Unemployment Insurance and the Length of the Fishing Season

by

Dr. Noel Roy
Department of Economics
Memorial University of Newfoundland
St. John's NF, Canada

Dr. Eugene Tsoa
Department of Economics
Memorial University of Newfoundland
St. John's NF, Canada

Dr. William E. Schrank
Department of Economics
Memorial University of Newfoundland
St. John's NF, Canada

and

Dr. Leigh Mazany
Department of Economics
Dalhousie University
Halifax, NS, Canada

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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 present Unemployment Insurance Act has been in force since 1972.

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

There is one exception to this. Section 146 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 1957.

Section 146 is found in a part of the Act labelled "Transitional and Repeal Provisions," and contains a sub-section stating that "this section shall be repealed on a day to be fixed by proclamation." However transitional this provision was intended to have been when it was established, the Special Seasonal Fishermen's Benefits Program, as it is called, has since taken on a political life of its own, and has become a fundamental element of and support mechanism for inshore fisheries on the Atlantic coast of Canada.

The present Unemployment Insurance Act was passed by Parliament in 1971 and replaced somewhat less generous legislation. After an initial period of stability, perceived difficulties with the Act led to a series of amendments, mostly in a more restrictive direction, 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, at least insofar as it affects inshore fishermen in Newfoundland.

The purpose of this paper is to examine how the 1971 Act and subsequent amendments have influenced the behaviour of inshore fishermen. This influence could potentially have been felt 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 fishermen engage in this activity over the fishing season; and

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

This paper is primarily concerned with changes of the second kind, that is to say, with changes in the length of time spent fishing over a season as a result of the unemployment insurance program.

The basic structure of the Canadian unemployment insurance program as it affects inshore fishermen is outlined in Part I of the paper. Part II develops a behavioural model of the decision to fish in a particular week within the season, which we subsequently use to evaluate the impact of seasonal fishermen's benefits on the length of the fishing season. Some econometric difficulties are discussed in Part III. The simulation possibilities which exist with a fully specified model are illustrated in Part IV.

I. The Unemployment Insurance Program

The Canadian Unemployment Insurance program works 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 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*, 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). This implies that even a minimal level of fishing activity qualifies a boat owner for unemployment insurance, and qualifies him or her at an artificially high rate.

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)). This means that 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. This practice became more widespread after 1986, when Revenue Canada released a statement which gave a broadened interpretation to this section of the *Regulations*. As landings have declined as a result of resource depletion, this characteristic of the program has increased in importance.

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 primary 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, fishermen in Newfoundland, especially full-time fishermen, have not been able to obtain sufficient regular employment to avail themselves of regular benefits. Table 1 presents a breakdown of the UI dependence of Newfoundland fishermen actively fishing in 1984, based on a survey conducted by the Department of Fisheries and Oceans.[1]

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[1]Source: Department of Fisheries and Oceans, *1984 Survey of Atlantic Fishermen*, unpublished data. In Newfoundland, 65 percent of active fishermen held full-time status in 1984.

Table 1
Distribution of active fishermen
by type of unemployment insurance benefit
and licensing classification,
Newfoundland, 1984

	Full-time Fishermen	Part-time Fishermen	All Fishermen
Fishermen's benefits	79.3%	36.4%	63.6%
Regular benefits	7.7%	26.1%	14.4%
Both	1.4%	4.8%	2.7%
Neither	11.6%	32.7%	19.3%

II. 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 over the year because of changes in resource availability. As a result, fishing income is subject to diminishing returns as the fishing season is extended past the peak season. The longer a fisherman continues to fish, the smaller the incremental returns from fishing an additional week. This relationship between fishing income and fishing weeks can be represented as a concave function similar to the FF curves in Figures 1(a) and 1(b).[2]

The factors that determine whether a fisherman will fish in a particular week depends on the nature of the alternative activities available to him or her. In Canada, fishermen are classified by the regulatory authority into full-time and part-time categories. Part-time fishermen typically have other employment activities available to them; they usually fish only during the peak of the season.[3] When incremental fishing income falls below the wage that could be earned in alternative employment, they discontinue fishing. This choice decision is represented in

[2]The weeks in Figure 1(a) and 1(b) need not be consecutive; there may be alternating periods of fishing and inactivity over the year, in response to variations in resource availability over time.

[3]In 1984, active full-time fishermen fished an average of 19.1 weeks in Newfoundland; active part-time fishermen, only 11.8 weeks. (Source: Department of Fisheries and Oceans, *1984 Survey of Atlantic Fishermen.* Economic and Commercial Analysis Series, Surveys and Statistics Report 37. Ottawa, 1987. Tables 4.8 and 4.9.)

Figure 1(a), where the slope of the tangent line WW equals the wage rate obtainable in alternative employment.

Full-time fishermen must fish on a consistent basis throughout the fishing season in their area in order to maintain full-time status for licensing purposes. They cannot work longer than 30 days at other employment within the fishing season, and can pursue only limited self-employment in specified primary industries outside the fishing season. Alternative employment is not a major consideration for such fishermen.[4] Their behaviour can be modelled as selecting 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(b).

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

(1) $$F = f(L),$$

where $f' > 0, \;\; f'' < 0$.

In this model, part-time fishermen divide their working weeks between fishing and non-fishing employment so as to maximize income earned in the work period. If non-fishing employment is available at a weekly wage w, income during the working period is maximized when fishing income in the marginal fishing week equals this wage.

(2) $$f'(L) = w.$$

Full-time fishermen,[5] on the other hand, seek to maximize the value of a utility function $U(F,L)$, where $U_F > 0$ and $U_L < 0$. This occurs where

(3) $$f'(L) = -\frac{U_L}{U_F} = \mathrm{MRS}_{LF}.$$

For both groups of fishermen, 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.

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[4]In 1984, active full-time fishermen in Newfoundland earned an average of only $664 in non-fishing employment income, as opposed to $6,798 in net fishing income and $3,421 in seasonal fishermen's benefits (Source: Department of Fisheries and Oceans, *1984 Survey of Atlantic Fishermen.* Economic and Commercial Analysis Series, Surveys and Statistics Report 37. Ottawa, 1987. Table 9.8.)

[5]We are using the terms part-time and full-time here rather loosely, to distinguish between fishermen who have, or do not have, alternative employment opportunities within the fishing season. This distinction may not strictly correspond to the licensing classification used by the Department of Fisheries and Oceans.

The income effects are discussed first. If leisure is a normal good, then the higher income from unemployment insurance leads to an increase in the demand for leisure. In the case of full-time fishermen, this would result in a reduction in the number of weeks spent fishing, in order to enjoy this additional leisure. Part-time fishermen would also reduce their work activity, while still maintaining the equilibrium condition $f'(L) = w$. However, any reduction in fishing weeks L would result in an increase in $f'(L)$ (since $f'' < 0$), so that this condition would no longer be satisfied. It must be the case then that *all* the reduction in work effort must be outside of fishing. There is thus no income effect on fishing weeks in the case of part-time fishermen with alternative employment opportunities.[6]

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

(4) $$S(L) = r\, E(L)\, B(L).$$

The benefit-earnings ratio r is a constant, which was equal to 2/3 over the period 1972-1978 and to 60 percent thereafter.[7]

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

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[6]For a further elaboration on this point, see Ferris and Plourde (1980), chapter 4.

[7]There was a special 3/4 rate for low-income claimants with dependants over the period 1972-74. However, this rate appears to have been almost irrelevant to fishermen in Newfoundland. In a 10 percent sample of fishing UI claimants over this period, only 31 out of 1350 claimants had insured earnings below the level required to qualify for this rate.

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 $L \geq 15$, 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.,

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

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. 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

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

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

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

Ultimately, as the number of fishing weeks is extended further, fishing takes place during the 'off-season', when seasonal benefits could be 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 $B(L) = 0$, and so (allowing for the two-week waiting period)

(81) $$B(L) = 50 - L.$$

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

(91)
$$\begin{aligned} B(L) &= \min\left[\frac{5}{6}L + B_{ext},\ B_{\max},\ 50 - L\right], \quad L \ge q, \\ &= 0, \quad L < q. \end{aligned}$$

An example is presented in Figure 2; this is the relationship which prevailed over the period 1972-75. 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 and illustrated in Figure 3. They are considered in greater detail in Roy, Tsoa, Schrank and Mazany (1992).

Table 2
Unemployment insurance benefit week parameters
Newfoundland, 1972-91

	q	B_{ext}	B_{max}
1972-75	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

(101)
$$\begin{aligned} F(L) &= f(L) + S(L) \\ &= f(L) + r\,E(L)\,B(L). \end{aligned}$$

An example of such a relationship, appropriate to the period 1972-75, is provided in Figure 4. This figure shows a typical pattern for earned fishing income $f(L)$, seasonal fishermen's benefits $S(L)$, and total fishing income $F(L)$. The shape of these relationships are obviously dependent on that of the $f(L)$ function, which affects the average insured earnings function $E(L)$ and therefore the $S(L)$ and $F(L)$ functions as well.

The optimum conditions can then be written as

(111)
$$F'(L) = f'(L) + S'(L) = w$$

for part-time fishermen, and

(121) $$F'(L) = f'(L) + S'(L) = \text{MRS}_{LF}(F,L)$$

for full-time fishermen.

The slope of $S(L)$ can be derived as

(131) $$S'(L) = r\,[E(L)B'(L) + E'(L)B(L)].$$

As was explained above, $E'(L)$ is generally negative,[8] 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. 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.

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,[9] so that normally $S'(L) > 0$ in Stage 2.

In Stages 3 and 4, it remains true that $E'(L) < 0$, but here $B'(L) \leq 0$, so it is necessary that $S'(L) < 0$. The level of seasonal fishermen's benefits, then, must decline as the number of fishing weeks is extended into Stages 3 and 4. Total fishing income inclusive of unemployment insurance $F(L)$ will continue to increase for a while, but we would expect that normally there will be a point at which extending the number of fishing weeks will add less to earned income $f(L)$ than will be lost from seasonal benefits $S(L)$ (i.e., $f'(L) + S'(L) < 0$), so that total fishing income would decline if the number of fishing weeks were extended beyond that point. The value of L at which this happens depends on the shape of the $f(L)$ and $E(L)$ functions.

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[8]Unless the fisherman earns the maximum qualifying income throughout the qualifying period, in which case it is zero.

[9]One simple example, reflecting a not particularly favourable circumstance, arises when the fisherman's benefits are based on the average earnings over the qualifying period, and these earnings never exceed the qualifying ceiling. Then $E(L) = f(L)/L$, and so

$$S(L) = r\frac{f(L)}{L}\left[\frac{5}{6}L\right] = \frac{5rf(L)}{6}.$$

Since $f'(L) > 0$, $S'(L) > 0$ as well.

Let us now examine the implications of these relationships for the behaviour of fishermen. Consider a part-time fisherman with less than the minimum number of insured weeks (Stage 1). Unless (s)he increases his/her insured weeks to at least the minimum level (Stage 2), (s)he will not receive benefits. It may be worth his/her while to extend his/her fishing effort into Stage 2, if the unemployment benefits received, plus the attendant fishing income, exceed the foregone wages. This case is illustrated in Figure 5(a), where the introduction of seasonal benefits leads to a change in the tangency from point E to point E'. On the other hand, if the foregone wage income is high enough, as it is in Figure 5(b), the fisherman will not modify his/her behaviour, because it remains optimal to fish less than the number of weeks required to qualify for unemployment insurance. In summary, 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.

If a part-time fisherman works enough weeks to qualify for seasonal benefits, (s)he is in equilibrium when $F'(L) = w$. The availability of fishermen's benefits clearly changes the value of L at which this occurs.[10] This value is increased if $S'(L) > 0$, and is decreased if $S'(L) < 0$. Thus, the behaviour of part-time fishermen is governed by the sign of $S'(L)$, so that they fish longer if $S'(L)$ is positive and cut back if it is negative. For full-time fishermen this effect is supplemented by an income effect as well, which if leisure is a normal good would induce a reduction in the number of weeks spent fishing.

In Stage 2 it is normally the case that $S'(L) > 0$, because additional insured weeks permit more benefit weeks. Therefore, part-time fishermen in Stage 2 are predicted to fish longer as a result of seasonal benefits. This is illustrated in Figure 6. For full-time fishermen, this may be offset to a greater or lesser degree by a negative income effect, so that such fishermen may choose to work less as a result of the higher income.

Fishermen working in Stages 3 and 4, whether full-time or part-time, suffer from no such ambiguity. Additional fishing effort lowers 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 lowers the amount of unemployment benefits received, and this creates an incentive to fish less, which augments any negative income effect. This effect is illustrated in Figure 7.

To summarize, then: the model predicts that seasonal fishermen's benefits will cause fishermen working in Stages 3 or 4 to reduce the number of weeks spent fishing. Those fishing less than this *may* be induced to increase the number of weeks spent fishing. The effect is one of compaction in the variance in fishing effort from that experienced without unemployment insurance. The basic conclusion of this theoretical analysis is that there is no theoretical presumption that

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[10]Throughout this analysis we assume that while alternative employment opportunities are available to part-time fishermen, these opportunities are insufficient to permit such fishermen to qualify for regular unemployment insurance benefits. Fishermen who qualify for regular benefits are ineligible to receive special seasonal fishermen's benefits.

seasonal fishermen's benefits will either increase or reduce the *average* amount of time spent fishing.

III. Some Econometric Considerations

The authors have elsewhere (Roy, Tsoa, Schrank and Mazany 1992) examined the impact of the various changes which have taken place in the seasonal fishermen's benefits program on the number of inshore fishermen in Newfoundland and on the number of weeks they have spent fishing over the year. This analysis is based on the application of the theoretical model outlined above to a ten percent sample of seasonal benefit recipients over the period 1972-1981, and a one hundred percent sample over the period 1981-1985. For the most part, the predictions of the theoretical model are reflected in the data.

In the final analysis, however, we would like to use econometric techniques to estimate the optimizing conditions in equation (8). Unfortunately, such estimation poses severe challenges. In rough order of seriousness, these are (1) problems of parameter identification, (2) suitable treatment of the piecewise non-linearities and discontinuities in the benefit function $S(L)$, and (3) the adjustments appropriate to the upper and lower limits associated with the number of insured weeks and the level of average insured earnings. We discuss each of these problems in turn.

1. Identification of parameters

The number of weeks worked by seasonal benefit recipients varies widely across our sample, from the minimum 8 or 10 weeks needed to qualify for benefits, up to nearly a full year. Such differences can be explained by the model as being due either to differences in the shape of fishermen's catch functions $f(L)$ (i.e., differences in their opportunity sets) or to differences in the shape of their indifference curves (i.e., differences in their preferences). That is to say, one fisherman may work a shorter period than another either because his/her productivity falls off more rapidly as his/her season is extended, or because (s)he has a stronger preference for "leisure" (understood to mean non-market activities generally). We can incorporate these parameters into the optimum condition for a full-time fisherman (8b), which then becomes

(141) $$F'(L_i;\beta_i) = \mathrm{MRS}_{LF}(L_i,F_i;\delta_i),$$

where β_i are the parameters associated with the i^{th} fisherman's catch function and δ_i are those associated with his/her utility function.

The difficulty is that neither β_i nor δ_i are directly observable. We cannot infer from the data to what extent differences in the behaviour of fishermen are due to differences in opportunities or to differences in preferences.

This problem is *potentially* less serious for part-time fishermen, whose optimum condition can be written as

(151) $$F'(L_i;\beta_i) = w_i.$$

Since the w_i, unlike the preference function parameters δ_i, are observable in principle, we should be able to identify the catch function parameters β_i. Unfortunately, our data sets do not contain information on alternative wage opportunities, so the identification problem exists in this case as well.

To evaluate the seriousness of this difficulty, we estimated a version of the optimum condition (10) under two alternative specifications: (1) all fishermen have identical preferences (all δ_i identical), so that all behavioural differences are due to differences in catch functions, and (2) all fishermen have identical catch functions $f(L)$ up to a scalar multiple (β_i identical), so that behavioural differences are due entirely to differences in tastes. The sample we utilized was the set of fishermen qualifying for seasonal benefits during 1982 in Newfoundland, meeting the following characteristics:

(1) worked between 10 and 23 insured weeks, so that they fall in Stage 3 of the benefit-weeks relationship (8);

(2) drew the maximum 27 weeks of benefits, so that they were unemployed throughout the benefit period; and

(3) earned less than the maximum weekly insured earnings of $350 in their qualifying weeks.

We are left with a sample of 5,631 out of a potential 13,142 claimants. Unfortunately, our data source does not distinguish between full-time and part-time fishermen. The 1984 DFO Income Study reveals that in that year, 77% of seasonal fishermen's benefit recipients were full-time fishermen, so we feel justified in using the full-time model on this sample.

We use log-linear approximations for both the catch functions $f(L)$ and the utility functions $U(F,L)$. We represent the catch function as

(161) $$f_i = \alpha_i L_i^{\beta_i}.$$

The elasticity of the seasonal catch f with respect to the number of fishing weeks L is measured by the β parameter, which should be between 0 and 1. The greater the curvature of the $f(L)$) curve, the lower is β.

The α 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, and innate skills. We assume that α is related to various socio-demographic indicators by a semi-logarithmic relationship of the form

(171) $$\ln\alpha_i = \boldsymbol{Z}_i\gamma + \epsilon_i,$$

where $\boldsymbol{Z}_i$ is the vector of relevant socio-demographic indicators and ϵ_i captures otherwise "unexplained" variations in α. In the regressions, we use the following indicators in $\boldsymbol{Z}$:

1. Age of the claimant (AGE).
2. A binary sex dummy variable (SEX) which equals zero if the claimant is male and one otherwise.
3. A binary occupation dummy variable (FISHER) which equals one if the claimant is classified as a fisherman in the database and zero otherwise.
4. A number of binary dummies for CEIC management areas (AREA) where the claimant has filed his/her claim.[11]

The first three variables are expected to be indicators of experience. The fourth should reflect local fish abundance.

Substituting (13) into (12) gives the catch equation

(181) $$\ln f_i = \boldsymbol{Z}_i\gamma + \beta_i \ln L_i + \epsilon_i.$$

The utility function used is a Cobb-Douglas function in income F_i and weeks of 'leisure' 52 - L_i,

(191) $$U_i = F_i^{\delta_i}(52 - L_i)^{1-\delta_i},$$

which implies the marginal rate of substitution function

(201) $$\mathrm{MRS}_{FL} = \frac{1-\delta_i}{\delta_i}\frac{F_i}{52 - L_i}.$$

Within the selected sample, $B(L) = B_{max}$, since all claimants are in Stage 3 of the $B(L)$ function. As well, we can reasonably assume that $E(L) = f(L)/L$, since weekly insured earnings are below the maximum. Thus from equation (4) unemployment benefits are

(211) $$S_i = rB_{max}\frac{f(L_i)}{L_i}.$$

Substituting (17) into (7) and differentiating with respect to L gives the slope of the fishing income function

[11] The CEIC management areas are coded as follows, with St. John's as datum: AREA40 = Clarenville, AREA41 = Happy Valley, AREA51 = St. John's Central, AREA52 = St. John's West, AREA53 = Harbour Grace, AREA54 = Gander, AREA55 = Marystown, AREA57 = Grand Falls, AREA58 = Stephenville, AREA60 = Corner Brook.

(221) $$F'(L_i) = \left[1 + \frac{rB_{max}}{L_i}\right] f'(L_i) - \frac{rB_{max}}{L_i^2} f(L_i).$$

The optimum condition (8b) can be arrived at by equating the slope of the fishing income function (18) with that of the indifference curve (16). After simplifying, we can express the optimum condition as

(231) $$\frac{1-\delta_i}{\delta_i}\frac{L_i}{52-L_i} + \frac{rB_{max}}{L_i + rB_{max}} = \beta_i,$$

where L_i is shown to be a function of both δ_i and β_i. Since neither parameter is directly observable, neither can be identified without further restrictions.

If we assume that fishermen have identical preferences ($\delta_i = \delta$), then we can, by substituting (19) into (14), express the optimum condition as the linear-in-parameters relationship

(241) $$\ln f_i - \frac{rB_{max}}{L_i + rB_{max}} \ln L_i = \boldsymbol{Z}_i\gamma + \theta\frac{L_i}{52 - L_i}\ln L_i + \epsilon_i,$$

where $\theta = \delta/(1-\delta)$. Since in this sample the replacement rate r is 0.6 and the maximum benefit period B_{max} is 27, we can estimate the parameters θ and γ through ordinary least squares. Values of β_i corresponding to various values of L_i can then be obtained from equation (20).

The regression results are reported in the column of Table 5 labelled Run 1. The estimated value of θ is 0.52, which corresponds to a value of the utility function parameter δ equal to 0.34. The γ parameters are also presented. Age is positively related to productivity, although not significantly. Males are significantly more productive than females, and those classified in the database as fishermen are more productive than those not so classified. There are also significant geographic differences, as reflected in the AREA dummies.

Values of the catch function parameter β which are implied by equation (20) are presented in Table 3 for various levels of L. The median value of L in the sample is 12.

Table 3
Values of β implied by Run 1 results

L_i	β_i	L_i	β_i
10	0.742	17	0.740
11	0.735	18	0.748
12	0.730	19	0.759
13	0.728	20	0.772
14	0.728	21	0.787
15	0.730	22	0.805
16	0.734	23	0.825

Suppose now that all fishermen have identical values for the catch function parameter β, rather than for the utility function parameter δ. We continue to permit the α parameter in the catch equation (12) to differ among fishermen, so only the curvature, and not the position of the catch function is invariant. Then the catch function in equation (14) is linear in parameters and can be estimated directly using ordinary least squares.

The regression results are reported in the column of Table 5 labelled Run 2. The estimated values of the γ parameters are similar to those estimated from the identical preferences model in Run 1, although the influence of age is much greater in the latter model. The estimated value of the catch function parameter β, however, is 0.91, which is significantly higher than those values implied in the identical preferences model and reported in Table 3. Similarly, the values of the utility function parameter δ implied by equation (19) for this value of β are presented in Table 4. We see values considerably higher than the value 0.34 estimated in the identical preferences model. The implication is that the model specification *does* matter.

Table 4
Values of δ implied by Run 2 results

L_i	δ_i	L_i	δ_i
10	0.449	17	0.535
11	0.460	18	0.548
12	0.472	19	0.561
13	0.484	20	0.575
14	0.497	21	0.588
15	0.509	22	0.601
16	0.522	23	0.615

It does not necessarily follow that we have to choose between two extreme specifications, those of identical preferences and identical opportunities. We may be able to identify the two sets of parameters on the basis of much weaker assumptions on the distribution of these parameters, through the utilization of maximum likelihood techniques. The existence of piecewise segments in the opportunities set should enhance the possibility of identifying the two sets of parameters, as should the parameter changes to which the unemployment insurance program (and therefore the opportunities set) has been subjected over the years. However, we have not yet solved this statistical problem to our satisfaction.

2. Piecewise non-linear opportunity sets

The theoretical structure outlined in Part II demonstrates that the optimum relationship governing the determination of the fishing season can be decomposed into four distinct segments. Linear estimation of this relationship across the entire spectrum of fishing seasons is clearly unacceptable, even as an approximation. This is clear from an examination of the relationships portrayed in Figure 4.

The easiest solution to this problem, and the one used in the early literature on non-linear budget constraints (see Hausman 1985 for a survey), is simply to estimate the relationship for each segment separately from the others.

There are two problems with this procedure. First, it is relatively inefficient in that information from data contained in one segment (on preferences, say) is not utilized in the estimation of the relationship across other segments. 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, pp. 198-201). First, optimization errors result when a random variable is added to equation (20). Then variable L_i becomes random as well, and therefore regression estimates of equations such as (14) or (20) are subject to simultaneity bias.

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. For example, a fisherman who would best locate in Stage 2 mistakenly fishes into Stage 3. When such points are grouped into the "wrong" segment, the resultant estimates are biased.

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, pp.201-205). The problem, however, is simplified considerably by the assumption usually made that work is available throughout the year at a fixed wage. The challenge is to adopt these techniques to contexts, such as the present one, in which the "wage" varies systematically through the year.

3. Upper and lower limits and partially observable data

In the regressions reported above, we removed from our sample claimants whose average insured earnings were at the maximum $350 per week, because we could no longer use the level of insured earnings as a measure of earned income. This required discarding 939 observations, a considerable loss of information. Moreover, there is considerable danger in this procedure of sample selection bias resulting from the removal from our sample of the most productive fishermen. Fortunately, there is an extensive econometric literature on this so-called partial observability problem (Pudney 1989, ch. 4).

We have tested two alternative specifications of the identical opportunities model. The first, labelled Run 3, re-estimates Run 2 using a sample which includes claimants reporting the maximum insured earnings during their qualifying weeks. The second, labelled Run 4, is a Tobit regression analogous to Run 3. The outcome, which frankly surprised us, is that there is only a negligible difference in the estimated values of β and most of the components of γ among these three runs. The truncation in the value of maximum insured earnings does not appear to be a serious problem, at least in this sample.

IV. Simulation exercises

Successful estimation of the optimal conditions would enable us to simulate the impact of changes in the parameters underlying the unemployment insurance program on the length of the fishing season. For example, let us take the identical opportunities model underlying Run 2 as valid. We can rewrite the optimum condition (19) as

(251) $$\theta_i = \beta\frac{52 - L_i}{L_i} - \frac{rB_{max}(52 - L_i)}{(rB_{max} + L_i)L_i},$$

which enables us to associate a value θ_i with each value of L_i, for an estimated value of β such as the 0.91 in Run 2. The implied δ_i values are reported in Table 3. Now rewrite equation (21) as

(261) $$(\beta + \theta_i)L^2 - [(52 - rB_{max})\beta + rB_{max}(1 - \theta_i)]L + 52rB_{max}(1 - \beta) = 0,$$

a quadratic equation in L. For the given β and θ, we can evaluate the value of the number of fishing weeks L which would prevail if either of the unemployment insurance parameters r and B_{max} were modified.

Table 6 presents the simulated outcome of (a) a reduction in the benefit-earnings ratio r from 0.6 to 0.5; (b) a reduction in the maximum number of benefit weeks B_{max} from 27 to 20 weeks; and (c) both changes simultaneously. The first change increases the number of fishing weeks by anywhere from 1.6 to 2.6 weeks, depending on the initial value of L. The second change increases the number of fishing weeks by from 2.2 to 3.9 weeks. The two changes together increase the number of fishing weeks by from 3.1 to 5.4 weeks. These are fairly large changes. As expected, the impact of the two changes together is not additive. Note that the simulated changes occasionally go outside Stage 3, and this would have to be taken into consideration in a full simulation.

Table 5
Regression coefficients and standard errors

Run	Run 1	Run 2	Run 3	Run 4
Model	Identical preferences	Identical Opportunities		
Upper bound treatment	Data with $E(L) <$ \$350 only		All Data	
Estimator	Ordinary Least Squares			Tobit
θ	0.519 (0.007)			
β		0.914 (0.014)	0.907 (0.013)	0.896
AGE	0.0036 (0.0025)	0.00007 (0.00024)	0.0015 (0.0023)	0.0002
SEX	-0.192 (0.015)	-0.172 (0.011)	-0.176 (0.011)	-0.188
FISHER	0.035 (0.007)	0.034 (0.007)	0.041 (0.007)	0.051
AREA40	-0.027 (0.018)	-0.136 (0.018)	-0.0005 (0.0166)	0.007
AREA41	-0.062 (0.023)	-0.056 (0.023)	-0.060 (0.022)	-0.059
AREA51	-0.051 (0.036)	-0.036 (0.036)	0.009 (0.032)	0.021
AREA52	0.021 (0.019)	0.031 (0.019)	0.082 (0.017)	0.129
AREA53	0.053 (0.018)	0.068 (0.018)	0.095 (0.017)	0.130
AREA54	0.039 (0.017)	0.047 (0.016)	0.056 (0.016)	0.067
AREA55	-0.153 (0.029)	-0.155 (0.029)	-0.172 (0.029)	-0.178
AREA57	-0.0001 (0.018)	0.0006 (0.018)	0.019 (0.017)	0.031
AREA58	-0.160 (0.033)	-0.137 (0.033)	-0.104 (0.030)	-0.096
AREA60	-0.042 (0.017)	-0.043 (0.017)	-0.039 (0.016)	-0.035
Constant	6.223 (0.019)	5.788 (0.040)	5.907 (0.127)	5.847
Adjusted R^2	0.53	0.48	0.48	

Table 6
Simulated number of fishing weeks,
various unemployment insurance parameter values

$r = 0.6$, $B_{max} = 27$	$r = 0.5$, $B_{max} = 27$	$r = 0.6$, $B_{max} = 20$	$r = 0.5$, $B_{max} = 20$

10	12.65	13.89	15.43
11	13.46	14.65	16.14
12	14.31	15.45	16.89
13	15.18	16.28	17.67
14	16.07	17.13	18.48
15	16.97	17.99	19.29
16	17.88	18.86	20.13
17	18.80	19.75	20.97
18	19.72	20.64	21.82
19	20.65	21.53	22.67
20	21.59	22.43	23.53
21	22.52	23.34	24.40
22	23.46	24.25	25.27
23	24.40	25.16	26.14

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