The Impact of Social Insurance on the Length of the Fishing Season

by

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The basic hypothesis underlying this paper is that the amount of fishing that a fisher undertakes over a year is not determined solely by circumstances which are exogenous to the fisher, such as weather conditions and resource availability, but are the subject of individual choice. As such, the decision can be analysed using the usual apparatus that economists use to model choice decisions at the margin — that is, that the decision to fish for an additional week is governed by a comparison of the marginal benefits and marginal costs of doing so. Modifications in these marginal benefits and costs, through institutional changes or otherwise, can alter the balance between the two, and so lead to a change in the decision as to how long in the year to pursue the fishing activity.

The marginal benefits and costs of fishing an additional week are an individual matter, dependent on both the productivity and the preferences of the individual fisher. As a result, testing of the basic hypothesis must be done on an individual level. The existence of a social insurance program in Canada to which fishers have access provides us with the opportunity to engage in such testing.

The Canadian unemployment insurance program was established to enable government to insure employees against the consequences of job loss. It has been a fixture of the Canadian social welfare system since 1940. The program which is the subject of this paper is governed by an *Unemployment Insurance Act*[1] which was enacted in 1971 and only recently (May 1996) supplanted by new legislation (which has been renamed the *Employment Insurance Act*).

Normally, an unemployment insurance claimant must necessarily have been involved in an employment contract with an employer in order to qualify for benefits,. Self-employed persons, in other words, normally do not qualify for coverage.

[1]*An Act Respecting Unemployment Insurance in Canada*, R.S.C. 1985, C. U-1.

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There is one exception to this general statement. Section 130 of the Act enables the Canada Employment and Immigration Commission to operate a scheme of unemployment insurance for "self-employed persons engaged in fishing." Such a scheme has been in existence since 1956.Basically, the program provides fishers with benefits during the 'off-season', the size of which depends on earnings during the fishing season. The Special Seasonal Fishermen's Benefits Program, as it is called, has become a fundamental support mechanism for inshore fisheries on the Atlantic coast of Canada.[2]

The Unemployment Insurance Act passed by Parliament in 1971 replaced somewhat less generous legislation. After an initial period of stability, perceived difficulties with the Act led to a series of amendments over the period between 1976 and 1980. Other than amendments passed in 1983 in response to recommendations by the Kirby Task Force on the Atlantic Fisheries, the Act has remained essentially unchanged since then insofar as it has affected inshore fishermen in Newfoundland.

There are two ways in which the program enables us to test hypotheses about fishers' behaviour in their decisions about the duration of fishing activity. First, the program provides us with a longitudinal panel of data regarding individual earnings of fishers, number of weeks worked during the fishing season, and benefits received as a result. Second, the program provides us with considerable variation in the incentives provided to fishermen both longitudinally and across individuals, since the extent to which fishers are able to enjoy benefits varies from case to case depending on individual circumstances, and also varies from year to year as the rules governing the determination of benefits has changes. This considerable contrast in incentives enables us to infer matching contrasts in behaviour.

The basic structure of the Canadian unemployment insurance program as it affects inshore fishermen is described in Section 1 of the paper. Section 2 briefly outlines a behavioural model of the decision to fish in a particular week within the season.[3] Section 3 presents an econometric model to the relationship between fishing earnings and fishing weeks, while Section 4 extends the model to the decision by individual fishermen as to how many weeks in the year to engage in fishing. Some limitations and possible extensions of the analysis are discussed in Section 5.

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[2]The historical background underlying this anomoly is discussed in considerable detail in Schrank 1996.

[3]The theoretical model is discussed only briefly here, since it has been presented in greater detail in Roy *et al.* 1994.

1. The Canadian Unemployment Insurance Program

The Unemployment Insurance Act could have influenced the behaviour of inshore fishers in three ways:

(1) by altering the attractiveness of fishing relative to other forms of economic activity, unemployment insurance can affect the number of people engaging in fishing as a full-time or part-time occupation;

(2) by modifying the returns to fishing, it can change the length of time that fishers engage in this activity over the year; and

(3) it can also change the intensity with which fishers are prepared to fish at any particular time.

Changes of the first kind have been analysed by Ferris and Plourde (1980, 1982), who conclude on the basis of aggregate data over the period 1956 to 1968 that the presence of unemployment insurance in this period accounted for one half the number of inshore fishing boats in Newfoundland (Ferris and Plourde 1980, 116). Since the database used in this paper contains no information on alternative employment opportunities, this paper can provide no additional insights into this question. The paper instead focusses on changes of the second kind, that is to say, with changes in the length of time spent fishing over a year as a result of the unemployment insurance program. Such changes have been the subject to early speculations by Copes (1972, 69) and formal modelling by Ferris and Plourde (1980, 1982), but so far appear to have escaped detailed testing.

The Canadian Unemployment Insurance program operates in the following manner. Employees who earn income in excess of a predefined minimum in a week are deemed to have insurable earnings in that week. Both the employee and the employer then contribute premiums at a given rate to an Unemployment Insurance Account. If the employee works a sufficient number of insured weeks, then upon an interruption of earnings (s)he may, after a two-week waiting period, obtain weekly unemployment insurance benefits equal to a percentage of the average weekly insured earnings received during the qualifying period. The level of weekly earnings which is insurable is subject to a ceiling, which limits the level of both the premiums which must be contributed and the benefits which can be received.

The length of the period over which benefits can be received depends on the number of insured weeks in the qualifying period, and on the national and regional rates of unemployment. Earnings received during the benefit period may be kept if they are less than 25 percent of the weekly benefit; earnings in excess of this amount result in a dollar-for-dollar reduction in benefits.

Most inshore fisheries in Atlantic Canada are organized as a co-adventurer rather than an employer-employee relationship. In the co-adventurer system, the boat owner receives a predefined share of the value of the catch net of operating costs. The remainder is shared evenly among the crew of the vessel. The structure of the unemployment insurance program is not well suited to this arrangement. It is not obvious who should be considered to be the employer; what should be treated as insured earnings; and when an interruption of earnings is deemed to take place.

Usually, the fish buyer is deemed to be the employer (*Regulations*,[4] s.76). The insured earnings of a crewman consist of the crewman's share. For the boat owner (or lessee), insured earnings are deemed to be the net value of the catch after deducting (a) his/her crewmen's shares and (b) 25 percent of the value of the catch to account for operating expenses. If the boat owner's earnings fall short of the minimum level of earnings required for a week's earnings to be insurable under the Act, these earnings are deemed to be at that minimum level (*Regulations*, s. 78). Thus, even a minimal level of fishing activity qualifies a boat owner for unemployment insurance.

Fishermen are permitted to arrange their affairs with buyers in such a way as to accumulate their catches over more than one week, and to average the accrued value over that number of weeks (*Regulations*, s. 79(5)). As a result, earnings in weeks during which catches are high can be applied to weeks in which earnings are lower. This enables fishermen to obtain increased benefits from weeks during which earnings exceed the ceiling, and to include as an insured week one in which earnings are below the minimum level.

Fishermen are categorized into year-round fishermen and seasonal fishermen for unemployment insurance purposes. The requirements for classification as a year-round fisherman are extremely stringent (*Regulations*, s. 84), and almost all inshore fishermen in Newfoundland, which is the focus of our analysis, are classified as seasonal fishermen. A seasonal fisherman can receive benefits only during the 'off season', which for most fishermen is the period between November and May (*Regulations*, s. 85(7)). For this reason, potential claimants regard entitlement to fishing benefits as inferior to entitlement to benefits from regular employment, which can be taken at any time in the year, and usually for a longer period of time.

To qualify for regular benefits, regular employment must be obtained for a minimum number of weeks during the qualifying period. For the most part,

[4] *Regulations Respecting Unemployment Insurance*, C.R.C. 1978, C. 1576.

fishermen in Newfoundland, especially full-time fishermen, have not been able to obtain sufficient regular employment to avail themselves of regular benefits.

2. A Model of the Length of the Fishing Season

Fishing is a seasonal occupation, and boat owners, if they are rational, will decide whether to fish in a given week on the basis of a comparison of the marginal benefits and costs of doing so. We model this decision-making process on the basis of a theoretical analysis similar to that formulated by Ferris and Plourde (1980, 1982).

The model is based on the supposition that fishing income varies from week to week over the year, primarily because of changes in resource availability. As a result, fishing income is subject to diminishing returns as the fishing season is extended. This relationship between fishing income and fishing weeks can be represented as a concave function similar to the FF curve in Figure 1[5]. It is further assumed that fishers select the level of fishing activity which places them on the highest possible indifference curve between work and income. This choice is represented in Figure 1 by the tangency between the FF curve and the highest possible indifference curve.[6]

Let us represent net fishing income f in a season as a concave function of the number of fishing weeks L.

$$f = f(L), \tag{1}$$

where $f' > 0$, $f'' < 0$. Fishers seek to maximize the value of a utility function $U(F,L)$, where $U_F > 0$ and $U_L < 0$. This occurs where

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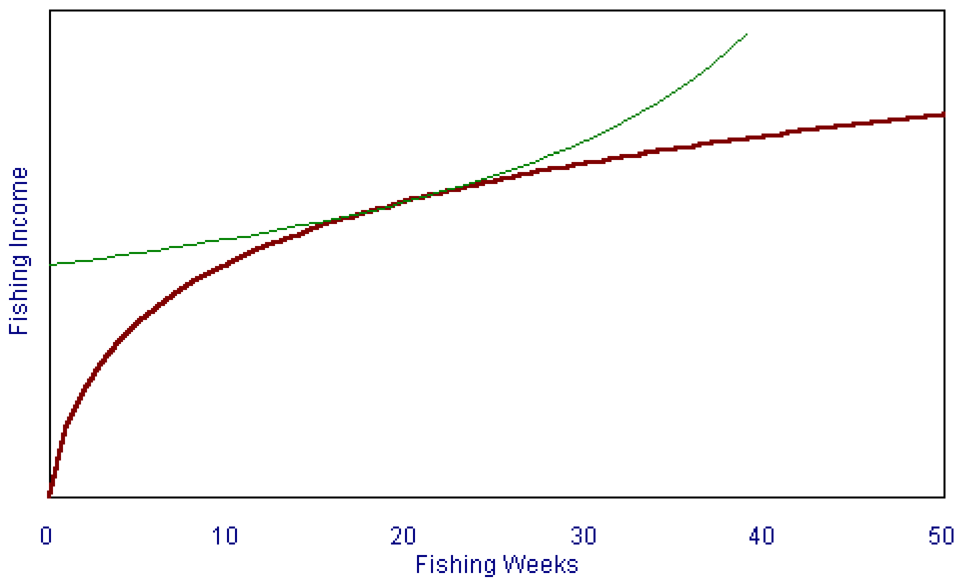
[5]The Fishing Weeks variable on the horizontal axis should not be taken as chronologically ordered — normally it will not be. However, if fishers prefer weeks when fishing income is high to weeks when it is lower, then as the number of weeks spent fishing is increased, the income earned in the marginal week must be less than income earned in intra-marginal weeks. The relationship between fishing income and fishing weeks is therefore concave.

[6]Roy *et al.* (1994) also consider the case in which fishers switch between fishing and wage employment as the marginal returns to fishing fall below the wage which could be earned in shore employment. We do not consider this case here, partly because of data limitations and partly because we do not consider that this case is representative of the employment options available in rural Newfoundland.

$$f'(L) = -\frac{U_L}{U_F} = \text{MRS}_{LF}. \tag{2}$$

Figure 1
Fisherman's Equilibrium



The seasonal fishermen's benefits program alters this pattern of incentives. The benefits received supplement earnings from fishing, and in so doing alter the incentives to fish, through both income and substitution effects.

The income effects are discussed first. If 'leisure' (understood to mean time spent in activities other than fishing)[7] is a normal good, then the higher income from unemployment insurance leads to an increase in the demand for leisure, and so a reduction in the number of weeks spent fishing, in order to enjoy this additional leisure.

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[7]We here use the term leisure in this context because it has become institutionalized in the labour economics literature. However, the term 'non-market household production' (from which true leisure is one possible output) would probably be a more accurate description of the alternative use of time by inshore fishermen.

The substitution effects are more complex, and are best represented through formal modelling. The amount of unemployment insurance income S earned in a benefit period is the product of three factors:

- the benefit-earnings or replacement ratio r, which is the proportion of average weekly insured earnings during the qualifying period which is returned to the claimant as benefits during a week of unemployment;
- the average level of weekly insured earnings E during the claimant's qualifying weeks, which is the basis on which the level of weekly benefits is calculated; and
- the number of weeks B over which the claimant is entitled to draw benefits.

This can be written as

$$S(L) = r\,E(L)\,B(L). \tag{3}$$

The benefit-earnings ratio r is a constant, which was equal to 2/3 over the period 1972–1978, then 60 percent until 1990, and 57 percent thereafter.

Until 1983, the average value of insured earnings was calculated over qualifying weeks in either the entire qualifying period (which usually begins in April), or in the last 20 weeks of this period, whichever was to the fisherman's advantage. We have assumed (equation (1) above) that fishing income increases at a diminishing rate as the number of fishing weeks increases. If weekly earnings are below the insurable ceiling, this implies that average weekly insured earnings decline as the number of fishing weeks is increased. This would have a negative effect on the level of unemployment benefits, which would act as a disincentive to extend the number of fishing weeks. Thus, we can specify that $E'(L) \le 0$, with the strict inequality holding where $f'(L)$ is below the maximum level of weekly insurable earnings.

In 1983, this provision was modified so that those fishermen with at least 15 qualifying weeks of fishing would receive benefits based on earnings in the *best* ten weeks of fishing. This would render $E(L) = E(10)$ for $L \ge 15$, which would remove the disincentive to extend the number of fishing weeks for those fishing at least 15 weeks.

The relationship $B(L)$ between the number of benefit weeks and the number of insured weeks during which income was earned can be separated into four stages. In Stage 1, the number of insured weeks L is less than the minimum number of qualifying weeks required to entitle a claimant to benefits, denoted by q. In Newfoundland, this minimum level of insured weeks was 8 until 1978, when it was raised to 10 weeks. In this stage, obviously, there are no benefits; i.e.,

$$B(L) = 0 \text{ if } L < q. \tag{4}$$

Once a claimant qualifies for benefits, the number of weeks in which he can claim benefits increases with the number of insured weeks, up to some maximum which is governed by the length of the off-season during which benefits may be claimed. In Stage 2, this maximum has not yet been reached, so there is a positive relationship between the number of benefit weeks and the number of insured weeks. This positive relationship creates an incentive to extend the number of fishing weeks in order to qualify for a longer period of unemployment benefits. In other words, $B'(L) > 0$ in this stage. Specifically, claimants are entitled to 5 weeks of benefits for every 6 qualifying weeks, so $B'(L) = 5/6$. As well, since 1976 fishermen have been entitled to a certain number of weeks of so-called "extended benefits", B_{ext}, which is independent of the number of qualifying weeks they have worked. Thus, in Stage 2 the number of benefit weeks can be written as the linear relationship

$$B(L) = \frac{5}{6}L + B_{ext}. \tag{5}$$

In Stage 3, the maximum number of benefit weeks B_{max} has been reached. Additional fishing does not increase the period over which a fisherman is entitled to benefits. The positive incentive to extend the number of fishing weeks which exists in Stage 2 is removed. In this stage we have $B'(L) = 0$, and

$$B(L) = B_{\max}. \tag{6}$$

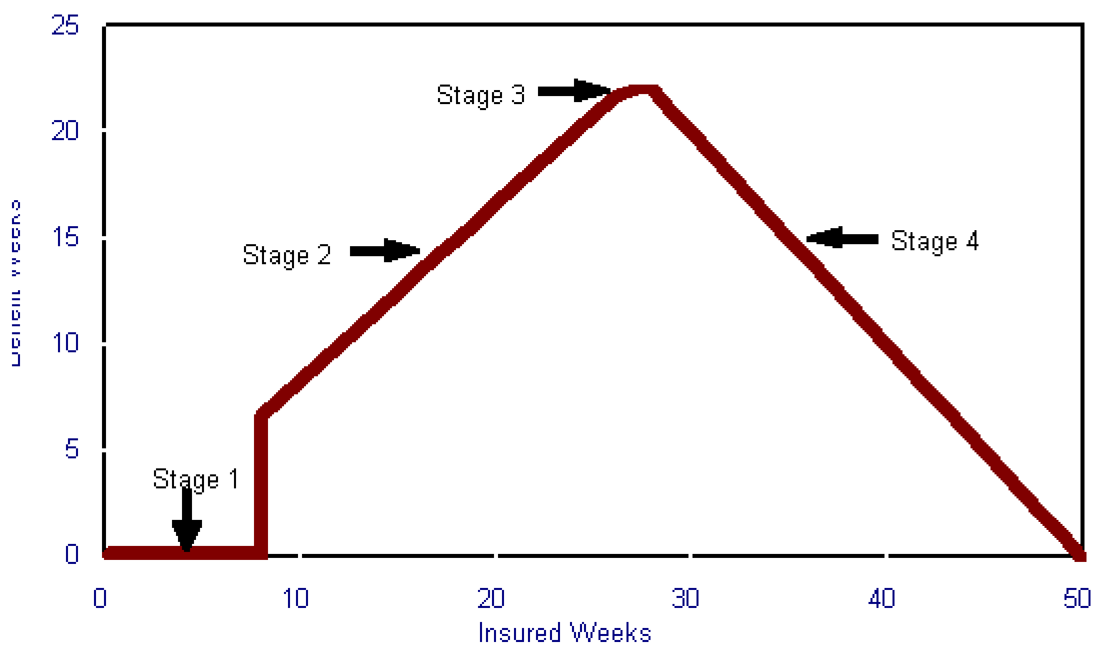
Ultimately, as the number of fishing weeks is extended further, fishing takes place during the 'off-season', when seasonal benefits could have been claimed. Obviously, in this stage, every additional week spent fishing is a week in which unemployment benefits could have been received. This is Stage 4, where there exists an incentive to *reduce* the number of fishing weeks. Here we have $B'(L) = -1$, and so (allowing for the two-week waiting period)

$$B(L) = 50 - L. \tag{7}$$

Overall, then, the relationship $B(L)$ is piecewise linear, with 4 distinct segments, and can be expressed as

$$\begin{aligned} B(L) &= \min\left[\frac{5}{6}L + B_{ext},\ B_{\max},\ 50 - L\right], \quad L \geq q, \\ &= 0, \quad L < q. \end{aligned} \qquad (8)$$

Figure 2
Benefit Weeks, Seasonal Fishing 1971-5



An example is presented in Figure 2; this is the relationship which prevailed over the period 1971–75. The relationship was altered by amendments in 1976 and in 1977, which modified the q, B_{ext}, and B_{max} parameters. These changes are summarized in Table 2. It should be noted that as a result of the 1977 changes, the levels of q, B_{ext}, and B_{max} had increased sufficiently that the second stage was swallowed up by the rightward expansion of Stage 1 because of the rise in q and the leftward expansion of Stage 3 because of the increase in B_{max}.

Table 2
Unemployment insurance benefit week parameters
Newfoundland, 1971–95

	q	B_{ext}	B_{max}
1971–75	8	0	22
1976	8	18	27
1977–	10	20	27

When income from seasonal fishermen's benefits is added to earned fishing income, total fishing income F becomes

$$\begin{aligned} F(L) &= f(L) + S(L) \\ &= f(L) + r\,E(L)\,B(L). \end{aligned} \tag{9}$$

The optimum conditions can then be written as

$$F'(L) = f'(L) + S'(L) = \mathrm{MRS}(F,L) \tag{10}$$

that is to say, the increased income (inclusive of unemployment insurance) from fishing an additional week equals the marginal rate of substitution between income and leisure. The slope of $S(L)$ can be derived as

$$S'(L) = r\,[E(L)\,B'(L) + E'(L)\,B(L)]. \tag{11}$$

As was explained above, $E'(L)$ is generally negative, since average weekly insured earnings decline as the number of fishing weeks is increased, so this factor will act to algebraically reduce the slope of the $S(L)$ function.[8] The behaviour of $B'(L)$ is more complex, as we have seen, and depends on the stage in which the value of L falls. It is worthwhile to consider each of the four stages separately.

In Stage 1, $S(L) = 0$, so the $F(L)$ and $f(L)$ curves are identical.

[8]However the term vanishes if $L \geq 15$ after 1982, because then the value of E will be determined by the ten best fishing weeks. The term also vanishes if the fisherman is earning above the maximum level of insurable earnings.

Fishermen working in Stage 2 are subject to two conflicting forces. On the one hand, $B'(L) > 0$, which implies that additional fishing increases the number of benefit weeks. On the other hand, $E'(L) < 0$, which implies that additional fishing reduces the level of average insured earnings as fishing becomes less lucrative, and so lowers the size of the unemployment benefit. Under normal circumstances, we expect that the former effect will dominate, so that normally $S'(L) > 0$ in Stage 2.

In Stages 3 and 4, it remains true that $E'(L) \leq 0$, but here $B'(L) \leq 0$, so it is necessary that $S'(L) \leq 0$ (with the strict inequality holding is Stage 4). The level of seasonal fishermen's benefits, then, must decline (or at least not increase) as the number of fishing weeks is extended into Stages 3 and 4.

Let us now examine the implications of these relationships for the behaviour of fishermen. A fisherman who would otherwise fish less than the minimum number of insured weeks (Stage 1), may well be induced to fish to at least the minimum level in order to receive benefits. A fisherman in Stage 1 may not modify his/her behaviour as a result of the unemployment insurance program, but if (s)he does, it will be to increase his/her insured weeks into Stage 2 (or Stage 3 after 1977). However, such fishermen would not fish more than the minimum number of weeks to qualify for Unemployment Insurance.

In Stage 2 it is normally the case that $S'(L) > 0$, because additional insured weeks permit more benefit weeks. This would lead fishermen to fish longer as a result of seasonal benefits. This may be offset to a greater or lesser degree by a negative income effect, so that fishermen may choose to work less as a result of the higher income, depending on which of these effects is the greater.

Fishermen working in Stages 3 and 4 suffer from no such ambiguity. Additional fishing effort normally lowers (or leaves unchanged) the value of insured earnings, as in Stage 2; in addition, the number of benefit weeks either does not change (Stage 3) or falls (Stage 4). Therefore additional fishing normally lowers the amount of unemployment benefits received, and this creates an incentive to fish less, which augments any negative income effect. There is one exception to this generalization. After 1982, fishermen who would otherwise be working in the 10–14 week range may be induced to increase their fishing to 15 weeks in order to take advantage of the 'ten best weeks' rule.

In the next two sections, we shall estimate an econometric model that consists of the earnings-weeks relationship (1) and the labour supply relationship (10) The unemployment insurance benefits equation (3) is part of this model as well, but as an identity, depending on known institutional parameters, and without a stochastic component. The model is estimated on a ten percent sample of seasonal benefit recipients in Newfoundland over the period 1971–1993 provided by the Department of Employment and Immigration of the Government of Canada. The sample contains panel observations on 21,447 benefit spells involving 5,999 recipients. The data consists of information on weeks of insured employment resulting in the benefits claim, the sum of insured earnings during this employment spell, weekly benefit rates when unemployment occurs, and total number of benefit weeks during the unemployment spell. A limited set of demographic data (such as age and sex) and economic data (such as occupational and industrial classifications) is also included. Since the data span a fairly long period (23 years), it is typically the case that observations on a particular individual span only a small portion of this period, and need not be contiguous observations.

3. An Econometric Model of the Earnings-Weeks Relationship

Let us begin with the specification of the relationship between earnings and insured weeks. For estimation purposes we use a log-linear approximation for this relationship as follows:

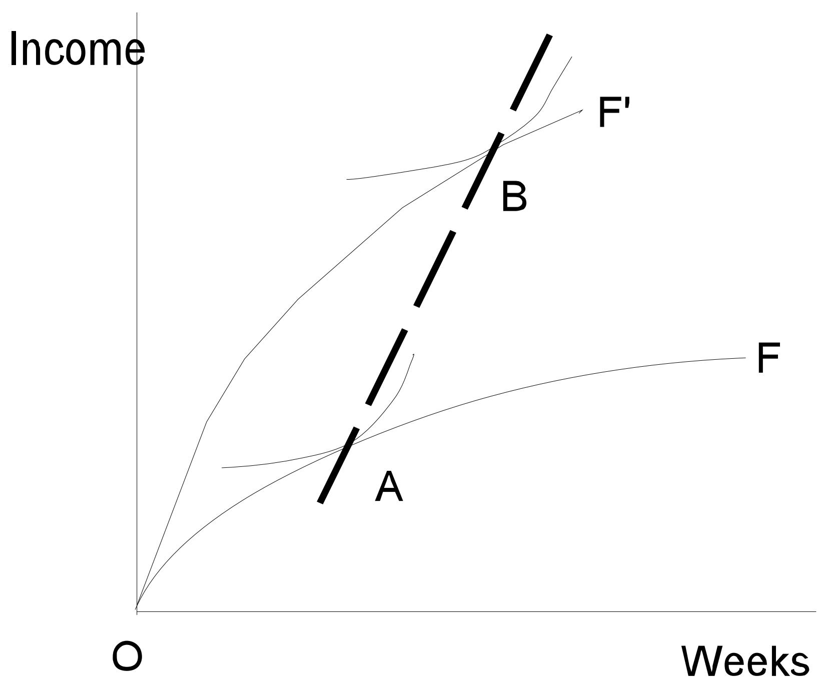
$$f_i = \theta_i L_i^{\beta}, \tag{12}$$

where earnings of fisherman i in a particular time period is represented by f_i and weeks worked by fisherman i in that time period by L_i. The elasticity of earnings with respect to the number of weeks is measured by the β parameter, which is assumed to be the same for all fishermen and which should be between 0 and 1. The greater the curvature of the $f(L)$ curve, the lower is β. The θ_i parameter reflects the productivity of the fisherman for a particular value of L. This is known to vary considerably from person to person, depending on such factors as experience, location, luck, and innate skills.

From the beginning we were confronted with a serious identification problem. The nature of the problem is captured in Figure 3. The figure represents the earnings-weeks relationship of two fishermen with different values of the parameter θ_i. Ideally, we would like to be able to trace this relationship while controlling for the value of θ_i through various methods. Unfortunately, we cannot observe θ_i directly, and so even if its effect is partly captured through the use of various correlates, the remainder will necessarily be incorporated in the equation disturbance . However, the number of weeks spent fishing is an endogenous variable, and is unlikely to be independent of θ_i; for example, high values of θ_i may be associated with a lengthy fishing season. Thus variations in θ_i which are not captured in the regression could be correlated with the independent variable L_i, causing the parameter estimates to be biased. In terms of Figure 3, instead of tracing out the earnings-weeks relationship OF, we will instead be tracing out a locus of tangencies such as AB.

The standard solution to this problem is to use an instrumental variable for L_i which is related to L_i but independent of variations in the earnings-weeks relationship. The latter requirement rules out the use of any factors underlying fishing productivity as instrumental variables, since these will in all likelihood affect the earnings-weeks relationship. Variables which are related to the income-leisure preferences of fishermen but not to productivity differences between fishermen would be appropriate candidates for consideration as instrumental variables. Unfortunately, our database does not provide any variables which clearly satisfy this criterion.

Figure 3



Notwithstanding this dilemma, we consider that we have been able to obtain a reasonable (although not perfect) solution to the problem by specifying the earnings-weeks relationship equation (12) as an error-components relationship. Specifically, we decompose the θ_i term into an individual-specific component α_i and a time-specific component η_t. The individual-specific component captures those aspects of productivity which are specific to the individual over all time periods, such as innate skill (although we have also incorporated an age factor into the regression specification in order to capture changes in this individual-specific component due to accumulated experience). The time-specific component captures those effects which are specific to the time period for all individuals, such as changes in resource availability and product price.

There are two alternative specifications for such effects in the literature. The fixed-effects model specifies the effect as a fixed parameter to be estimated, through dummy-variable estimation.To the extent that these fixed effects capture that part of θ_i which is correlated with the regressors (and particularly with L_i), the parameter estimates are unbiased.

The random-effects model, by contrast, specifies the effect as a random variable possessing specific characteristics — usually, but not always, that it is identically and independently distributed — and is estimated by Generalized Least Squares (GLS) (see Judge *et al.* 1985, ch. 13; Greene 1993, ch. 16.4). The random-effects model has some methodological attractions, and can be shown to lead to efficient estimation when the model specification is valid. Its main disadvantage is that when the random effects are correlated with the explanatory variables, as discussed above, least-squares bias results. Fortunately, the latter situation is testable, through the Hausman specification test (Greene 1993, 479–80).

Because the number of time periods in our analysis is small (23 years), and there is typically little time overlap in observations on individuals, we have specified the time-effect as a fixed (dummy variable) effect. We have estimated the individual effect as both a fixed effect and a random effect. The fixed effect model, after logarithmic transformation, is as follows:

$$\ln f_{it} = \alpha_i + \eta_t + \gamma \ln a_{it} + \beta \ln L_{it} + \epsilon_{it}, \quad \epsilon_{it} \sim \mathrm{IID}(0, \sigma_\epsilon^2) \tag{13}$$

where f_{it} is the earnings of individual i at time t, a_{it} is the age of individual i at time t, L_{it} is weeks worked by individual i at time t, α_i is the fixed effect specific to individual i, η_t is the fixed effect specific to time period t, and ϵ_{it} is the equation disturbance for individual i at time t, assumed to be identically and independently distributed with zero mean and constant variance.

The random effects model, by contrast, is specified as

$$\begin{gathered} \ln f_{it} = \alpha + \eta_t + \gamma \ln a_{it} + \beta \ln L_{it} + u_i + \epsilon_{it}, \\ u_i \sim \mathrm{IID}(0, \sigma_u^2), \quad \epsilon_{it} \sim \mathrm{IID}(0, \sigma_\epsilon^2) \end{gathered} \tag{14}$$

where the individual effect u_i is now a random variable which is identically and independently distributed with constant variance. The model is estimated by Feasible GLS, with the variance components estimated using the technique outlined in Greene 1993, 474–75.

For comparison purposes, we also estimate an Ordinary Least Squares (OLS) model in which the individual effects α_i are constrained to equal one another.

$$\ln f_{it} = \alpha + \eta_t + \gamma \ln a_{it} + \beta \ln L_{it} + \epsilon_{it}, \quad \epsilon_{it} \sim \mathrm{IID}(0, \sigma_\epsilon^2) \tag{15}$$

The regression estimates and estimated standard errors of the constant parameters for all three models are presented in Table 3 below. The estimate of β is in all cases fairly high, but significantly below unity, ranging from 0.85 for the fixed effects model to 0.94 for the constrained OLS model. The hypothesis of diminishing returns is thereby confirmed. The estimate of the age effect is more variable, but in all cases is significantly positive, consistent with the maintained hypothesis that productivity rises with age.

Table 3
Regression coefficients and standard errors, earnings-weeks relationship

	Constrained OLS	**Fixed Effect**	**Random Effect**
α	4.088 (0.033)	--------	4.077 (0.050)
β	0.945 (0.007)	0.856 (0.008)	0.866 (0.007)
γ	0.063 (0.006)	0.873 (0.070)	0.133 (0.012)
$\mathbf{R^2}$	0.750	0.923	-------

The fixed effects model can be used to test the hypothesis that the individual effects take the same value, so that the Constrained OLS model is valid. Under the null hypothesis, when the ϵ_{it} are normally distributed, the F-statistic has a value of 5.80 with 5 998 and 15 424 degrees of freedom. At these values, the null hypothesis is decisively rejected at any reasonable level of significance.[9] As well, the Hausman statistic for orthogonality of the random effects with the independent variables, which under the null hypothesis is asymptotically distributed as chi-squared with 24 degrees of freedom, has a value of 137.03, once more leading to rejection of the null hypothesis.

We conclude from these results that the fixed-effects model is the most satisfactory one for our purposes, because the alternative models possess significant least-squares bias which is absent from the fixed-effects model. There may remain some least-squares bias to the extent that the model errors ϵ_{it}, which by design are orthogonal to both the individual effects and the time effects, are nonetheless correlated with weeks worked. Since most of the variance in $\ln L_{it}$ is between-group variance rather than within-group variance, and therefore by design independent of the model error, we think that most of the least-squares bias has been removed in the fixed-effect model. We also note that the estimates of β generated by the fixed-effect and random-effect models are quite similar, despite the fact that we know that these is some bias in the random-effects model which is absent from the fixed-effects model.[10]

4. An Econometric Model of the Optimality Condition

We then constructed a model of the optimality condition (10), which equates the marginal return to an additional week of work $F'(L)$ to the marginal rate of substitution between income and leisure. The former concept, which we refer to below as the real marginal return to work (RMRW), was derived as follows. Substituting equation (11) into equation (10) and adding appropriate subscripts, we obtain

$$F_{it}^{\prime}(L_{it}) = f_{it}^{\prime}(L_{it}) + \boldsymbol{r}_t\,[E_{it}(L_{it})B_t^{\prime}(L_{it}) + E_{it}^{\prime}(L_{it})B_t(L_{it})]. \qquad (16)$$

We derived $f'(L)$ by differentiating the log-linear specification (12) for $f(L)$ to obtain

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[9]Similarly, in the random effects model, the Breusch-Pagan (1980) Lagrange multiplier test can be utilized to test the hypothesis that $\sigma_u^2 = 0$, so that random effects are absent. The value of the Lagrange multiplier, which under the null hypothesis is distributed as chi-squared with one degree of freedom, is 37 105, so the null hypothesis once more is decisively rejected.

[10]In the random effects model, the standard error of the u_i term (which is absent from the fixed effects model) is estimated as 0.420, while that of the ϵ_{it} term is only 0.199.

$$f_{it}^{\prime}(L_{it}) = \beta \alpha_{it} L_{it}^{\beta-1} = \beta \frac{f_{it}}{L_{it}} \tag{17}$$

The expression *B(L)* was derived from equation (8), and *B′(L)* by differentiating (8). The expression *E′(L)* was set equal to zero if a fisherman was at the maximum level of insurable earnings, or if (s)he was working at 20 weeks or more in years before 1983 and 15 weeks or more afterward. Otherwise, *E′(L)* was derived by differentiating *E(L) = f(L) / L* to obtain

$$\begin{aligned} E_{it}^{\prime}(L_{it}) &= \frac{f_{it}^{\prime}(L_{it})}{L_{it}} - \frac{f_{it}(L_{it})}{L_{it}^{2}} \\ &= (\beta - 1)\frac{f_{it}(L_{it})}{L_{it}^{2}} \\ &= (\beta - 1)\frac{E_{it}(L_{it})}{L_{it}} \end{aligned} \tag{18}$$

Values for E_{it} (as well as for f_{it}, F_{it}, and L_{it}) were obtained from our database. The value of β was set equal to the fixed-effect estimate obtained in the previous section. Finally, the entire expression was divided by the Consumer's Price Index for St. John's in order to convert the expression to a *real* return to work.

Because of the presence of kinks and discontinuities in both the *B(L)* and *E(L)* equations resulting from the design of the Unemployment Insurance program, *F′(L)* is not defined at several points, and so the optimality condition (10) is not in general satisfied at these points.[11] We have dealt with this problem by excluding such observations from the sample used for estimation of the optimality condition. This is not entirely satisfactory, since a considerable amount of information (8,140 observations) is removed as a result, including all cases in which the claimant qualifies with a minimum number of weeks — a group which is of considerable interest for policy purposes. We shall consider this issue more fully in a subsequent section.

The expression used for the marginal rate of substitution was based on the assumption that the underlying preference functions of fishermen between real

[11]Specifically, *B′(L)* fails to exist at the boundaries between the separate stages of the *B(L)* function, and *E′(L)* fails to exist (after 1982) at *L* = 15, when average insured earnings is deemed to equal the average earnings in the best ten weeks of fishing.

income and leisure could be approximated by the constant-elasticity-of-substitution form

$$U_{it} = [(F_{it}/P_t)^{\rho} + \delta_i(52 - L_{it})^{\rho}]^{1/\rho} \tag{19}$$

where F_{it} / P_t is real income of fisherman i in period t, 52 - L_{it} is 'leisure' enjoyed by fisherman i at time t, δ_i is an individual-specific parameter reflecting the relative preference of fisherman i for income versus leisure, and ρ is a parameter, assumed to be the same for all fisherman, which is related to the elasticity of substitution σ between income and leisure by the relationship $\rho = 1 - (1/\sigma)$. Since $MRS = -\frac{\partial U}{\partial L} \Big/ \frac{\partial U}{\partial(F/P)}$, through differentiation we obtain

$$MRS_{it} = \delta_i \left[\frac{52 - L_{it}}{F_{it}/P_t}\right]^{\rho - 1} \tag{20}$$

Setting MRS_{it} equal to $RMRW_{it}$, taking logarithms to both sides, and rearranging, we obtain the regression equation

$$\ln\left[\frac{52 - L_{it}}{F_{it}/P_t}\right] = \sigma \ln \delta_i - \sigma \ln\left[\frac{F'_{it}}{P_t}\right] + \zeta_{it}, \quad \zeta_{it} \sim \mathrm{IID}(0, \sigma^2_{\zeta}) \tag{21}$$

when the individual preference term δ_i is treated as a fixed effect parameter. On the other hand, when it is treated as a random effect, the optimization equation becomes

$$\begin{gathered} \ln\left[\frac{52 - L_{it}}{F_{it}/P_t}\right] = \sigma \ln \delta - \sigma \ln\left[\frac{F'_{it}}{P_t}\right] + v_i + \zeta_{it}, \\ v_i \sim \mathrm{IID}(0, \sigma^2_{v}), \quad \zeta_{it} \sim \mathrm{IID}(0, \sigma^2_{\zeta}) \end{gathered} \tag{22}$$

In both cases the ζ_{it} term may be considered to be the effect of optimization errors occurring due to mechanical breakdown, incorrect anticipations, and so on. It should be noted that F'_{it} is a function of L_{it} (see equation (16) above), so there is some possibility that this variable is correlated with the equation disturbances v_i and ζ_{it}, creating least-squares bias.

We estimate both models, along with a constrained OLS model that imposes the restriction that all fishermen have the same preferences, in which case the regression equation can be written as

$$\ln\left[\frac{52-L_{it}}{F_{it}/P_t}\right] = \sigma\ln\delta - \sigma\ln\left[\frac{F'_{it}}{P_t}\right] + \zeta_{it}, \quad \zeta_{it} \sim \mathrm{IID}(0,\sigma_\zeta^2) \tag{23}$$

The regession estimates and estimated standard errors of the constant parameters for the three models are presented in Table 4 below. The estimate of the elasticity of substitution parameter σ is in all cases statistically significant but fairly low, ranging from 0.14 with the fixed-effects model to 0.29 for the constrained OLS model. The conclusion is that real income and leisure are not regarded as close substitutes by this sample of fishermen.

The fixed effects model can be used to test the hypothesis that individual preferences (as reflected in the δ_i parameter) are identical, so that the Constrained OLS model is valid. Under the null hypothesis, when the ζ_{it} are normally distributed, the F-statistic has a value of 3.68 with 4981 and 8324 degrees of freedom. The null hypothesis is clearly (and not unexpectedly) rejected.[12] Finally, the Hausman statistic for orthogonality of the random preference effects with the independent variable, which under the null hypothesis is asymptotically distributed as chi-squared with 1 degree of freedom, has a value of 242.25, once more leading to rejection of the null hypothesis.

Table 4
Regression coefficients and standard errors, optimality relationship

	Constrained OLS	**Fixed Effect**	**Random Effect**
σ **ln**δ	-3.986 (0.043)	--------	-4.343 (0.043)
σ	0.297 (0.008)	0.142 (0.009)	0.222 (0.008)
$\mathbf{R^2}$	0.099	0.923	-------

[12]Similarly, in the random effects model the Breusch-Pagan (1980) Lagrange multiplier test is utilized to test the hypothesis that $\sigma_v^2 = 0$, so that random effects are absent. The value of the Lagrange multiplier, which under the null hypothesis is distributed as chi-squared with one degree of freedom, is 14 836, so the null hypothesis once more is decisively rejected.

Once more we conclude from these results that the fixed-effects model is the most satisfactory one, since it appears that the value of RMRW is correlated with individual income-leisure preferences, and therefore with the individual effect in the random-error model. There may remain some least-squares bias in the fixed-effects model to the extent that the optimization errors ζ_{it} are correlated with RMRW. Some suggestions as to how to deal with this possibility are discussed in the next section.

While it would be premature to base a full model simulation on these results, it is nonetheless of interest to derive some estimates of the impact of the Unemployment Insurance program on the length of the fishing season from them. Table 4 presents three examples of individuals with preference functions and earnings-weeks functions based on the fixed-effects models presented in this and the previous section. The Unemployment Insurance parameters utilized are representative of the situation in 1983–89.

Table 6
Simulated Effects of Unemployment Insurance Program on Fishing

		Weeks Worked L_i	**Earned Income** $f_i(L_i)$	**UI Income** $S_i(L_i)$	**Total Income** $F_i(L_i)$
Case I	With UI	12	\$2,933	\$3,373	\$6,306
	Without UI	21.9	\$4,905	-	\$4,905
Case II	With UI	20	\$4,528	\$3,466	\$7,994
	Without UI	28.1	\$6,051	-	\$6,051
Case III	With UI	30	\$6,391	\$3,014	\$9,405
	Without UI	37.8	\$7,773	-	\$7,773

While the details differ from case to case, the results suggest that the program results in a reduction in the fishing season on the order of 8–10 weeks, and a concomitant reduction in earned income which is however more than made up for by unemployment insurance receipts on the order of \$3,000 or more per year. These are fairly significant effects. There could however be counteracting effects as marginal fishermen increase their fishing to the ten week minimum in order to qualify for Unemployment Insurance. Since we have excluded such individuals from our sample in the estimation of the optimality condition, however, it is arguably illegitimate to extend our model to such individuals, and so we have not done so.

5. Limitations and Extensions

The analysis presented above has two limitations which particular concern us. First, as discussed in section 1, the level of earnings which qualify for unemployment insurance is subject to a weekly maximum. If earnings exceed this maximum, they are deemed to be at that maximum. Similarly, a week's earnings must exceed a particular level in order to qualify for insurability, If earnings fall short of this minimum, they are deemed equal to that minimum for a skipper, but not for a crewman. Therefore, our data in insured earnings is indirectly censored upward — indirectly because the censoring is imposed on a week-by-week basis, not on the total. Similarly, the series is indirectly censored downward for a skipper, and indirectly truncated downward for a crewman.

Truncation and censoring can cause regression estimates to be biased, and the bias can sometimes be severe (see, for example, the Monte Carlo results presented in Davidson and MacKinnon 1993, 538). Maximum-likelihood estimation is normally used to estimate models with censored and truncated data. This method, however, necessitates the specification of an exact functional form (typically although not necessarily normality) for the distribution of the disturbances. The methods used in the previous two sections, in contract, required only the assumption of identical and independent distribution with finite variance, a considerably weaker assumption.

While there is a rich and extensive literature on the handling of censored and truncated data, we must modify the standard approach to incorporate the *indirect* censoring and truncation which occurs in our data. That is to say, our data consist of sums of a series of censored and truncated data, rather than being directly truncated or censored.

The second area for concern arises from the piecewise mature of the benefits function (3), which led us to remove observations which occurred at the kinks and discontinuities in this function in the estimation of the optimality function. here are two problems with this procedure. First, it is inefficient because information is discarded.

Second, optimization errors on the part of fishermen (as a result of uncertainty, for example) can result in behaviour which would introduce bias into the parameter estimates. The source of this bias is twofold (Pudney 1989, 198–201). First, there is the simultaneity bias already discussed, in that model error affects weeks worked, which in turn affects RMRW. The second source of bias is that with optimization errors, the observed and optimum positions of a given data point may lie on different segments of the benefits function. For example, a fisherman who would best locate in Stage 2 may mistakenly fish into Stage 3 as a result of overoptimistic expectations of the return to fishing in that stage. When such points are grouped into the “wrong” segment, the value of RMRW at the optimum is calculated incorrectly, and so the resultant parameter estimates are subject to errors-in-variables bias.

A problem related to the above is that points whose optimum position is at the corner vertex formed by two segments will generally satisfy a tangency condition for neither segment. Inclusion of these boundary points in the estimation will also bias the results. When fishermen make optimization errors, however, we cannot identify cases with corner optima.

This is not a new problem. There exists an extensive literature (Wales and Woodland 1979; Zabalza 1983; Phipps 1990; Osberg and Phipps 1989) on the impact of piecewise-linear constructs such as progressive income taxes and unemployment insurance on the length of work spells. Maximum likelihood methods have been successfully utilized to resolve these difficulties (Pudney 1989, 201–205). The problem, however, is simplified considerably by the assumption usually made that work is available throughout the year at a fixed wage. Our objective in future work is to adopt these techniques to contexts, such as the present one, in which the “wage” varies systematically through the year.

To summarize, it is our view that we have obtained as much from the weak assumption of identical and independent distributions that our data permit. Next on our research agenda is the confirmation or refutation of these results when more specific assumptions are made about the distribution of the disturbances in our econometric specification.

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