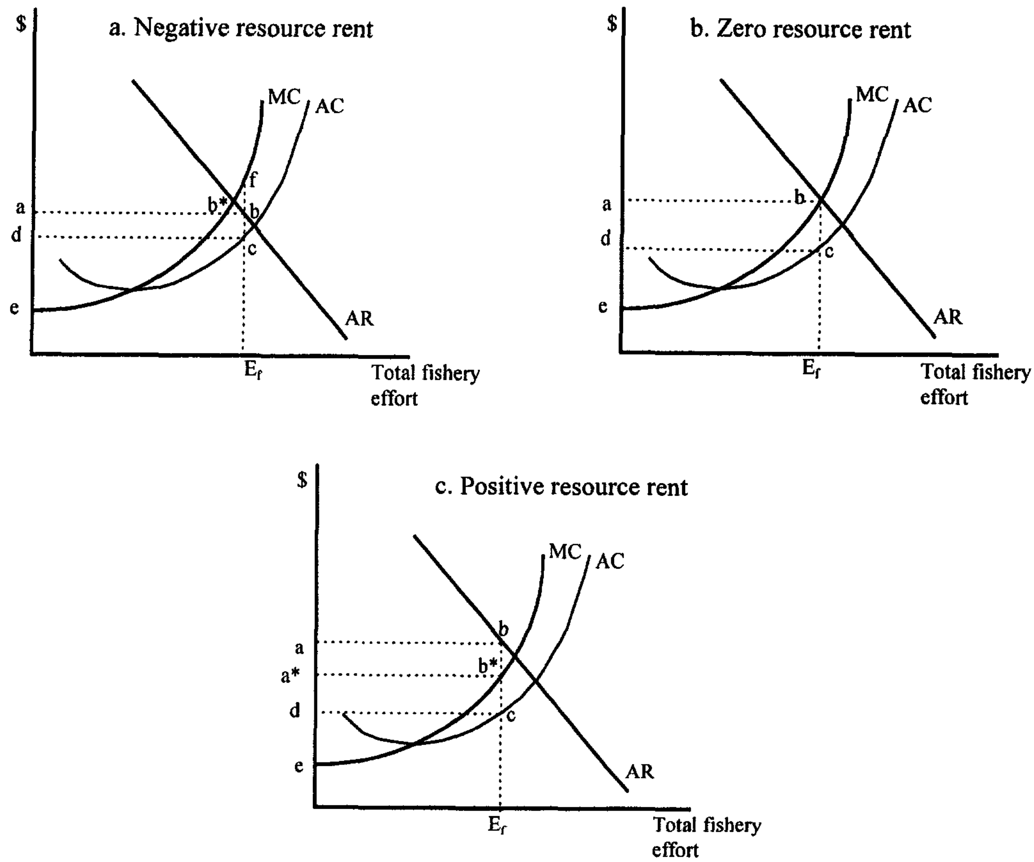


Figure 4. Effects of Management on Resource Rent.

normal profit into the rent components is dependent upon the level of economic profits (if any) generated by the marginal boat. Given that above normal profits can exist in an unmanaged fishery through technical externalities, positive resource rent can only be identified when even the least profitable boat is earning above normal profit. However, identifying the marginal boat in a fishery can be problematic. Nevertheless, an estimate of the level of resource rent in the fishery as a whole can be derived from information collected in a survey.

At the fishery level, the resource rent can be estimated as the difference between total fishery economic profits and the total level of intra marginal rent. In figure 4, three management scenarios are presented. Each assumes that management has been successful in reducing effort below the open access disequilibrium level. In figure 4a, total fishery profits are positive and defined by the area abcd. The level of intra-marginal rent is given by the area ab*e. As the intra-marginal rents are greater than the total economic profits, the level of resource rent in the fishery is negative, and is equivalent to the area b*bf. In this case, however, the level of resource rent is still greater than in the unregulated fishery (figure 2) in that the loss is not as large. In figure 4b, the level of economic profits is equal to the total intra-marginal rent in the fishery. As a result, the level of resource rent in the fishery is zero. This is equivalent to the theoretical open access equilibrium, which ironically may not be achievable without management. The third example, figure 4c, illustrates the potential for positive resource rents to be achieved through effort reduction. In this case, total fishery profits are given by abcd, while intra marginal rents are given by a*b*e. Total resource rent is given by abb*a*.

Resource Rent in Multi-species Multi-purpose Fisheries

Most theoretical models of resource rent relate to the single species, single gear type fishery. However, many fisheries are characterized by multi-gear boats targeting a variety of fish species. Such multi-purpose fishers will allocate their effort across the range of available activities (and hence across a range of species) such that the marginal profitability from each activity is equal (Anderson 1982). Each boat will change its marginal activity to exploit any price advantage of a particular species resulting in opportunistic targeting behavior. In such a case, the boundaries of the fishery are less clearly defined, and therefore it is important to look at all interacting components. The level of resource rent being generated in the fishery is thus less related to the individual species or activity, but to the overall profitability of the boats which may undertake a number of different activities over the year and target a number of different species.

Identifying and comparing individual cost curves in such a case is difficult as both the cost structure and the output mix may vary from boat to boat. Hence, the graphical representation of the conditions for identifying resource rent outlined above are not directly applicable to a multi-purpose fleet operating in a multi-species fishery. Nevertheless, the general principles outline above are applicable to a multi-purpose fleet. That is, given boats are able to modify their fishing activity to maximize their individual profitability, resource rents can only exist in a multi-purpose fleet if all boats are earning economic profits.

Estimating Resource Rent from Survey Data

Economic surveys of fisheries are generally conducted in order to determine the mean economic performance of fishing boats. From these, conclusions are often drawn regarding the level of economic rent and the performance of fisheries management. However, as can be seen from figures 2 and 3, the average of the boat profits in both examples would indicate an above normal return, but resource rents are only being accrued in the second example (figure 3). Hence, survey estimates may provide misleading information as to the existence and/or magnitude of resource rents. Even in a regulated fishery, economic profits observed in a fleet may be indicative of intra-marginal rent alone rather than resource rent. This problem with use of survey estimates was evident in the survey of the English Channel fishing fleet.

The English Channel Fishery

The English Channel is exploited commercially by fishers from several European states although the majority of the catch in the Channel is taken by French and UK fishers. Some 4,000 boats in total operate in the fishery annually of which about 2,200 are from the UK. These boats use a number of different types of gear (e.g. trawl, nets, lines and pots) and catch a range of species, resulting in a substantial number of technical interactions in the fishery. In addition, many of the boats are multi-purpose. Most boats carry more than one gear type, with the fishers switching gear during the year in response to environmental and economic conditions (e.g. prices and relative costs of harvest). In some cases, fishers used four or more different gear types over the year. As a result, the Channel fleet needs to be considered as one large multi-purpose fleet rather than a number of separate fleets geographically co-located.

The fishery is managed through a combination of output controls (total allowable catches of major species set by the European Commission) and input controls (for example, mesh size restrictions, unitization and license limitations set by national and regional management authorities). In addition, a decommissioning scheme and unit forfeiture program on boat replacement is in place in an attempt to reduce the overall fleet size and capacity operating in the fishery. The latter measures have been in place in the fishery since the mid-1980s and have reduced the overall fleet size during this period.

An economic survey of UK fishers along the English Channel was conducted during late 1995 and over the first half of 1996. A stratified sample of boats was selected based on their home port, size class and engine power. The distribution of the sample was based on both boat numbers in each strata and estimated value of production by each strata. In total, information on 77 boats was collected. Observations were weighted on the basis of the total number of boats within each strata and the number of boats surveyed in each strata. Further details on the sample methodology and non-response are given in Pascoe, Robinson and Coglan (1997).

Average Economic Performance Indicators

The estimated average economic costs and revenues by boat size class are given in table 1. For most inputs, financial costs were assumed equivalent to economic costs. Imputed values of owner-operator labor were derived from the equivalent shares paid to employed skippers. Economic depreciation costs were estimated as the real loss in capital value of the boat resulting from fishing over a years. Full equity profits were estimated as the difference between revenue and total economic

Table 1. Economic Performance Indicators by Size Class (£, Average per Boat, 1994–95)

	Under 7		7–10		10–12		12–20		20–30	
	Mean	RSE	Mean	RSE	Mean	RSE	Mean	RSE	Mean	RSE
Revenue	11505	19	27515	11	68996	15	108352	23	280096	12
Total running costs										
· Fuel and oil	545	32	1290	13	5908	14	7630	22	52578	14
· Ice	22	112	40	90	625	37	1265	20	3275	12
· Food	7	146	55	53	1476	35	2959	28	8266	14
· Bait	539	58	2221	26	3744	48	0	0	0	0
· Levies	399	52	406	35	2385	20	8626	25	19791	17
Total running costs	1512	29	4012	15	14138	16	20481	22	83911	13
Labor costs										
· Crew	1215	59	5052	21	10283	14	26110	30	62664	16
· Skipper	3408	19	8122	11	14970	15	19950	25	24159	12
Total labor costs	4623	27	13174	14	25253	14	46060	27	86823	14
Fixed costs										
· Repairs and Maintenance	1339	32	3724	16	14811	19	15569	16	49157	20
· Harbor dues	382	57	323	22	739	26	2105	45	3320	45
· Insurance	253	30	632	14	2215	12	4870	12	17297	14
· Administration	286	81	429	15	1274	14	1557	6	4156	24
· Survey costs	0	0	0	0	23	89	1020	31	5911	45
· Other costs	233	53	971	26	1534	20	419	38	2365	36
· Depreciation	154	12	385	10	1303	20	2818	15	7174	20
Total fixed economic costs	2647	30	6465	14	21897	15	28358	13	89380	12
Full equity profit	2722	28	3863	33	7707	39	13453	43	19981	63
Capital value	7020	12	17517	10	59245	20	128092	15	326108	20
Rate of return (%)[a]	39		22		13		11		6	

notes: a) Estimated by dividing full equity profit by capital value. No relative standard error was estimated.

costs, excluding interest and rental payments. Thus the performance of boats can be compared irrespective of the level of equity held by the owner. Rates of return to capital were derived by dividing the profit at full equity by the capital value of the boat. The expected rate of return (i.e. the opportunity cost of capital) was assumed to be 10% based on the rate of return achieved by a major UK fishing company listed on the stock market. Full details of the economic valuation of the costs are given in Pascoe, Robinson and Coglan (1997).

Boats under 10 metres in length had rates of return that, on average, exceeded the expected rate of return (table 1). In other words, capital invested in this part of the fishery on average earned a greater return for society than the next best alternative. Since the returns were greater than what would be required to keep the fisher in the industry, these boats were considered to be earning, on average, positive economic profits. However, this was more likely to be a function of the relatively low capital value than relative efficiency in production.

For boats within the 10 to 20 metre range, the rate of return to capital was slightly higher than the expected rate of return. However, given the possible margins of error surrounding the mean values, it can be concluded that there were no significant economic profits being earned. In contrast, the 20–30 metre boats were making economic losses on average since the estimated average rate of return was less than the expected rate of return.

Resource Rent or Intra-marginal Rent?

From the above results, it appears that there is resource rent being earned by some sectors of the fleet. However, this would only be the case if all boats within each subgroup were homogenous. Further, differentials in economic profits between size classes may be more an indication of intra-marginal rent than resource rent since some size classes may be more technically efficient than others.

Within a year, differences in profitability would be expected even within a size class. Many fishers used several different gear types over the year, and the different gear types over the year, and the different gear types caught a range of overlapping species (but in different proportions). Hence, while the costs of the boat in a given size class may be relatively similar, the revenues would vary given the gear used, the catch combination and the prevailing prices at the time. While operators using some gear types may earn greater profits than those using other gears in a given year, the ability of fishers to change gear would ensure that any intra-marginal rents accruing through gear use would be dissipated rapidly. Hence, the existence of intra-marginal rent is not due to the use of any particular gear type, but the combination of all inputs (e.g. boat size, engine power, gear and the skill of the crew and skipper).

About 9% of fishers interviewed were earning positive full equity profits but had rates of return less than 10%. This implies that they were covering their own labor costs but were not covering the opportunity cost of capital. A further 20% of boats had negative full equity profits and hence negative rates of return to capital. This implies that they were not covering the full opportunity cost of either labor or capital. In total, 29% of boats had rates of return less than the expected rate of return. These were distributed across all size classes (including the most profitable size class on average), indicating that the "average" boat is not representative of the marginal boat.

Given that there are a number of extra-marginal boats (i.e., earning less than their opportunity cost of capital) any above normal profits earned on average by the boats must be indicative of intra-marginal rent rather than resource rent. Consequently, the use of average rates of return in this case are not indicative of resource rent in the fishery.

Estimation of Resource Rent

These results can be reinforced by looking at the average and marginal cost curve for the fleet as a whole. In order to derive the marginal and average cost curves for the fleet, a total cost curve was first estimated from the survey data. An industry cost curve is generally derived by comparing different levels of output with the cost of producing that output. As the fleet operating in the Channel are largely multi-purpose boats (i.e. use several gear types over the year) and catch a range of different species with each gear type, separating the fleet into particular gear or species groups is not meaningful. Instead, the fleet is considered to consist of a set of heterogeneous firms using different combinations of inputs to produce different combinations of a common set of outputs. These outputs can be combined into a single measure of output (e.g. revenue) using the prices of the different species. Similarly, the different combinations of inputs can be aggregated into a single measure based on their unit costs, the result being equivalent to the total costs.

Table 2. Estimated Total Cost Curve for the UK English Channel Fleet

Variable	Coefficient	Standard error	t-statistic
Revenue	0.7193	0.0119	60.329
Revenue^2	1.9731E-6	3.9258E-7	5.026
Revenue^3	1.0071E-4	3.1110E-12	3.237
$\bar{R}^2 = 0.99$	F = 280348.7	No. obs = 77	

Boats in the sample were sorted on the basis of their profitability from highest to lowest. Points along the total industry cost curve were estimated by multiplying the total cost of each sample boat by the total number of boats that sample boat represented in the fishery. Similarly, the total output associated with the total cost of the boat "group" (i.e. the boats represented by the sample boat) was estimated by multiplying the revenue of each sample boat by the number of boats it represented in the fishery.

From these, a stepped total cost curve can be derived from the cumulative total of the scaled individual total costs of each boat (Heathfield and Wibe 1987). The cumulative total costs were regressed against the level of output (i.e. revenue). A cubic functional form was chosen to ensure a quadratic marginal and average cost curve. As the estimation technique is based on cumulative costs of additional boats, zero output is produced at zero cost (i.e. zero boats). Hence, a zero intercept is appropriate. The results of the regression analysis are presented in table 2. From the t-statistics, all variables were significant at the 5% level or greater. While the adjusted R^2 was very high this is an unreliable measure given the absence of an intercept and the existence of multicollinearity between the independent variables.

The marginal cost curve was derived by differentiating the total cost curve with respect to output, while the average cost curve was estimated by dividing the total cost curve through by revenue (figure 5). Given revenue was the output measure, average revenue per unit of output was constant (i.e. 1) for all levels of output. Consequently, average revenue also equaled marginal revenue.

Average (and marginal) revenue was above average costs but below the marginal cost at the estimated total level of output. Hence, the fishery as a whole was making economic profits even though a number of boats were making economic losses (the shaded area above the average/marginal revenue curve). Total economic profits were estimated to be in the order of £1.42m, the difference between total fishery revenue and total fishery costs

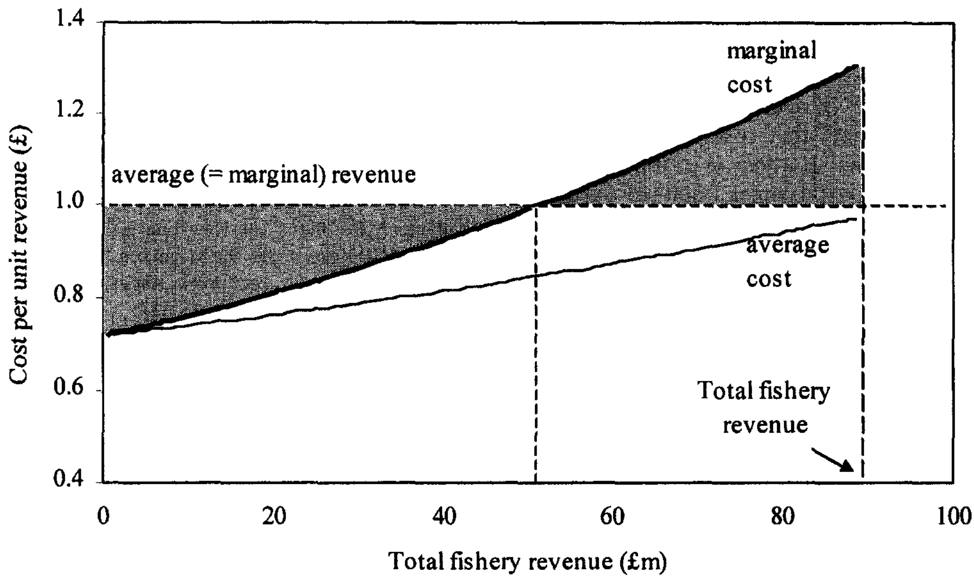


Figure 5. Average and Marginal Cost Curves for the Fishery.

at the observed level of effort. However, a large proportion of the fleet were accruing intra-marginal rent (the shaded area below the average revenue curve). The level of intra-marginal rent, given as the area between the average revenue and the marginal cost curves below the point of intersection, was estimated (through integrating both the marginal revenue and cost curves) to be in the order of £7.47m. Hence, while economic profits were positive in the fishery the level of resource rent being generated was estimated to be in the order of –£6.05m (i.e. negative resource rent was being generated in the fishery).

Discussion and Conclusions

The importance of separating intra-marginal rents and resource rent from total economic profits in the fishery goes beyond the assessment of the economic performance of management. In most countries where fisheries management has been introduced society as a whole has been identified as the owners of the resource. Where the resource rent is not collected in a managed fishery, the value of the resource rent accrues to the fisher in the form of economic (or above normal) profits. In this sense, the resource rent being generated is being allocated to one sector of society—the fishers. In some countries, consideration has been given to the introduction of a resource rent charge to ensure the return of some of the rent to society as a whole (see for example Hatcher and Pascoe 1998). Removing more than the resource rent component (that is, removing some of the intra-marginal rent) will remove the incentive for boat owners to move to more efficient technologies (Anderson 1989, Johnson 1995).

From the theoretical models presented earlier, the existence of boats making a loss in a fishery is sufficient to indicate the existence of negative resource rents in the fishery as a whole. The existence of extra-marginal boats in the fishery is largely due to the non-malleability of the boat capital (Clark; Clarke and Munro 1979). In addition, the introduction of new, more efficient boats into the fleet over time may force previously marginal or intra-marginal boats to become extra-marginal, the so called fisheries treadmill (Whitmarsh 1998). The marginal cost curve depicted in figure 5 represents the long-run marginal costs, and includes the non-cash capital costs associated with the fishing operation (e.g. depreciation and the normal return to capital). Provided returns exceed the variable costs of fishing (including the annual fixed costs), fishers will continue to operate in the fishery in the short run as there is no-where else that the capital can be employed.

An important assumption of the analysis is that all boats are profit maximizers. Hence, a loss is the result of an inability to earn profits due to excessive effort in the fishery. However, other factors may result in boats making losses. Small-scale part time fishers may operate their boat more as a hobby than a business, and may be prepared to subsidize their fishing activity. Knowledge of the individuals in the survey will allow assessments of the extent of such non-profit maximizing behavior, so the analysis may be modified to exclude these boats if necessary. In addition, some boat owners may incur problems that result in an otherwise profitable boat making a loss (e.g. illness). Again, knowledge of these problems obtained during the survey would enable the analyst to decide if the boat is to be included in the analysis for the purposes of assessing the components of economic profits.

When using survey data to estimate changes in rent between years, account also needs to be taken of changes in prices and costs. Profitability may increase in the fishery due to an exogenous increase in prices (due, say, to a shift in consumer preferences to seafood) or a reduction in costs (e.g. reduced fuel costs). Unsustainable resource rents may also be generated in the short term through natural fluctuations in stock abundance resulting in higher than average revenue per unit of effort. The resultant increase in profitability will only be a quasi rent rather than resource rent if the price, cost or stock changes are only temporary. In contrast, if the price increase was permanent, then the value of the fish stocks would expect to increase in much the same way that the value of agricultural land would increase with rising farm prices. Hence, the rent accruing to the stock would also increase and the higher profits would be resource rent. However, these rents are likely to be dissipated through increased fishing effort unless effective management measures can be implemented to prevent this.

The above analysis has focused on identifying the level of resource rent in heterogeneous fisheries. This will become an increasingly important requirement for the assessment of the economic performance of fisheries management. The introduction of policies such as a landing levy to extract resource rent will require the policy maker to identify the contribution of each species in the generation of the rent. Identifying the source of any resource rent in a multi-species multi-gear fishery will provide an additional challenge to fisheries managers. While the existence and magnitude of resource rent may be determined through economic surveys, the contribution of the various species or gear types to rent generation will require additional bioeconomic modeling to ascertain.

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