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Estimating the Demand for Salmon Angling in Ireland

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Abstract: This paper reports the results of a count data travel cost model for estimating the demand and economic value of salmon angling in Co. Donegal, Ireland. Angling quality, age and nationality were found to affect angling demand, while estimated consumer surplus per angler per day was approximately IR£138 based on a truncated negative binomial model allowing for endogenous stratification.

I INTRODUCTION

Salmon has long held an important position in Irish society, as demonstrated by its place in Irish mythology and its position on Irish coins prior to the introduction of the Euro coinage. Though no longer the mythical *Bradán Feasa*,[1] today the migrating wild salmon is a prized quarry of anglers and viewed more generally as an indicator of good water quality. For instance, the return of migrating salmon to the Rhine, once dubbed the sewer of Europe, is heralded as a restoration triumph.

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[1] Salmon of Knowledge.

Ireland boasts being one of the few locations that can still offer anglers the opportunity to demonstrate their skill in tempting a salmon returning to spawn into taking their presented bait. A large number of anglers avail of this opportunity, as in recent years approximately 31,000 angling licences were issued annually.[2] At a minimum, angling is a prevalent recreational pursuit but it also makes a significant contribution to the economy. The best salmon rivers are located on the northern, western and southern coasts, generally remote areas with low-income levels where angling related employment is often the lifeblood of communities and where there are few alternative employment opportunities.[3] In a dedicated angling survey Whelan and Marsh (1988) estimated annual domestic angler expenditure in 1987 at IR£15.6 million, foreign tourist angler expenditure of at least IR£12 million, with both supporting 1,900 full-time job equivalents with IR£15 million tax revenue. Whereas in a more general marine leisure survey, Marine Institute (1997) estimated that domestic game anglers, which include salmon anglers, spend IR£10 million per annum supporting almost 400 jobs. While the exact extent of the economic contribution of angling might be uncertain, the expenditures of the magnitudes indicated and associated dependent employment are critical for periphery areas.

With few and disparate data sources most previous work on the economics of Irish salmon angling is based on survey research. O'Connor and Whelan (1973) and O'Connor *et al*. (1974) were the first detailed attempts at studying salmon angling in Ireland with Whelan and Marsh (1988) providing a update of the earlier work. These reports focus mainly on analysing angler expenditure through a series of cross tabulations and forecasting income multiplier effects. Recent work by O'Connor and Ó Maolchallann (1994) was also limited to profiling anglers, their expenditure and estimating the economic contribution of the angling resource but in this instance at a local rather than national level.

O'Connor *et al*. (1974) also estimated a series of relationships explaining the number of angling licences issued using variables such as disposable income per capita and aggregate foreign tourist numbers. But the first and only published estimate to date of an angling demand function in an Irish context was by O'Neill and Davis (1991), who estimated a demand function for coarse and game angling in Northern Ireland. They inferred a price elasticity of positive 0.7 and total user benefits of Stg£9.1 million. However, their OLS

[2] *Source:* Central Fisheries Board *Annual Report 1999*. Marine Institute (1997) estimates 76,000 game anglers but only salmon and sea trout angling requires a licence.

[3] Meredith (1998) demonstrated the socio-economic importance of the fishing industry to periphery areas associated with commercial sea fisheries.

estimator may be biased, which possibly provides an explanation for the positive price elasticity.[4]

This paper's contribution to the understanding of salmon angling in Ireland comes from the estimation of the first salmon angling demand function. Such knowledge of salmon angling demand has at least two practical uses. First, fishery managers can use the information on the factors that drive salmon angling demand to increase the attractiveness of their individual fisheries to anglers. Using the welfare estimates to be presented in the paper they can also infer the value to anglers of trips to their fisheries and attempt to extract the surplus enjoyed by anglers. The second area where the paper's empirical results may be of practical use are at a national level where there is an ongoing debate about the management and exploitation of the salmon fisheries.[5] Part of this debate involves the comparison of the relative values of the commercial and recreational salmon fisheries and their contribution to the economy. This paper presents the first systematic estimate of the anglers' total valuation of a recreational salmon fishery to this debate.

II ECONOMETRIC MODEL

The travel cost approach is employed to estimate a salmon angling demand function, where demand at a given location is a relationship between the number of days taken by an individual in a given period, trip price (i.e. travel cost), and angler characteristics. Since the model's dependent variable is an integer valued variable then a count data estimator is appropriate and the count data travel-cost model has been widely used to estimate demand for recreational amenities.[6]

Count data models are typically estimated based on either the Poisson or negative binomial distributions, however, the dataset used in the present paper poses two problems that invalidate following a similar approach. The dataset only contains observations on active anglers and as such is truncated at positive trip demand. Such an occurrence is not uncommon and the usual remedy is to adapt the traditional models for the truncation, as Chakraborty and Keith (2000) or Grogger and Carson (1991) do, for example. The second

[4] Hellerstein and Mendelsohn (1993) discuss the bias associated with the OLS estimator in the context of count data models.

[5] Recent contributions to this debate include Salmon Management Task Force (1996) and Whelan and Ó Muircheartaigh (1999).

[6] Examples include Loomis *et al*. (2000) for whale watching; Chakraborty and Keith (2000) for mountain biking; Font (2000) for national park recreation; Greene *et al*. (1997) for recreational fishing; Offenbach and Goodwin (1994) for hunting; and Shaw and Jakus (1996) for rock climbing.

problem is due to the method of data collection, which was through an on-site survey. An on-site survey of resource users generates a sample truncated at positive trip demand but the sample is also subject to endogenous stratification, as the likelihood of being sampled depends on the frequency with which an individual visits the site. Englin and Shonkwiler (1995) following Shaw (1988) have extended the traditional models to correct for both endogenous stratification and truncation associated with on-site survey samples. If y_i is the number of trips demanded by person i (i=1…N), the negative binomial log-likelihood function for trip demand controlling for endogenous stratification is

$$\ln L = \sum_{i=1}^{N} \left[\begin{array}{l} \ln y_i + \ln(\Gamma(y_i + 1/\alpha)) - \ln(\Gamma(y_i + 1)) - \ln(\Gamma(1/\alpha)) \\ + y_i \ln \alpha + (y_i - 1) \ln \lambda_i - (y_i + 1/\alpha) \ln(1 + \alpha\lambda_i) \end{array} \right] \quad (1)$$

where α and λ_i are parameters of the negative binomial distribution with λ_i defined as a function of variables that affect demand, (e.g. $\lambda_i = \lambda(X_i; \beta)$). $\Gamma(\cdot)$ indicates the gamma function. The conditional mean and variance are given by $E(Y_i|X_i) = \lambda_i + 1 + \alpha\lambda_i$ and $Var(Y_i|X_i) = \lambda_i(1 + \alpha + \alpha\lambda_i + \alpha^2\lambda_i)$.[7] The negative binomial is a consistent estimator even when the dependent variable exhibits overdispersion (a form of heteroscedasticity), which is a common occurrence in travel cost data (Gourieroux *et al*., 1984).

The conventional approach when applying count data models is to model latent demand, λ_i, as a semi- logarithmic function of price, income and other independent variables (e.g. Shaw (1988), Hellerstein (1991), Grogger and Carson (1991), Englin and Shonkwiler (1995)),

$$\ln \lambda_i = \beta_0 + \beta_p P_i + \beta_1 X_i + \beta_m M_i \quad (2)$$

where P_i and M_i are the ith individual's travel cost and income, with X representing a vector of other exogenous variables.

III DATA

The data for this paper were collected from an on-site in-person survey of anglers visiting Co. Donegal in 1992 for a study undertaken by O'Connor and Ó Maolchallann (1994). The dataset is not ideal for the estimation of travel cost models, as the data was collected for a different purpose, however, the

[7] See Englin and Shonkwiler (1995) for further detail.

main components of a travel cost dataset are present to allow estimation. Haab and McConnell (2002, p.148) list five basic assumptions of travel cost models and each is addressed below in the context of the available data.

The first assumption relates to travel and time costs being proxies for the price of the recreational trip. There is no obvious reason why the travel elements of the angling trips to Donegal provided utility for their own sake that violate the assumptions of the travel cost model.

The second assumption holds that travel time is neutral, providing no utility or disutility, or at least that there are no gross violations of this neutrality. As we have no information on site choice decisions, we cannot assess whether this assumption has been violated, that is, whether the Donegal site was chosen over other sites because travelling to Donegal provided utility.

The third assumption, which is that the decision unit is trips of roughly equal length, posed more serious problems for the estimation of a travel cost model. O'Connor and Ó Maolchallann's data is limited to 176 observations with the length of the surveyed on-site trip varying between a single day and three weeks. Extracting observations of equal length would have yielded insufficient observations to estimate separate meaningful demand functions for day-trips, week length trips etc. Given the dataset available, there was only one feasible option for estimation with decision units of equal length. That specification has as a dependent variable the number of days spent angling during the surveyed trip with explanatory variables including the angler's travel cost per day fished.

Travel cost models assume that trips are for a single purpose only. The original Donegal dataset included multiple purpose observations, including three types of rod fishing and fishing as part of multipurpose vacations. However, the survey did elicit information on the main purpose of the trip and using this information the data employed in the analysis relates to salmon anglers whose primary reason for visiting Donegal was to fish. Other types of fishing were excluded because their demand is likely to differ from the demand for salmon angling. A limitation of the dataset is that no information was available to facilitate accounting for substitute salmon angling fisheries. The final dataset for analysis contained 118 observations.

The fifth basic assumption of travel cost models is that the quantity consumed, i.e. fishing days, relates to the same site for all consumers. The estimation in this paper presumes that all salmon angling sites within Donegal are identical. This is obviously incorrect but the dataset available provided no information on the particular sites fished within Donegal.

The angler's travel cost per day mentioned above was calculated as the sum of travel costs, such as air fares and car hire, fishing expenses, such as the access fees, and accommodation costs including meals, all divided by the number of fishing days during the trip in which the angler was surveyed. The cost variables are all reported costs and not calculated on the basis of distance and cost per mile. The calculation of costs on the basis of distance and mileage costs, as is normally carried out in US applications of the travel cost model, is not really justifiable when many of the trips involve air travel, nor necessary if reported costs are valid. As mentioned above the dependent variable is the number of days fished during the entire length of the trip in which the angler was surveyed, therefore, the demand function estimated is for the number of fishing days demanded per fishing trip.

Table 1: *Descriptive Statistics*

Variable	*Mean*	*Minimum*	*Maximum*
Days demanded per trip	6.017	1.000	23.000
Travel cost (IR£000/day):	0.068	0.006	0.410
: Travel element	0.022	0.000	0.273
: Fishing expense element	0.014	0.000	0.084
: Accommodation element	0.032	0.000	0.250
Income, (IR£000)	23.602	2.500	45.000
Professional & Good Rating on Angling Quality*	0.373	0.000	1.000
Professional & Age 50+	0.246	0.000	1.000
Non-Professional & Age 50+	0.076	0.000	1.000
Irish	0.203	0.000	1.000
German	0.161	0.000	1.000
Other European	0.153	0.000	1.000

* Professional & Angling Quality = 1 if angler has a professional occupation and if during previous Donegal angling trip, if any, angler rated the quality of angling as "good" or excellent", zero otherwise.

IV RESULTS

Descriptive statistics from the dataset used in this paper are presented in Table 1. Mean travel cost across all anglers was IR£68 per day divided between accommodation and meal costs (IR£32/day), fishing expenses (IR£14/day) and actual travel expenses (IR£22/day). But the breakdown varied considerably by nationality, for example, German and other European anglers spent an average of IR£56/day on accommodation and meals and IR£58/day on travel. Northern Ireland anglers spent the most on fishing expenses with IR£18/day compared to IR£8/day by other European anglers.

Table 2 presents the parameter estimates for the specified model. Several alternative specifications of the demand equation were estimated: the one that best fits the data is presented. Alternative specifications of the count data travel cost model were also estimated, including standard and truncated Poisson models, Poisson allowing for endogenous stratification, and standard and truncated negative binomial models. These alternative count data models were rejected in favour of the negative binomial controlling for endogenous stratification using likelihood ratio tests.

Table 2: *Model Parameter Estimates*

Parameters	*Estimates*	*Standard Error*	*Est/s.e.*
Constant	0.071	0.255	0.276
Travel cost	–3.553	1.391	–2.554
Income	0.002	0.007	0.332
Professional & Good Quality Rating	0.386	0.188	2.053
Professional & Age 50+	0.451	0.178	2.535
Non-Professional & Age 50+	0.791	0.278	2.848
Irish	0.956	0.201	4.768
German	1.850	0.224	8.274
Other European	1.224	0.242	5.052
α	0.614	0.240	2.560

The explanatory variables used in the demand equation are the angler's income, calculated as the midpoint of the reported income range, whether the angler positively rated the quality of angling in Donegal on previous visits, age, occupation and nationality. It was hypothesised that the demand for angling days (in the trip) would be higher for anglers that had rated previous angling trips highly, and positively correlated with income and age.

The positive and significant estimate for the α parameter, which is the dispersion parameter in the negative binomial, indicates that the data is overdispersed, as is common in recreation trip data. The insignificance of this parameter would have meant the collapse of the model to a Poisson count travel cost model. The model's estimate of mean fishing days demanded is 4.9 days, which is an underestimate of the actual mean of 6 days.

As the conditional mean of the dependent variable is $\lambda_i + 1 + \alpha\lambda_i$, interpretation of the coefficient estimates is a little involved.[8] For each IR£50

[8] The marginal effect of covariates on mean fishing days demanded is $\frac{\partial E(Y|X)}{\partial x_j} = (1 + \alpha)\lambda_i \beta_j$

increase in daily travel cost, the number of days demanded declines by 0.69 or approximately 14 per cent. Responsiveness to price is highest amongst German anglers and anglers over 50 years, where for each IR£50 increase in daily travel cost, days demanded declines by 2.0 and 2.2 days respectively. Even so price elasticity of demand is quite inelastic at –0.19, and unlike O'Neill and Davis's elasticity estimate has the intuitive negative value.

The insignificance of the parameter estimate on income suggests that there is no income effect on the number of fishing days demanded, however, this is conditional on participation in the Donegal salmon fishery. While this result might appear implausible it is not uncommon to encounter small or even negative income effects in recreational travel cost models (e.g. see Chakraborty and Keith (2000) or Grogger and Carson (1991)).

Prior to estimation it had been anticipated that anglers positively rating the quality of angling in Donegal, based on their previous visits, might demand trips with greater number of days. The estimates confirm this but only among anglers with a professional occupation. The converse of this variable is a mix of anglers either not having previously visited Donegal, did not positively rate angling in Donegal or have non-professional occupations, so it is difficult to fully interpret the result. However, the result does suggest that anglers who positively rate the Donegal fisheries are likely to demand a higher number of fishing days in subsequent trips, with the marginal effect estimated at +1.5 days.[9] The implication for fishery managers is that improvement in fishery quality and facilities has a direct return on fishing days demanded.

Demand for angling is differentiated by age category with the 50 plus age group taking trips three times the duration of those aged lower than 50; 12 compared to 4 days. However, trip length by anglers aged 50 plus in professional occupations was lower, at approximately 6 days. Work commitments may be playing a part in this result, with retired anglers being less constrained to take trips of longer duration. The result suggests that fisheries' marketing strategies might be best targeted at older or retired anglers.

While travel costs obviously affect the decision to travel, costs are also likely to affect trip duration. If travel to Donegal is lengthy or costly, anglers may

[9] To ensure that we are isolating a quality effect the model was also estimated conditional on anglers having a professional occupation and having previously fished in Donegal implying that the quality variable in the re-estimated model simply measures whether these anglers positively or negatively rated the quality of Donegal salmon angling on previous trips. The magnitude of the quality coefficient in the re-estimated model is higher, therefore we can be confident that estimates presented are capturing a quality effect, that is, a positive quality rating leads to a higher number of days demanded in subsequent trips.

wish to spread the cost over several fishing days and therefore reduce travel cost per day's fishing. Model estimates of trip length based on nationality were 3 days for Northern Ireland anglers, 6.1 days for Irish, 13.5 days for German and 7.7 days for other European anglers, which compares favourably to actual trip lengths of 3.3, 6.6, 12.3, and 6.9 days respectively.

V WELFARE ANALYSIS

Consumer surplus (CS) is obtained by integrating the demand function, (2), over the relevant price range, usually between the average price or travel cost P0 and the choke price P1.

$$CS = \int_{P0}^{P1} \lambda_i \, dP = \frac{\lambda_i}{\beta_p} \Big|_{P0}^{P1} \quad (3)$$

Compensating variation (CV) and equivalent variation (EV) can also be calculated using the method developed by Hausman (1981), however, due to the small estimated income effect, the CV and EV estimates closely bracket the consumer surplus estimate and are therefore not reported.[10]

Table 3: *Welfare Estimates*

Description	*Trip Consumer Surplus – IR£*	*Fishing Days Demanded (per trip)*	*Consumer Surplus per day – IR£**	*90% Confidence Interval (IR£CS/day)*
Mean of covariates	675.7	4.9	138.6	49.1–228.2
Professional & Good Quality Rating	860.7	5.9	145.0	49.7–240.3
Age 50+	1972.1	12.3	160.2	56.6–263.9
Less than Age 50	569.4	4.3	133.5	47.0–220.1
Professional & Age 50+	893.7	6.1	145.9	52.3–239.5
Northern Ireland	342.7	3.0	115.6	38.9–192.3
Republic of Ireland	891.6	6.1	145.9	50.8–240.9
Germany	2179.2	13.5	161.5	58.4–264.6
Other European	1164.9	7.7	151.7	55.0–248.4

* Due to rounding the figures in this column do not exactly equal column 1 divided by column 2.

[10] Bockstael *et al.* (no date) derived
$CV = \frac{1}{\beta_m} \ln \left(1 + \frac{\lambda\beta_m}{\beta_p}\right)$ and $EV = -\frac{1}{\beta_m} \ln \left(1 - \frac{\lambda\beta_m}{\beta_p}\right)$.

Table 3 reports the consumer surplus estimates evaluated at the mean of the data and also conditional on different angler characteristics. The first column gives CS for the angling trip, and when divided by the fishing days demanded gives CS/fishing day in the third column. At the mean values of the covariates, mean trip consumer surplus equalled IR£675.7, with mean trip duration of 4.9 days, giving mean consumer surplus per day of IR£138.6. While the largest consumer surplus per trip estimates are for non-Irish and older anglers, the estimates of CS per fishing day do not vary much across angler characteristics and range between IR£115.6 and IR£161.5. In declining order, German, other European anglers and Irish anglers enjoy the largest daily surplus from their angling trips. The 90 per cent confidence intervals for the CS/day estimates were calculated using the delta method.[11] Given the small size of the dataset it is not surprising that the 90 per cent confidence intervals are large, yet the estimates are all significantly different from zero.

Mean travel cost per day, including accommodation and fishing expenses, ranged from IR£38.3 for anglers from Northern Ireland, IR£48.8 for anglers from the Republic of Ireland, IR£132.6 for German and IR£117.6 for other European anglers. The variation in these figures partly reflects the fact that many day trip anglers were Irish and avoided accommodation costs. The sum of travel costs and consumer surplus per day gives the total per-day value of salmon angling in Donegal. German anglers have the highest valuation at IR£300/day, closely followed by other European anglers at IR£270/day. Anglers from the Republic of Ireland valued Donegal angling at just below IR£200/day, while anglers from Northern Ireland valued the angling at IR£150/day.

The welfare estimates presented are very sensitive to the choice of count data model chosen for estimation. If the negative binomial model is estimated ignoring the endogenous stratification the resultant estimate of mean CS/fishing day is more than double the IR£138 estimated in Table 3. When a truncated Poisson model allowing for the endogenous stratification is estimated, estimated mean CS/fishing day is almost IR£100 higher than that in Table 3. The negative binomial model's estimates presented were preferred to the other models estimated because it fitted the data best. For example, the value of the maximised log-likelihood was –284.5 compared to –317.9 of the Poisson model allowing for the endogenous stratification.[12] Though the welfare estimates are sensitive to model choice, the presented welfare

[11] The delta method calculates the asymptotic variances of a function that depends on the parameter estimates and their covariances, using a Taylor series expansion of the variance of the function (See Greene (1993), pp. 297).

[12] A likelihood ratio test statistic of 66.8 compared to a critical value of 3.84 rejected the Poisson in favour of the negative binomial (both models allowing for endogenous stratification).

estimates are the most conservative of those estimated and are from the preferred model both on theoretical grounds and model fit.

Even given the conservative valuation estimate, in the light of the sensitivity of the welfare estimates to model choice it is instructive to compare with other published welfare estimates. From estimates of a single site linear demand function of the Penobscot River, Maine, Morey *et al*. (1993) calculate the value of the Atlantic salmon recreational fishery at $2,124 per annum per angler and dividing by mean trip demand of 11.85 day-trips gives $179/day-trip. Due to a lack of welfare estimates on Atlantic salmon fisheries we also make comparisons with other fisheries. Layman *et al*. (1996) have estimated CS/trip of US$51 for Alaskan Pacific salmon recreational fisheries. This estimate is at the lower bound of the CS/day confidence intervals in Table 3 but Pacific salmon as an angling quarry is less highly rated, and therefore we might expect a lower valuation. The Red Snapper fishery in the Gulf of Mexico has faced a similar situation as Atlantic salmon with excessive commercial exploitation and stock collapse. In that fishery Gillig *et al*. (2000) have estimated a CS/day-trip of up to $213, which is comparable in magnitude to the estimates presented here. The magnitude of the welfare estimates presented here are therefore consistent with published fisheries research elsewhere.

VI CONCLUSIONS AND POLICY IMPLICATIONS

This research has found that mean willingness to pay (i.e. CS + travel cost) of the average salmon angler visiting Donegal in 1992 was IR£206/day. While the result is conditional on the survey sample, it reveals the high value of the salmon resource. Mean sample travel costs were only IR£68/day compared IR£206/day total value, meaning that salmon anglers receive a considerable benefit from angling in excess of their angling costs. The implication for fishery managers is that there appears to be considerable scope for them to increase their revenues, given that consumer surplus is such a large proportion (67 per cent) of total willingness to pay.

The ability of fishery managers to capture the surplus enjoyed by anglers may be limited, as the estimates also indicated that anglers with the largest surplus were those most sensitive to price (i.e. German anglers). Individual fishery managers will also be aware of substitute fisheries, which will constrain their ability to unilaterally raise angling fees. The result that anglers who positively rated Donegal fisheries on previous visits, and subsequently made trips of longer duration, will be reassuring to fishery managers that have attempted to improve the facilities and quality of their fisheries. While the estimates do not imply that higher quality leads to higher willingness to pay (they suggest it will lead to more days demanded), it is not unreasonable to suggest that fisheries could increase revenue by improving stocks, possibly through more restrictive access or catch and release policies. The actual effect on revenue depends on price elasticity, which is favourably inelastic, and the effect of improved fishery quality (e.g. prospective catch rates) on angling demand, which this paper was unable to examine.

In so far as it is relevant, the Irish economy only benefits from expenditures by domestic and foreign anglers and the CS enjoyed by domestic but not foreign anglers. Only when some of the CS enjoyed by European anglers is captured through additional foreign expenditures will the welfare of EU citizens be transferred to Ireland.

In the debate on the management of salmon stocks it has been argued that the value of salmon exploited is much higher in recreational than commercial fisheries (Wild Salmon Support Group, 1996). The welfare estimates presented here affirm that the salmon resource is highly valued as a recreational fishery, though it says nothing of the value of commercial fisheries. Economic argument suggests that salmon should be exploited where they have the highest marginal value but reluctance by national government to change management strategy is tempered by the potential socio-economic losses that would arise in the commercial fisheries. The capture of anglers' consumer surplus for use as compensation to commercial fisheries in a new management strategy might avoid that impasse. Access to salmon angling is currently subject to effectively a two-part pricing scheme. The first flat-rate fee is a salmon angling licence, which is issued by a fishery board. The second component of the fee is charged by fishery managers and varies widely. Private fisheries' fees may vary by duration of angling and time of year, whereas angling clubs usually charge only a membership fee. An increase in the licence fee might offer an opportunity to extract some of the large consumer surplus enjoyed by anglers, without any substitution effects between salmon fisheries within the state. The additional licence revenue may generate significant funds for government and allow it, through the central and regional fishery boards, to negotiate a more efficient management strategy for the exploitation of the salmon resource.

There are several limitations of this study and further research is necessary to fully examine potential policy initiatives. While the results indicate that the value of the angling resource is high, more research on a larger sample is required to draw more reliable conclusions, which ideally should be based on angling trips of uniform length and controlling for varying fishing site characteristics. Also the data relates to angling in 1992 and the demand for angling may have changed in the intervening period. Significant exogenous developments since 1992 that also might affect the relevance of the present results is the dramatic reduction in the cost of air travel and the return of relative normality in Northern Ireland.

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