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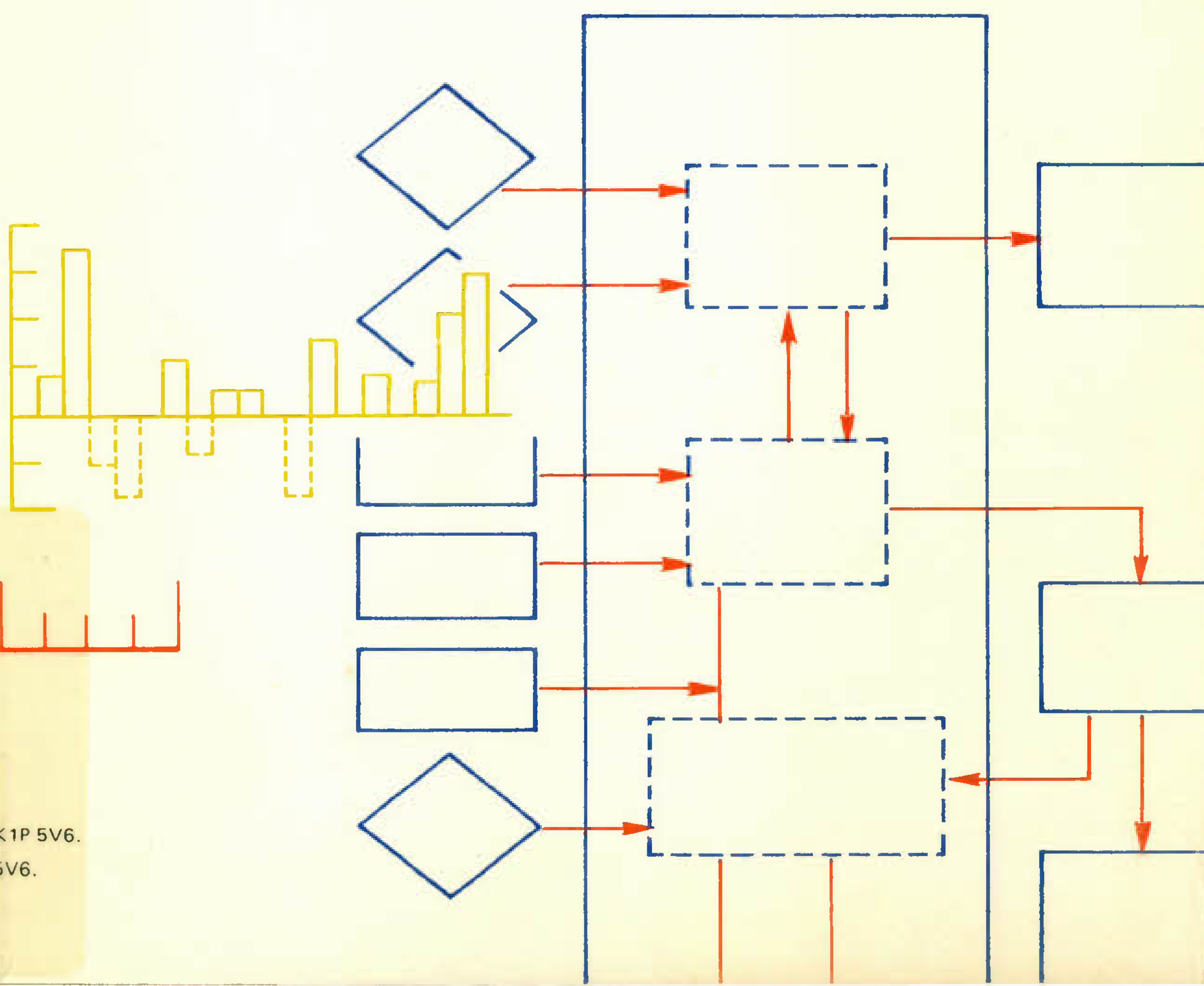

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DISCUSSION PAPER NO. 173

Fisheries Management and Employment in the Newfoundland Economy

by

Stephen Ferris and
Charles Plourde

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ISSN-0225-8013

Résumé

Les auteurs de ce document présentent ici une analyse théorique et empirique des effets de divers programmes de subventions publiques sur les revenus, l'emploi et la productivité dans l'industrie de la pêche à Terre-Neuve. Après un bref survol des ouvrages les plus importants sur l'industrie de la pêche, l'analyse recourt d'abord à un modèle à deux secteurs (pêche côtière et en haute mer) axé sur le gaspillage des rentes économiques et l'utilisation excessive des ressources attribuables au caractère de propriété commune (canadienne) du stock de poissons en eaux libres. Trois domaines où l'absence d'un mécanisme interne provoque des problèmes particuliers sont mis en lumière : la répartition inefficace des ressources au sein de chaque secteur, entre secteurs et dans le temps. Le chapitre 3 examine les effets qualitatifs des subventions pour les bateaux, l'équipement et la pêche, sur les objectifs conflictuels de l'accroissement du revenu et de la productivité avec celui de la conservation des ressources. Les répercussions des divers programmes de permis de pêche et de quotas sont également analysées. Le chapitre 4 présente un examen théorique et empirique détaillé d'un programme particulier de subventions, soit les prestations saisonnières d'assurance-chômage. Les auteurs sont d'avis que cette tentative visant à suppléer aux revenus des pêcheurs va en définitive à l'encontre du but poursuivi. En attirant plus

de candidats, l'emploi s'accroît, mais au coût d'une réduction grave des revenus, de la productivité et du stock des ressources de la pêche. Le chapitre 5 analyse l'incidence des risques et la justification d'une assurance sur les prises. Enfin, les auteurs recommandent l'établissement de droits de propriété privée relativement aux parts accordées sur le quota annuel global de la pêche.

ABSTRACT

This study presents a theoretical and empirical investigation of the effects of various government subsidy programmes on incomes, employment and productivity in the Newfoundland fishery. After a short survey of the fisheries literature, the analysis begins with a two sector (inshore-offshore) model that focuses on the rent dissipation and excessive resource use arising from the common (Canadian) property characteristic of the fish stock under open access. Three areas where the absence of an internalizing mechanism leads to particular problems are highlighted: misallocation within each sector, between sectors, and through time. Chapter 3 considers the qualitative effects of boat, gear and fish subsidies on the conflicting objectives of income and productivity improvement combined with resource conservation. The likely consequences of various licensing and quota programmes are also discussed. Chapter 4 presents an extensive theoretical and empirical investigation of one particular subsidy programme -- seasonal unemployment insurance benefits. It is concluded that this attempt to supplement fishing incomes is ultimately self-defeating. By attracting entry, employment rises at the cost of significantly lower fishing incomes, productivity and resource stocks. Chapter 5 discusses the implications of risk and the case for crop insurance. The study concludes by advocating the establishment of private property rights in the shares of the aggregate annual fishing quota.

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Chapter 1

Introduction

The purpose of this study is to analyze a specific aspect of a specific sector of the Newfoundland economy. The sector involved is the fishing sector which is essentially characterized by two distinct technologies - offshore harvesting in various kinds of trawlers and inshore or daily, smallboat harvesting. Within these two classifications there are variations such as in gear types which affect both the quantity and quality of the harvest.

In this study attention will be focussed on the labour employment aspects of the fishing sector.

The essential properties of the two technologies are as follows. The inshore sector is characterized by many small boats with (relatively) large employment capability and a low capital/labour ratio. The inshore fishery is seasonal with gear varying among hooks, nets and traps. Because of the warm weather in the productive summer season, and the technology used, quality in the inshore may be low. Moreover, fish processing plants tend to have backlogging due to the glut of the summer season adding to the deterioration of quality. The inshore fishery relies heavily on the inshore migration of capelin, squid and particularly cod. As well, it is affected by the size of the offshore trawler harvest. As a consequence, governments have tended to subsidize many of the aspects of inshore fishing. Much of our attention will be focussed on these subsidies and their effect on employment in later chapters.

The inshore fishery is subject to uncertainty, a victim of random influences such as weather. Various institutional arrangments have been devised to cope with the risk and uncertainty of the inshore fishery.

The offshore fishery, on the other hand, is a year round operation both at the harvesting and processing levels with more diverse products. It is characterized by relatively low labour employment capabilities and a high capital/labour ratio. Salaries in this sector are substantially higher than those of the average inshore worker. Quality of output is more uniform but could be improved by various handling and freezing techniques. Costs per unit effort are probably on average higher in this sector.

Because these two fisheries are in some sense competing for exploitation of the same resource base, trade-offs must occur for any fixed total exploitation level. Because the fish resource is common property and of open access, Federal governmental control is necessary for efficient management. Hence a decision must be made as to how to allocate harvests both intertemporally and intratemporally. This decision will affect the employment in the province.

In undertaking a study of this nature the first step that must be made is to choose the extent of the analysis. An economy is a very complex structure and a general equilibrium approach would at the outset seem advisable. However, such a general approach is costly and complicated. If a partial equilibrium analysis is then accepted, one must decide on the breadth of allowable variation, or equivalently, what will be assumed to be parameters.

In our analysis which follows we assume at the outset that the technologies are established and that the fish harvesting sector is competitive with a parametric price. We assume as well that there is in the province a prevailing competitive wage rate and return to capital.

Among the variables involved, resource biomass is probably the most significant. As later analysis will point out, lack of appropriation of this variable is probably the single most important reason for the problem of the fishery. In the place of appropriation there will exist a set of licencing and quota rules which will have certain efficiency and equity consequences. Any analysis that includes an efficiency objective will, however, conclude that certain Ricardian-like rents will exist. The extent to which the province can and should extract the rent for a resource which may (or may not) lie within its domain is clearly a political decision.

The text of this study will be as follows. The introductory chapter, of which this is part, will continue with a brief survey of the economic literature relevant to fish harvesting and employment. Chapter 2 will provide an equilibrium model of the fishing sector isolating the key decision making agents and the interdependencies that exist. That chapter will also contain a set of corresponding optimality conditions to indicate the deficiencies of the untrammelled competitive solution.

Chapter 3 will explore the various interferences by governments in the fishing industry (with the exception of unemployment insurance), such as gear subsidies and price supports. The main concern at this stage will be to consider the comparative statics and to see if these interferences will likely lead the competitive solution in the right direction (toward efficiency).

Chapter 4 will continue the pursuit of Chapter 3. Here attention will be set solely on the direct subsidy to labour, that is, the special provisions of the Unemployment Insurance Act granted to the fishing sector. Both a quantitative and qualitative analysis will be provided of the employment related problems of the inshore fishery and the effects of Unemployment Insurance legislation. For instance, our theoretical analysis in both Chapters 3 and 4 will lead us to conclude that attempts to subsidize the incomes of inshore fishermen will fail. Because of the institutional arrangement, we conclude that fishermen income supplementary schemes will imply industry expansion and higher boat-owner shares, but not necessarily higher fishermen incomes. We provide empirical testing of these hypotheses.

Other income supplementary schemes are considered as well.

Chapter 5 is included to discuss the special ways in which risk and uncertainty are accounted for in the fishery. Crop insurance, as an option to unemployment insurance, is discussed.

A bibliography relevant to this study follows Chapter 5.

A Brief Review of Some Literature Relevant to Fisheries Management and the Newfoundland Fishery

In order to place the present resource management problem in Newfoundland in perspective, we will extract from the existent body of published economic literature . Our review will be brief and it will be restricted to the theoretical fisheries literature. We will purposely not attempt a review of the extensive policy literature related to the Newfoundland literature . Such an excellent review is given within this Reference by Gordon Munro.

Optimal Economic Management: Single species

The need to have overt control of commercial fisheries predates the well known economic analysis of the reasons for this control. For instance, due to dwindling stocks and low profits the Pacific Halibut Commission was instituted in 1924. Yet, it was not until the middle 1950's that any specific literature appeared in the economic journals on the fishery.

The first analyses to appear were static in nature and addressed the 'common property' problem which leads to rent dissipation. This problem was presented and analyzed by H.S. Gordon (1954) and is discussed in many recent publications such as Copes (1978) and Clark (1976).

The issue is essentially that one of the inputs in production is not appropriated (specifically, the fish stock) and hence its implicit share of factor payment is dissipated among the other inputs (capital and labour, or more generally, effort). Hence fishing effort is overexpanded and the reward system results in a steady state involving too much fishing effort and a too small fish stock size. The result is a depressed industry such as experienced in the inshore groundfish (cod) industry of Newfoundland beginning in 1974.

The usual solutions put forward for this non-appropriation problem involve attempts to appropriate through governmental action. A government, acting as sole owner of the fish stock can impose taxes or quotas to restore the fishery to what would be the optimal situation.

The above rent dissipation problem is essentially a problem of the relationship between firm and industry. It does not take into account the important intertemporal interrelationships among fish stock sizes. Vernon L. Smith (1965) refers to this as the 'stock' externality. It is well known that the size of todays catch affects the stock available for harvesting tomorrow (or next year). The economic literature has now been saturated with publications on this issue - not all highly original. In historical perspective, some of the well known articles include Crutchfield and Zellner (1962), V. Smith (1968, 1969), Quirk and Smith (1970), Plourde (1970, 1971, 1979), Clark (1976), Clark and Munro (1974), Gardner Brown (1974), Neher (1974), McRae (1979) and J.B. Smith (1978).

These articles analyze either in a social welfare maximizing (Plourde) or competitive (Clark) environment the effects and control of this stock externality through variations on the mathematics of dynamic programming. It is illustrated that fish stock quotas (or whatever other controlling device is used) can be instituted to effectively manage the fishery over time.

It was recognized some time ago, such as by A. Scott (1955), that natural resource problems are basically applications of capital theoretical problems (see, for instance, Clark & Munro, 1974). The similarities between resource (fish) stocks and capital are their intertemporal or dynamic properties and the fact that each has an internal rate of return over time (an interest rate, opportunity cost or user cost).

Basic differences exist, however, in that, i) replenishable natural resources (such as fish stocks) regenerate (perhaps) costlessly; and

ii) it is acceptable to reduce stock of capital to size zero; it is disastrous for a resource stock (that is, there is the possibility of extinction of a species due to its irreversibility).

Some authors such as V. Smith, Vousden, Brown, Clark and Munro, specifically address this possibility of species extinction. In general, it is concluded that it is not economical to harvest a species to an endangered level.

Most authors in their analysis make assumptions of the fish stock growth that abstract from such issues as mesh size. Specifically, the models adopted are generally of the Volterra-Lotka type and identified as the Schaefer (1956) model. A basic assumption of this specification is that human harvesting does not affect the parameters of the growth process (a function of biomass). The Schaefer model seems reasonable for some aspects of commercial exploitation of a single species but a cohort model such as the Beverton-Holt specification used by Clark (1972) may be more appropriate if interacting species are involved. (For instance, if capelin eat cod roe and adult cod eat capelin then a model that distinguishes cod roe from adult cod will be useful.)

Turvey (1968) uses a cohort model to represent the tradeoff that occurs between mesh size and effort. His analysis is static.

The basic intertemporal model described in Plourde (1972) and Quirk and Smith (1968) has been extended to a trading economy. For example, McRae (1979) has shown that to optimally control fish stocks over time in a trading economy, a proper mixture of quotas and tariffs is required.

Uncertainty plays an important role in the fishery. It is suggested in Chapter 2, for instance, that coventuring (or sharecropping) is an effective organization of the inshore and offshore fishing industries because it simultaneously rewards good outcomes of an uncertain harvest and shares bad outcomes. (It is observed that the Unemployment Insurance Act is perverse in this case because it redistributes more income to fishermen who have been 'lucky'.)

Uncertainty in fishing occurs because of many 'random' events such as weather. Theoretically, the effects of random weather or climate may affect the harvesting potential (if the season is defined in number of days - a problem in the Pacific herring industry) or it may affect the growth parameters of the species. (For example, a one degree temperature change due to ozone imbalance in the stratosphere could cause migration of some species out of out 200 mile limit and/or species extinction due to incubation problems.)

J.B. Smith (1978) has shown that random reproduction parameters in a standard Schaefer model should not likely lead to extinction but may require quota rules which are dependent on the parameters of the distribution function of the uncertain environment.

In summary, the theory of resource management has come a long way since the time when 'maximum sustainable yield' was accepted as a management maxim. It is clear that economic considerations must be made in defining total allowable catch (TAC) and that extended economic jurisdiction (the 200 mile limit) should facilitate optimal economic management.

The model we present in this study is consistent with the theoretical literature to date. With few exceptions, there is little written on firm-industry relationships in the fishery or relating to the inshore-offshore issue. Exceptions are Anderson (1974), Huang and Lee (1978) and Clark (1976).

Firm and Industry Relationships

In order to apply existent models of fishery analysis, it would be useful to have a good specification of the production process. This would be useful in analyzing the efficiency of the inshore as compared to offshore fishing. A common specification of production at the aggregate level is Cobb-Douglas with inputs N (fish stock) and L (labour or effort) although there is not even agreement on whether there is increasing returns to scale (as in Neher, 1972) or decreasing returns to scale (as in Plourde, 1971).

Huang and Lee suggest an empirical approach which allows for expansion of an inshore fishery to offshore as crowding occurs. Anderson (1977) presents a more conventional approach on which to build an empirical model essentially assuming a steady-state.

It is apparent that data problems occur. Of major concern is estimation of stock size. For instance, if yield is used to estimate stock size and subsequently, stock size is used to determine yield, econometric difficulties arise. As well, published data in general contains subsidies and market interferences and hence efficiency units cannot be easily determined. The data is data of a second best situation.

iii) Multispecies Models

A last word about the theoretical literature is related to multispecies problems. It is recognized that biological species interact, such as in predator-prey or other relationships. Whereas biological and economic models exist in general, (See, for example, Williamson, 1972; Goh, Clark, 1976; and Quirk and Smith, 1979) these must be tailored to fit the characteristics of the Newfoundland fishery, such as the cod-capelin-squid interactions, if they are to apply.

Chapter 2

A Two Sector Model of the Newfoundland Fishery

In recent decades evidence has steadily accumulated confirming the hypothesis that open access to a common pool property resource ultimately leads to the overexploitation of the resource and the dissipation of economic rents. Nowhere has this been more apparent than in Canada's East Coast fisheries. The free entry of foreign and domestic fishing vessels has seemingly greatly reduced what was once an abundant natural resource. Moreover, the response to declining yields has not been towards a more rational utilization of the resource. Governments have responded with expansionary subsidy programs and industry competition has lead to the development of highly capital-intensive harvesting techniques which seem to have exacerbated the problem. In Newfoundland fishing incomes have consistently lagged behind other sectors in the region and this lag is by many reasonably attributed to excessive inputs of manpower and capital in fishing.

The 1977 extension of Canadian jurisdiction over a 200-mile offshore coastal zone represented a significant altering of the property right structure relevant to resource exploitation in this region. Effective ownership of the common fishing pool was transferred to a single (political) authority. In this way a mechanism was created by which previously ignored interdependences in the fishing industry could be more effectively coordinated.

The effect of individual fishing units'(and particularly national groups) on each other and on the common pool could now be taken into account in fostering rational resource use.

A separate in-depth investigation of the consequences of the 200-mile limit on the Newfoundland fishery is being undertaken in this reference by Gordon Munro and so we shall confine our remarks to a few sentences. The evolution of property rights from common to state ownership is significant in focusing attention on the externality issues inherent in common property use. While state ownership has inevitably directed attention to the question of domestic versus foreign use of the fisheries, a potentially much more serious problem remains domestically. The gain that may arise from the exclusion of foreign fishing vessels will prove to be only transitory unless the interdependences of the domestic fishing industry are recognized and controlled.[1]

In this chapter we present a model of the exploitation of a common fishing pool by two separate (although interrelated) fishing sectors. Such is the situation in Newfoundland where for geographic, economic and biological reasons two distinct fishing sectors have evolved. Inshore fishermen, operating out of numerous small villages that dot the Newfoundland coast, typically fish as coventurers from small fishing boats on a daily basis. Weather conditions, the relatively frail nature of their craft and the migratory habits of commercial fishing species combine to keep the inshore fishery seasonal. Offshore fishermen, on the other hand, work for contracted wages from large equipment-intensive vessels that are frequently tied to fish processing plants in major ports.[2] The large size of the offshore trawler makes it less subject to weather conditions, increasing the time spent offshore and permitting virtually year round operation. The two sectors, then, differ technologically. For our analysis this difference is assumed to be embodied in a unique boat design that is adopted by all the entrepreneurial fishermen in that sector.

The interdependences in the Newfoundland fishery arise from the simultaneous exploitation of a common fishing stock by fishermen both within and across fishing sectors. Various types of technological interdependences and their consequences are the focus of our analysis. First, within each sector, individual boats impose higher (real) catching costs on each other as increases in the number of vessels and/or amount of fishing effort thin out the catch available in any time period. This intrasector interdependence will be called the thinning effect. Second, as the number of boats increases, the closer proximity of individual vessels results in gear entanglement and the lack of sufficient space for efficient operation. This latter phenomenon, known as "crowding", is sometimes thought to be a problem in parts of the fisheries (Huang and Lee, 1976). Third, because a number of commercial species migrate between fishing grounds, the catch in any one sector will reduce the fish stock and hence the potential catch of the other. In Newfoundland, the annual summer migration of fish, in particular cod, inshore means that offshore trawling has a potentially serious impact on the catch available to the inshore fishery.[3] In our analysis we have included the intersector externality in this direction alone. Finally, an intertemporal stock interdependence exists for both sectors jointly in that each season's aggregate catch will significantly influence the size of future fishing stocks. Because private property rights exist only in harvested fish, fishermen tend to undervalue fish left in the sea. In this way fishing stocks have become badly depleted.

For reasons of simplicity in this section we have chosen to abstract from the inter species problem but recognize its existence. For instance, the size of one season's capelin harvest may have serious repercussions on next season's inshore cod stock if cod is highly dependent upon these species for food.

Our discussion begins with an investigation of whether the contractual sharing of the fishing harvest (i.e., coventuring) in the inshore fishery will impose any additional constraint on our analysis. A formal static model of the fishery is then developed. The short run (fixed fleet size and fishing stock) and long run competitive equilibriums are derived and compared to the Pareto optimal result in order to isolate the effects of different fishing externalities. The purpose of constructing this model is to develop a framework in which one can predict and evaluate the consequences of different government assistance programmes to the fisheries. A particular objective of our analysis is the comparative evaluation of alternative assistance schemes and their effects on labour productivity, employment and incomes.

I. The Significance of Coventuring in the Inshore Fishery

The analysis of the Newfoundland fishery is complicated by the coexistence of two alternative contractual arrangements for rewarding inputs. In the offshore fishery the traditional practice of hiring labour at fixed money wages is employed.[4] The residual, net of operating costs, accrues to the boat owner which is usually a vertically integrated corporation combining the packing, transporting and wholesaling operations. In the inshore fishery, however, the return from the vessel's catch (net of operating costs) is divided among inputs on a predetermined share basis. In our analysis it is assumed that the boat owner receives a fraction, r, of the output net of operating costs, while the remaining fraction, (1-r), is shared by labour as a group. The boat owner and his accompanying fishermen are then coventurers, sharing the risks and benefits of each year's annual fishing harvest. The purpose of this section is to explore the significance of coventuring as an additional constraint on the efficient use of resources in the inshore fishery.

The traditional approach to sharecropping argued that sharing contracts were necessarily inefficient. Under output sharing arrangments, it was argued, labour would enter the industry only as long as the marginal private return to labour exceeded the return available in other employment. In equilibrium, the marginal private return, $(1-r)VMP_L$, equals the foregone wage, w. Because the marginal private return is only a fraction of the marginal social return, VMP_L, too little labour will enter the industry. This analysis is illustrated in Figure 1 where L_0 represents the traditional employment solution and L^* represents the employment of labour required for efficiency.

The incomplete nature of the traditional solution was first recognized by Steven N. S. Cheung (Cheung, 1969). Suppose, he argued, workers stopped entering the industry at L_0. Workers would then earn a surplus $\left[\sum_0^{L_0} (1-r)VMP_L - wL_0\right]$ relative to their next best alternative. The solution at L_0, therefore cannot be an equilibrium. With no limit on entry, labour will continue to be attracted into the industry until the surplus (the shaded area in Figure 1) is eliminated. In the context of our diagram, competition among fishermen leads to the employment of L_1 fishermen.

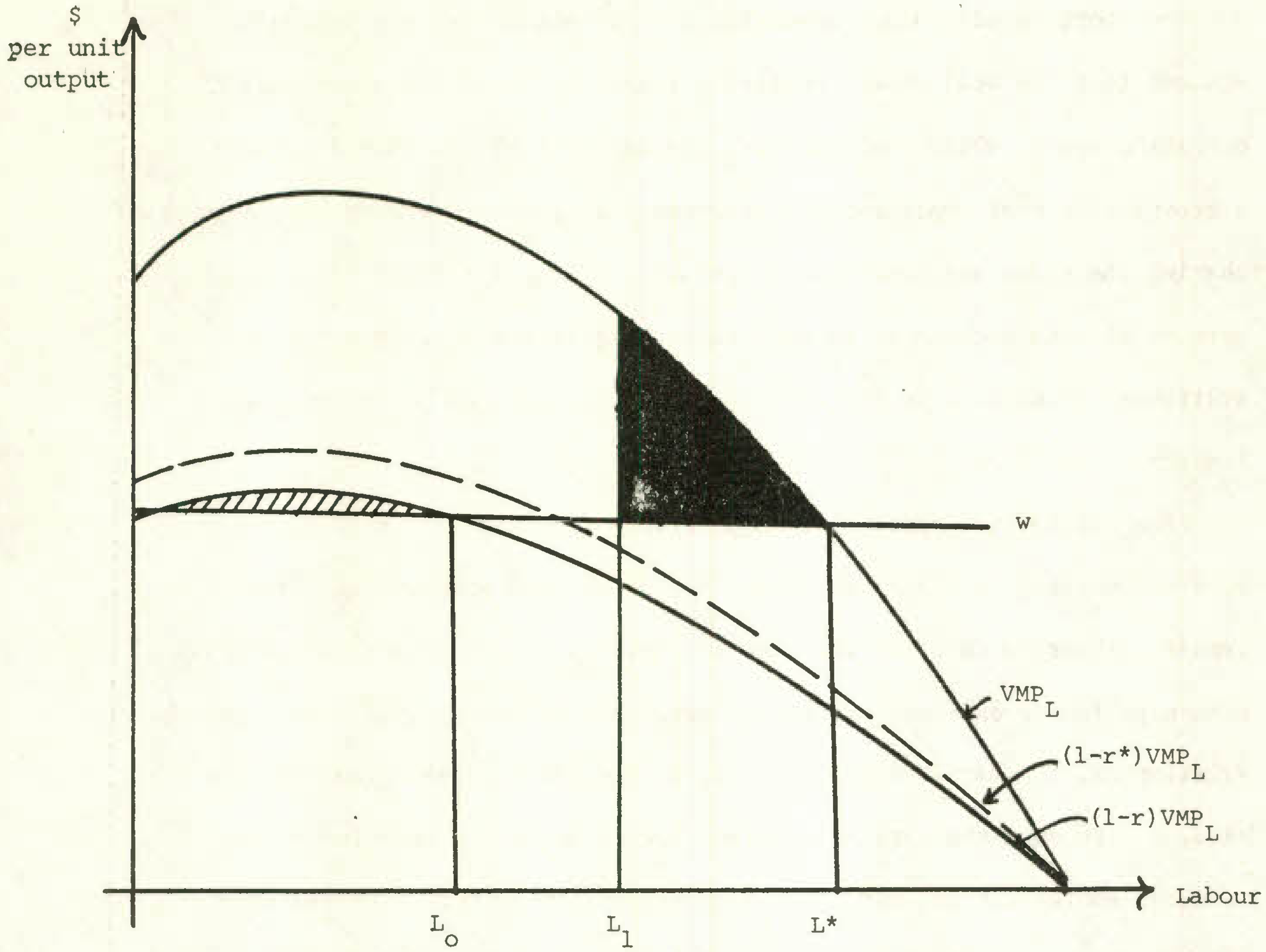


Figure 1

Consider now the position of the boat owner. Given present sharing arrangments, boat owners receive $\sum_{L_0}^{L_1} rVMP_L$. A more revealing representation of this return is the area between the VMP_L curve and the wage through L_1 units of labour. Two things are now apparent. First, the maximum possible return that boat owners could receive when labour is paid its opportunity cost will occur when L^* units of labour are employed. Second, L^* units are not employed because the sharing formula is non optimal. In our example, boat owners forego a return of $\sum_{L_1}^{L^*} VMP_L - w$ (the solid area in Figure 1) by setting the share received by labour too low. Given profit maximizing behaviour by boat owners and a competitive labour market, labour's share of output will be revised upwards so that the efficient solution is realized. This is illustrated in Figure 1 by the dashed line that corresponds to the optimal sharing ratio r^*.

It follows from this analysis that sharecropping or coventuring contracts are not, on any a priori grounds, less efficient than alternative contractual reward systems. The desirability of coventuring in the inshore fishery arises from its ability to share among inputs the risks associated with uncertain harvests. Under fixed wage hiring contracts the risk may be borne solely by the owner. As shown in our riskless analysis, however, the competitive sharecropping solution is identical to what would obtain if labour were hired at competitive wages.[5] This congruence of results allows us to ignore the particular coventuring characteristic in modelling the labour allocation aspect of the inshore fishery.

However, coventuring plays an important role later in Chapters 3 and 4 when we consider the effects of subsidies. It is perhaps obvious that the ability of the boat owner to renegotiate his share, along with the assumption that competition will always drive the value of marginal product of labour to the prevailing wage rate will mean that any attempt to supplement a fisherman's income will be counteracted by fleet expansion and owner renegotiation of share. Theory predicts that the boat owners' share will rise and the number of boats increase. We test these hypotheses in Chapter 4.

II. A Two Sector Model of the Newfoundland Fishery

In modelling the fisheries, the basic decision-making unit is taken to be a representative boat owner. A production relationship, unique to each sector, is defined by the characteristics of a representative boat and forms the output constraint facing the representative owner. The boat owner then chooses the combination of inputs that maximizes his profits.

In its most general form the production function in the i^{th} fishing sector is $y_i = f^i(L_i, g_i, Y_0, K_i, N)$ where y_i, L_i, and g_i, represent output, labour, and gear servicesper boat in the i^{th} sector (i = 0 for offshore or i = 1 for inshore); K_1 represents the number of boats in the i^{th} sector; Y_1 and Y_0 represent the aggregrate output of the inshore and offshore fishing sectors; and N represents the size of the common fishing pool. f^i_k is used to designate the partial derivative of the production function in the i^{th} sector with respect to the k^{th} variable, k = 1, 2, ..., 5. The marginal physical products of labour and gear, f^i_L and f^i_g, are assumed to be positive in both sectors. $f^1_{Y_0}$ captures the effect on the inshore output of a thinning out of the common fishing stock by the offshore fishery. These relationships will, in general, be negative. In our analysis, it is assumed that the only significant thinning effect is that of the offshore catch on the inshore fishery. The crowding effect is assumed to be present in both sectors and is represented by $f^i_{K_i}$. Finally, fishing is more productive when there are more fish to be caught. The partial derivative f^i_N is then positive in both sectors. In the absence of biological data and for other reasons, we have implicitly assumed that a fixed proportion of migratory fish (cod) migrate inshore each season. Otherwise we would have to distinguish N_1 and N_0.

We assume $N_1 = \gamma N$ where γ is the constant migration fraction.

The superscripts on the production functions and the subscripts on the variables will be used to identify the two sectors. The inshore fishery will be designated sector 1 and the offshore fishery sector 0. Total industry output can then be written as $Y = Y_1 + Y_0 = K_1 y_1 + K_0 y_0$. The output of the industry is assumed to be sold in a competitive world market at the price p, while labour and gear are hired at the competitive rates w and r_i. Fishing boats, on the other hand, are assumed to be industry specific. In the longer run, however, capital invested in the representative fishing vessel must earn the competitive return ρ_i. Private property rights do not exist for the remaining fishing input, fish in the sea. In the absence of state control, then, the fish stock can be appropriated at a zero user cost. Competition and profit maximizing behaviour imply that this input will continue to be used until its marginal contribution to output falls to zero.

While the biomass of fish in the short run is fixed, the longer run fish stocks will change depending on the size of current catches and the biological conditions underlying their rates of growth. In our analysis we consider only one representative stock (cod) and we make the traditional assumption that the catch rate does not interfere with the biological conditions dictating stock growth. The rate of growth of the fish stock, dN/dt is then equal to the biological rate of growth, F(N), less the annual fishing catch, Y.

A. The Fisheries in the Short Run: The Competitive Solution

In our analysis, the short run refers to the decision problem faced by a representative boat owner when both the existing capital stock (embodied in the number of boats) and the biomass of fish are fixed. The individual boat is assumed to be small in relation to the size of the fisheries so that the effect of individual catch on the productivity of other boats, and their effect on him, is ignored by the representative boat owner. This implies that Y_1 and Y_2 will be treated as parameters by the representative decision maker. The only variables over which the boat owner exercises control in the short run are hours of labour and gear services.

The assumption that the catch of the inshore fishery has no effect on the productivity of the offshore fishery means that it is convenient for us to begin our analysis with this latter sector. In the offshore fishery the representative boat owner will

$$\max_{L_0,\, g_0} R_0 = pf^0(L_0, g_0, \overline{K}_0, \overline{N}) - wL_0 - r_0 g_0 \qquad (1)$$

where $R_0 > 0$. First order conditions for an interior maximum in the offshore fishery are

$$p\, f^0_{L_o} = w \qquad (2)$$

$$p\, f^0_{g_o} = r_o \qquad (3)$$

Diminishing marginal productivity and complementarity between factors is assumed so that f^0_{LL} and f^0_{gg} are both negative while f^0_{Lg} and f^0_{gL} are both positive. Moreover, we assume that as the optimal combination of inputs is increased relative to the fixed size of the representative boat, diminishing returns are encountered. This ensures that the second order conditions are met. The marginal cost curve will then cut the competitive price line from below in equilibrium.

When the partial conditions represented by equations (2) and (3) are both met, the profit maximizing catch size is determined as a function of the fixed number of boats and size of the fish stock. With identical firms, expansion by the representative boat means that the whole industry expands, assuming for now a fixed fleet size of K_0. In this way the representative boat owner's decision problem, when bounded by the industry constraint, can be written as

$$\underset{L_0,\, g_0}{\text{Max}}\ R = pf^0(L_0, g_0, \bar{K}_0, \bar{N}) - wL_0 - r_0 g_0 + \alpha[\bar{Y}_0 - \bar{K}_0 f^0] \qquad (4)$$

where the individual chooses his use of labour and gear as if he satisfied the first order conditions

$$f^0_L\,(p - \alpha\bar{K}_0) = w \qquad (2)'$$

$$f^0_g\,(p - \alpha\bar{K}_0) = r_0 \qquad (3)'$$

From equation (4) it can be seen that α measures the effect on the representative boat's rent of a change in industry output. That is $\alpha^* = \frac{\partial R^*}{\partial \bar{Y}_0}$.

It should be noted that equations $(2)'$ and $(3)'$ give the same efficiency conditions for the optimal combination of labour and gear as (2) and (3). In both cases $f^0_L/f^0_g = w/r_0$. The reason for writing the first order conditions in this way is that it explicitly accounts for the industry effect. Together with $Y_0 = \bar{K}_0\, y_0$, $(2)'$ and $(3)'$ solve for the competitive output of the representative boat and industry. Let us call these outputs Y_0' and Y_0'.

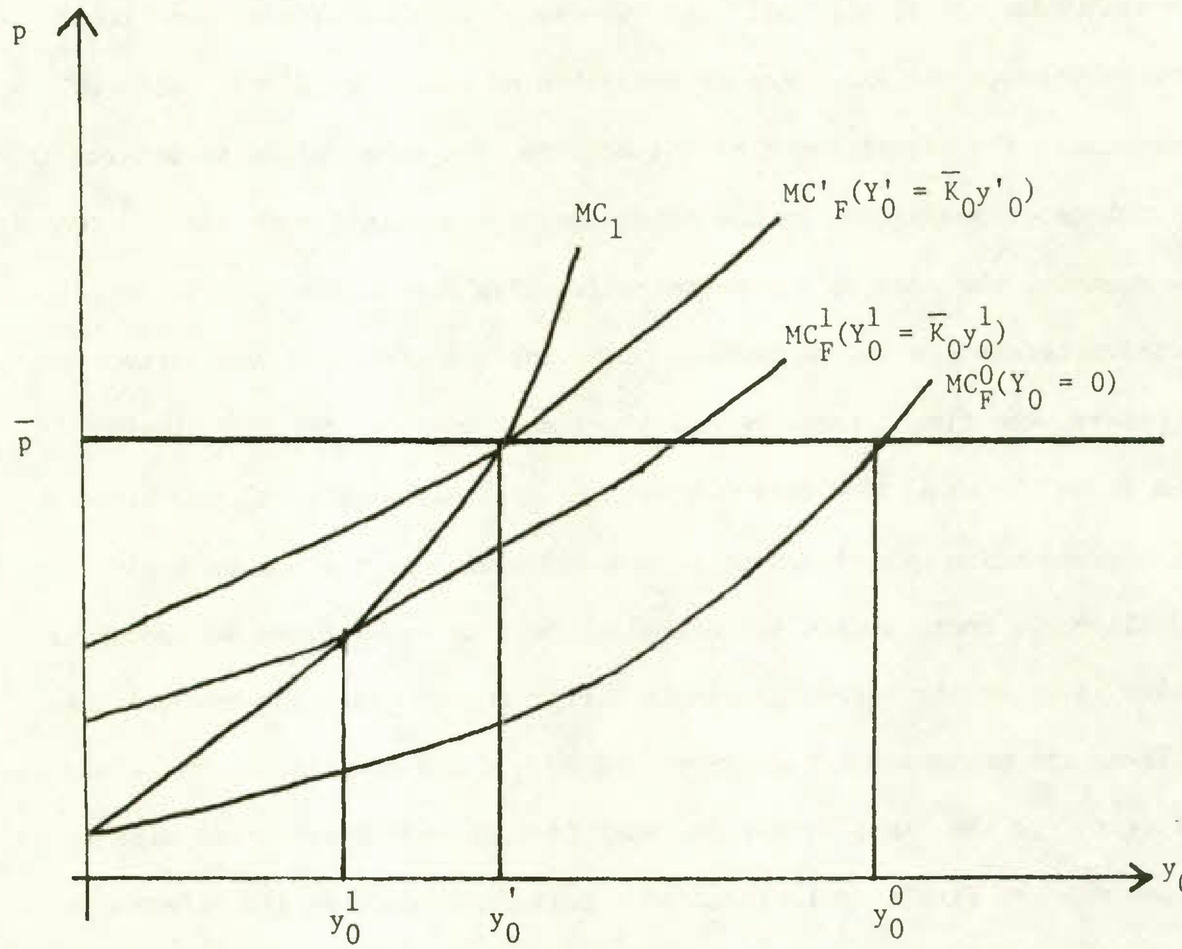


Figure 2

The interesting feature of our presentation of the case of a technological interdependence external to the firm but internal to the industry is that although the firm bears only a minor fraction of the costs of its expansion (in this case $1/\bar{K}_0$), the full consequences of its decision rebound back upon it through the simultaneous expansion of all other firms. Without recognizing the significance of its actions, the externality is internalized through exogenous shifts in the firm's private marginal cost curve.[6] Consider, for example, the case of a representative firm making its optimal output decision before the season begins. Ignoring the effect of his activities on others, the firm's perceived marginal cost curve is MC_F^0. Believing this to be the case, the firm projects an optimal catch of Y_0^0 and hires the corresponding quantities of labour and gear. As the season begins and all other boats follow his example, the firm experiences an exogenous upward shift of its perceived marginal cost curve. This induces the firm to lower its projected annual catch and reduce its commitments to labour and gear. In the final iteration, when firm and industry output rise to Y_0^1 and Y_0^1, the firm's optimal decision fully incorporates its effects on others.[7]

The significance of the divergence between individual and industry costs cannot adequately be captured by a representative (identical individual) analysis that imposes consistency in decision making. It should be noticed from our diagrammatic presentation, however, that the initial response of each firm (and hence the sector) will be to overreact to changes in external demand conditions. In a world where hiring decisions must be made in advance of realized output and cannot be easily (costlessly) reversed, too much labour and gear will be absorbed into the sector following a rise in demand and may not exit as warranted. The transactions costs that inhibit the movement of factors into and out of the sector may work to imprison redundant factors within the sector.

Because the inshore fishery is assumed to have no effect on the offshore fishery in the short run, the output of the offshore fishery can be determined independently of the scale of inshore fishing. The reverse is not the case. The offshore fishery, by reducing the size of the available catch, decreases the productivity of labour and gear in the inshore sector (i.e., $f^1_{LY_0}$ and $f^1_{gY_0}$ are negative). Moreover, in the absence of private property rights in fish the inshore fishery has no mechanism by which it can transpose these costs back onto the offshore fishery. The output of the offshore fishery thus appears as a parameter in the production function of the representative inshore boat owner. The representative owner in the inshor fishery then,

$$\max_{L_1,\, g_1} R_1 = pf^1(L_1, g_1, Y_0', \bar{K}_1, \bar{N}) - wL_1 - r_1g_1 + \beta[\bar{Y}_1 - \bar{K}_1 f^1] \qquad (5)$$

Ignoring the consequences of his catch on the productivity of other boats in making its optimal decision, but having the interdependence exogenously effect its production function, the first order conditions become

$$(p - \bar{K}_1\beta)f^1_L = w \qquad (6)$$

$$(p - \bar{K}_1\beta)f^1_g = r_1 \qquad (7)$$

Together with the sector output constraint

$$Y_1 = \bar{K}_1 y_1 \qquad (8)$$

(6), (7) simultaneously determine the level of output for the representative boat and the aggregrate inshore sector.[8] Let us represent these levels of output as y_1' and Y_1'. As with the offshore sector, the effect of thinning out the available catch within the sector is internalized through exogenous shifts in the representative firm's perceived marginal cost curve.

B. Pareto Optimality in the Short Run

The Pareto optimal levels of output in the fisheries can be derived by determining the levels of output that would be produced if the two sectors were owned and operated by a single profit maximizing agent (Gifford and Stone, 1972). The reason that these outputs are Pareto optimal is because every technological interdependence will effect the productivity and hence the profits (rents) earned by another component of the same industry. While this is also the case in the competitive solution, there is no private reason for the individual decision maker to take into account his effect on others. The single owner, on the other hand, is concerned with maximizing global profits rather than the profits of individual units. In making one overall production decision, the interdependencies are internalized in their effect on his profit position.

In the short run, the single owner faces the problem of allocating labour and gear over a fixed number of identical boats in the two sectors. The number of fish in the sea are assumed to be fixed so that the inter-temporal problem does not arise. Operating boats within each sector identically, the single owner will

$$\max_{L_1, g_1, L_0, g_0} R = \bar{K}_1 p f^1(L_1, g_1, \bar{Y}_0, \bar{K}_1, \bar{N}) + \bar{K}_0 p f^0(L_0, g_0, \bar{K}_0, \bar{N}) - w(\bar{K}_1 L_1 + \bar{K}_0 L_0) - \bar{K}_1 r_1 g_1 - \bar{K}_0 r_0 g_0 + \bar{\alpha}[\bar{Y}_0 - \bar{K}_0 f^0] + \beta[\bar{Y}_1 - \bar{K}_1 f^1] \quad (9)$$

With awareness by the owner of the interdependencies both within and across sectors, the first order conditions for profit maximization become:

$$(p - \bar{\beta}) f^1_{L_1} = w \quad (10)$$

$$(p - \bar{\beta}) f^1_{g_1} = r_1 \quad (11)$$

$$f^0_{L_0}(p - \bar{\alpha} + pK_1 f^1_{Y_0}) = w \quad (12)$$

$$f^0_{g_0}(p - \bar{\alpha} + pK_1 f^1_{Y_0}) = r_0 \quad (13)$$

Assuming that the second order conditions hold, equations (10) through (13) are sufficient to solve for the optimal employment of labour and gear. From these the optimal levels of firm and industry output can be derived. Let us represent these levels by y^*_1, y^*_0, Y^*_1, and Y^*_0.

Having obtained the Pareto optimal outputs for the two fishing sectors, we are now in a position to contrast these results with the solution that will arise under competition. This can be done by directly comparing the use of inputs by the representative firms as given in their respective first order conditions. By inspection it is apparent that the wage-rental ratios of equations (10) through (13) and equations (2)', (3)', (6) and (7) are identical. This is a reflection of the condition that profit maximization will lead to the employment of factors until the value of the marginal product equals the competitive factor cost. It is also apparent, however, that the left hand side of the Pareto conditions are somewhat more complicated than their competitive counterparts.

Let us begin by comparing the two sets of first order conditions for the inshore fishery. Since $\bar{\beta} = K_1\beta$ (10) and (11) are identical to (6) and (7). This implies that if the catch of the offshore sector were the same under competitive and Pareto conditions, the use of inputs and hence the levels of output in the inshore fishery would be identical. On the other hand, because $f^1_{L_1Y_0}$ is negative, the relative size of the outputs of the inshore fishery under competitive and Pareto conditions will vary inversely with their relative size in the offshore fishery.

The second terms of equations (12) and (13) represent the technological interdependence internal to the offshore fishery. As with the inshore fishery, this term states explicitly what will be internalized by the competitive market process. It is, then, not because of the presence of the second term that the competitive solution will diverge from the efficient one. The Pareto conditions for the offshore sector, however, also contains a third term on the left hand side of equations (12) and (13). This term states that as input use is increased by a representative boat in the offshore fishery, output will increase ($f^0_i > 0$), thinning the catch available to the inshore fishery, and decreasing the productivity of each boat in that sector ($\bar{K}_1 f^1_{Y_0} < 0$).[9] The third term, then, formally represents the externality that exists between fishing sectors and reflects the fact that a single owner (the efficient solution) will take this interdependence (social cost) into account. Because there is no mechanism by which the inshore fishery can bring this cost to bear on the offshore fishery, this effect will not be internalized by the competitive market process (under present property rights structures).

The existence of the third term marks a significant divergence in the Pareto optimal solution from the competitive one. Since the third term is negative, the value of the marginal product of each unit used in equations (12) and (13) must be smaller in magnitude than the corresponding values of the marginal products in $(2)''$ and $(3)''$. With social productivity lower than private, too many inputs will be absorbed and too much output produced by a competitive offshore fishery. On the other hand, with $f^1_{Y_0}$ negative, social productivity will exceed private in the inshore fishery. Too few inputs will be employed and too little output produced relative to their efficient levels. Formally: $y_0' > y_0^*$, $Y_0' > Y_0^*$, $y_1' < y_1^*$, and $Y_1' < Y_1^*$.

In summary, even if the number of boats in the two fisheries were fixed at their optimal level, and even if there were no future consequences on the fishing stock by present catch sizes, inefficiency would still arise in a competitive Newfoundland fishery. In essence the problem arises from the absence of a mechanism (such as private property rights in the fish stock) by which the offshore fishery will be affected by the damage it imposes on the inshore fishery. Ignoring this cost, the offshore fishery will overproduce, the inshore fishery will underproduce.

C. <u>The Fisheries in the Long Run: The Competitive Solution</u>

While the stock of fish is fixed in the short run, the long run size of the fish pool will depend on the aggregrate size of today's catch. Unharvested fish have economic value, they serve as inputs in the production of future fish. The long run problem of the Newfoundland fisheries, then, presents an intertemporal decision problem that did not exist in the short run analysis. It must incorporate, and be consistent with, the biological constraints dictating the relationship between the size of the present catch and the natural rate of growth of the fishery. Our long run analysis will focus on the characteristics of the steady state. Second, the long run solution must allow for the entry and exit of fishing boats from each sector of the industry. Formally, we will assume that entry (exit) will take place as long as the quasi-rents earned by the representative boat exceed (fall below) the opportunity cost of a new fishing boat. This assumption, however, may not accurately reflect the decision to exit in the intermediate to long run. Given the sector specific nature of fishing capital, the opportunity cost of existing capital may approach zero during a contraction. In this case only persistent negative (accounting) profits and/or the absence of replacement investment will lead to the gradual shrinking of the size of the fishing fleet and the slow return of profits back to normal. Of course, governments through licensing and subsidization can influence fleet sizes.

The solution to the long run equilibrium proceeds in the same manner as the short run solution, except that the number of boats and the size of the fish stock are now endogenously determined variables. The representative boat owner in the offshore fishery again has discretion over his use of labour and gear. He will

$$\max_{L_0,\, g_0} \; R_0 = pf^0(L_0, g_0, \bar{Y}_1, \bar{Y}_0, K_0, N) - wL_0 - r_0 g_0 - \rho_0 + \delta\left[\bar{Y}_0 - K_0 f^0\right] \qquad (14)$$

The first order conditions for a maximum are:

$$p(f^0_{L_1} + K_0 f^0_{Y_0} f^0_{L_1}) = w \tag{15}$$

and

$$p(f^0_{g_0} + K_0 f^0_{Y_0} f^0_{g_0}) = r_0 \tag{16}$$

where $\delta \equiv -f^0_{Y_0}$.

Equations (15) and (16) can be solved for the firm's optimal use of labour and gear as a function of industry output, Y_0, the number of boats in the offshore sector, K_0, and the size of the available fish stock, N. At any point in time, however, the output of the offshore sector will be a simple multiple of the output produced by the representative boat, i.e. $Y_0 = K_0 y_0$. (17) Equations (15), (16) and (17) are then sufficient to simultaneously determine the competitive sectoral and per firm output as a function of K_0 and N.

With open access to the offshore fishery, the number of boats in the steady state can be determined. Entry will continue into the sector as long as the representative boat earns a rate of return (rents) in excess of normal (i.e., ρ_0). Assuming that the rate of entry is proportional to the rents earned by the representative boat, in the absence of state intervention, offshore fleet expansion will take place according to the equation

$$\dot{K}_0 = \alpha \left[p f^0(L_0, g_0, 0, Y_0, K_0, N) - wL_0 - r_0 g_0 - \rho_0 \right] \tag{18}$$

where α is an exogenous positive constant. In the steady state, the rent earned by the representative boat will be reduced to zero, i.e.,

$$R_0 = p f^0(L_0, g_0, 0, Y_0, K_0, N) - wL_0 - r_0 g_0 - \rho_0 = 0 \tag{19}$$

The system of simultaneous equations: (15), (16), (17) and (19) allows us to solve for the number of boats, the aggregrate catch, and the optimal per firm use of labour and gear (and hence per firm catch) in the offshore fishery as a function only of the size of the fish stock. To complete the model, we need only determine the size of the fish stock. In order to do that, however, we must first determine the output of the inshore fishery.

As in the offshore fishery, the representative inshore boat owner directly controls only his use of labour and gear. He will, then,

$$\max_{L_1,\, g_1} \; R_1 = pf^1(L_1, g_1, \bar{Y}_1, \bar{Y}_0, K_1, N) - wL_1 - r_1 g_1 - \rho_1 + \emptyset[\bar{Y}_1 - K_1 f^1] \quad (20)$$

where the first order conditions for a maximum are:

$$p(f^1_{L_1} + K_1 f^1_{Y_1} f^1_{L_1}) = w \quad (21)$$

$$p(f^1_{g_1} + K_1 f^1_{Y_1} f^1_{g_1}) = r_1 \quad (22)$$

where $\emptyset = -f^1_{Y_1}$. These equations, together with the equations determining industry output and the size of the inshore fleet, i.e.,

$$Y_1 = K_1 y_1 \quad (23)$$

$$R_1 = pf^1(L_1, g_1, Y_1, Y_0, K_1, N) - wL_1 - r_1 g_1 - \rho_1 = 0 \quad (24)$$

form a system of simultaneous equations sufficient to solve for the number of boats, the aggregrate catch, and the optimal use of labour and gear per boat in the inshore fishery as a function of the size of the available fish stock.

The model will now be completed by introducing the relationship between the biological conditions governing the natural rate of growth of the fish stock and the aggregrate catch of the combined sectors of the fishery. Assuming (as is traditional) that the biological rate of growth first rises then falls as the size of the fish stock grows, and that the size of the present catch will not change this functional relationship, the rate of growth of the fish stock will be

$$\dot{N} = F(N) - Y \tag{25}$$

where $F_1 > 0$ for $0 < N < N_s$; $F^1 = 0$ when $N = N_s$; and $F^1 < 0$ for $N > N_s$. N_s is then the maximum value of the F(N) function and is denoted the maximum sustainable yield. In the steady state the fish stock will be neither rising nor falling, i.e.,

$$\dot{N} = F(N) - Y = 0 \text{ or } F(N) = Y \tag{26}$$

The completed competitive model now consists of the set of equations (15), (16), (17), (19), (21), (22), (23), (24) and (26). The simultaneous meeting of these conditions determines the steady state values of the system: L_1'', L_0'', g_1'', g_0'', Y_1'', Y_0'', K_1'', K_0'', and N''. The double primed superscript will be used to signify the competitive steady state values.

D. Pareto Optimality in the Long Run

The Pareto optimal allocation of resources can again be determined by considering the decision problem faced by a single profit maximizing owner of a joint fishery. The single owner will

$$\underset{\{L_1,\, L_0,\, g_1,\, g_0,\, K_1,\, K_0\}}{\text{Max}}\ R = K_1[pf^1(L_1, g_1, \bar{Y}_0, K_1, N) - wL_1 - r_1g_1 - \rho_1] + \beta[\bar{Y}_1 - K_1f^1]$$
$$+ K_0[pf^0(L_0, g_0, K_0, N) - wL_0 - r_0g_0 - \rho_0] + \alpha[Y_0 - K_0f^0]$$
$$- \lambda[Y_1 + Y_0 - F(N)] \quad (27)$$

The first order conditions for pareto Optimality are now

$$(p - \lambda)f^1_{L_1} = w \quad (28)$$

$$(p - \lambda)f^1_{g_1} = r_1 \quad (29)$$

$$(p - \lambda)(f^1 + K_1f^1_{K_1}) = 0 \quad (30)$$

$$(p - \lambda + K_1pf^1_{Y_0})f^0_{L_0} = w \quad (31)$$

$$(p - \lambda + K_1pf^1_{Y_0})f^0_{g_0} = r_0 \quad (32)$$

$$(p - \alpha)(f^0 + K_0f^0_{K_0}) = 0 \quad (33)$$

and $$K_1y_1 + K_0y_0 - F(N) = 0 \quad (34)$$

where $\alpha = \lambda - pK_1f^1_{Y_0}$, $\beta = \lambda$

The major difference between this set of first order conditions and their long run competitive counterparts comes from the presence of the $(p - \lambda)$ term as the value counterpart to simply p. From (27), however, it can be seen that λ represents the sensitivity of the objective function R to changes in biological constraint governing natural fish recruitment. An alternative, and more useful way of viewing λ is as the market value of a unit of fish left uncaught in the ocean (i.e., in terms of the future fish it will generate).[10] Since p represents the market price of a unit of fish caught and hence unavailable for future reproduction, $(p - \lambda)$ is the social or net market value added by catching a fish today as opposed to leaving it in the ocean. As can be seen by comparing equations (28), (29), (31) and (32) with their competitive counterparts in equations (15), (16), (21) and (22), the absence of property rights in unharvested fish will lead the competitive industry to undervalue unharvested fish and hence employ more labour and gear than is optimal. This, commonly called "stock" externality, is even more apparent when the entry conditions are considered. Equations (19) and (24), in the competitive case, give explicit recognition to the condition that competition will lead to the total dissipation of economic rents. In the Pareto solution, equations (30) and (33), the implicit value of uncaught fish is formally recognized as socially productive. Equations (30) and (33) specify that the socially optimal fleet sizes will occur when net rents, corrected for the crowding externalities, are exhausted. The competitive equivalent gives expansion of the fleets to the point where 'gross' rents are dissipated. And so the competitive solution indicates overexpansion of the fleets because the market is incapable of allowing for the property rights of unharvested fish and the crowding externality costs. For all these reasons, then, the existence of open access to common fishing pool will induce the employment of too much labour, gear and fishing vessels. The fish stock will be overexploited and the productivity of all factors will be too low.

E. Long Run Pareto Optimality: A Look at the Dynamics

In section D we examined the steady state of the long run Pareto optimal solution. In this section we take a brief look at the dynamic adjustment process implied by that solution. In doing so we can focus explicitly on the question of the optimal fish stock.

Assuming a single joint owner of the two sectors with expected rates of return $p_1 = p_1 = p$ where p is the social rate of discount, the owner will maximize

$$\mathcal{L} = \int_{t_0}^{\infty} (R_1 + R_2)e^{-pt} - Rh_o pt \, dt \qquad (35)$$

subject to the condition that

$$\frac{dN}{dt} = F(N) - Y_1 - Y_2 \qquad (36)$$

Intertemporal optimization will give the short run conditions (28) through (33) and an additional transitional requirement:

$$\frac{d\lambda}{dt} = \rho N - \lambda F^1 - (p - \alpha)K_0 f_N^0 - (p - \beta)K_1 f_N^1 \qquad (37)$$

In a steady-state $\frac{d\lambda}{dt} = 0$, which implies

$$(p - \alpha)K_0 f_N^0 + (p - \beta)K_1 f_N^1 + \lambda F^1 = \rho N \qquad (38)$$

The first two terms of equation (38) encompass the benefits to the fishery of conservation. They represent the social value to the inshore and offshore fishery of a larger fish stock. $\lambda F'(N)$, represents the loss to society of having a perpetual decrease in the steady state flow that results from a larger fish stock. Thus equation (38) presents the trade-off that will go into the determination of the size of the optimal fish stock. Larger stocks will mean larger present catches (more correctly higher productivity) but since natural recruitment rates will fall (in the region of optimal harvesting) future catch rates must be reduced. Pareto optimality is reached when the marginal values are equalized.

F. Final Notes and Observations

The dynamic analysis presented above is brief and simplistic and is only meant as an example of one aspect of reality omitted by the static framework. In fact, the dynamic adjustment of fleet sizes could have been considered, particularly because of the irreversible nature of the investment decision.[11] Most importantly, and not necessarily independently of inflation or the rate of adjustment, is the necessity to discount future earnings in the face of high and rising opportunity costs in acquiring capital.

It is especially noteworthy in moving towards the incorporation of government assistance into the model that government intervention seems to occur in all parts of the fishery. In both sectors gear and boats are highly subsidized as are insurance premiums. Ground fish deficiency payments have been instituted and fishing purchases of fuel and equipment are exempt from provincial sales taxes. The inshore fishery receives seasonal unemployment benefits and is not, at present, subject to the quota, licensing and "closed" seasons often imposed on the offshore fishery. In addition, highly subsidized loans (3½% interest) are available for the construction of longliners. Although labour use is not subsidized in the offshore fishery construction of the vertically integrated processing plants and their operations are. Minimum guaranteed trip payments to unexploited (domestic) fishery areas are available and although there was a moratorium up to May 1979 on trawler construction, the offshore fishery has in the past shared in the construction subsidies available. There is little doubt they will continue to do so in the future.

NOTES

1. To some extent domestic rivalry between the competing components of the Newfoundland fishery has been minimized by the existence of a common foe in the form of foreign trawlers. The evolution to state ownership provides a mechanism by which this externality can be internalized and hence resolved. On the other hand, the resolution of this problem will heighten domestic rivalries--inshore versus offshore, provincial versus federal control. State ownership of the common resource implies that competition between components will be political rather than economic in nature.

2. Although a substantial portion of an offshore fisherman's income comes from union contracted wage payments, some part of his income still comes from the older catch sharing provision.

3. This appears to be a serious problem in some parts of the fishery while not in others. The north-east coast, for example, experiences inshore migration from the Hamilton banks while cod do not appear to migrate inshore from the Grand Banks. In 1978 trawler catch was limited on the Hamilton banks until inshore fish stocks were rebuilt. A building program in 1979 for the Grand Banks does not seem to have this stock externality in mind.

4. See footnote 2.

5. A single boat owner can choose r, his share of output, but must live with the response of the market which is defined by

$$wL - (1 - r)f(L) = 0 \qquad (1A)$$

Equation (1A) defines L implicitly as a function of r which we can write as $L^*(r)$. The owners problem then can be written

$$\max_r \mathcal{L}^* = rf(L^*(r) + \lambda[wL^*(r) - (1 - r)f(L^*(r)]$$

First order conditions for an interior maximum are

$$f = -rf'L^{*'} \qquad (2A)$$

and

$$wL^{*'} - (1 - r)f'L^{*'} + f = 0 \qquad (3A)$$

which combine to yield

$$w = f' \qquad (4A)$$

Condition (4A) states that labour will be employed up to the point where the value of the marginal product equals the wage. Solving for r^* gives

$r^* = 1 - \frac{Lf'}{f} = 1 - E$ where E is the output elasticity, or function coefficient.

6. The firm's marginal cost curve can be found by first solving the following problem:

$$\min_{L_0,\, g_0} C = wL_0 + r_0 g_0 \quad \text{subject to the conditions}$$

$$\bar{y}_0 = f^0(L_0, g_0, \bar{K}_0, \bar{N}) \text{ and } \bar{Y}_0 = K_0\bar{y}_0$$

To solve, introduce the Lagrangean function

$$\mathcal{L}(L_0, g_0, \lambda, \gamma) = C + \lambda[\bar{y}_0 - f^0(L_0, g_0, \bar{K}_0, N)] + \gamma[\bar{Y}_0 - K_0\bar{y}_0]$$

Then the firm's marginal cost $\frac{dC}{dy_0}$ can be shown to be simply $[\lambda^* - \gamma^* K_0]$ where * represents cost minimizing values. The value λ^* is the firm's perceived marginal costs net of the "industry effect" ($\gamma^* K_0$), and so the firm perceives costs to be less than they are, except at the efficient output level, since γ^* is negative. Differentiation of $\mathcal{L}^*$ with respect to $\overline{Y}_0$ establishes that $\gamma^* = \left[\frac{\partial C^*}{\partial Y_0} - \frac{\lambda^* - \gamma^* K_0}{K_0}\right]$.

Interestingly in Figure 2 the curve labelled MC_I represents points where marginal costs are correctly calculated, or where $\lambda^* = (\lambda^* - \gamma^* K_0)$ which implies $\gamma^* = 0$.
Thus along the curve MC_I the value of $\lambda^* = \frac{1}{K_0} \frac{\partial C^*}{\partial Y_0}$. In this case it is observed that the equation system (2), (3) becomes identical to (2'), (3') since $\alpha^* = 0$. It will later be illustrated that these give Pareto optimal values of L_0^*, g_0^*.

7. The complete internalization of this potential externality arises from the assumption of a "representative" boat. This implies that all boats within each sector are identical and respond identically. With individual differences within the sector the externality will reappear. Moreover, the model permits only a limited form of competition among boats. More generally, individual boat owners have a variety of ways of competing and an individual incentive to cheat on efficient fishing practices--such as leaving earlier in the morning to be first out fishing. It is interesting to observe that this externality has always been recognized in the inshore fishery and that local customs have evolved to minimize socially unproductive "cheating". See Report of the Commission of Enquiry Investigating the Sea Fisheries of Newfoundland (1937).

8. Diminishing marginal productivity and complementarity are assumed for L_1 and g_1. The second order conditions for a maximum are assumed to hold.

9. The absence of a third term on the left hand side of equations (10) and (11) is a reflection of the assumption that $f^0_{Y_1} = 0$, i.e., that in the short run inshore harvesting will not decrease offshore production potential.

10. It is important to recognize that the future value of leaving today's fish in the ocean refers not only to fish reproductive capabilities but also to fish sizes. It is in this later area (particularly in relation to processing economies) that significant gains can be expected.

11. See, for instance, Clark and Munro (1975).

Chapter 3

The Comparative Static Effects of Government Assistance Programmes Within the Fishery

Introduction

In Chapter 2 we developed a competitive model of the Newfoundland fishery in the absence of government intervention. The emphasis in that chapter was on the existence of a variety of externalities arising from the common property characteristic of the fish stock under conditions of open entry. The inability to internalize the benefits of leaving fish in the ocean leads to an over expansion of fishing effort, a depletion of fish stocks, (possible) misallocation of resources between sectors and low levels of labour productivity. The conclusion arising from that analysis was the need for management within the Newfoundland fishery where the objective of management would be to induce a movement toward the long run Pareto optimal solution.

If the presentation of this set of conclusions was the sole objective of this study, these conclusions could be derived from a much simpler analysis. Moreover, when the conclusions are stated in these terms very little that is new is added by our complexity. Both fishermen and policy makers are fully aware (if only through experience) of both the complexity and the tendency toward over expansion, and this awareness has motivated much of the assistance given by various levels of government. However, the presentation of these standard conclusions is intended only as a starting point for our analysis. It forms a foundation for what will be a recurring theme throughout our study; that is, that well meaning attempts by governments to correct for specific weaknesses within the fishery are almost always inadequate (and frequently perverse) because they ignore the complicated set of interactions set in motion by their initial act. To capture the essence of this proposition a model of some complexity is required. It cannot be illustrated in the context of a single sector Schaefer model, for these models surpress the range of adjustment possibilities available within the fishery. Rather the reader must constantly keep in mind that our analysis, while permitting a greater range of flexibility, is still overly simplified. It is intended as a starting point, rather than an exhaustive treatment, of the impact of government assistance programmes on the productivity and output of the components of the Newfoundland fishery.

In the following pages the existence of a number of government assistance programmes is acknowledged. Governments indirectly manage the size and technology of fishing fleets through gear and boat subsidies; resource stock sizes are controlled through quotas and licenses and labour force participation is influenced through subsidy programmes, in particular Unemployment Insurance. In discussing the consequences of these programmes our analysis will be largely verbal but is based on comparative static experiments derived from the model of Chapter 2. The intent of this chapter is to describe the complex set of interactions set in motion by direct governmental attempts to improve labour productivity and hence fishing incomes within the inshore fishery. While the discussion is kept at a fairly general level, it sets the stage for the extended theoretical and empirical investigation of the impact of the Unemployment Insurance Programme presented in Chapter 4.

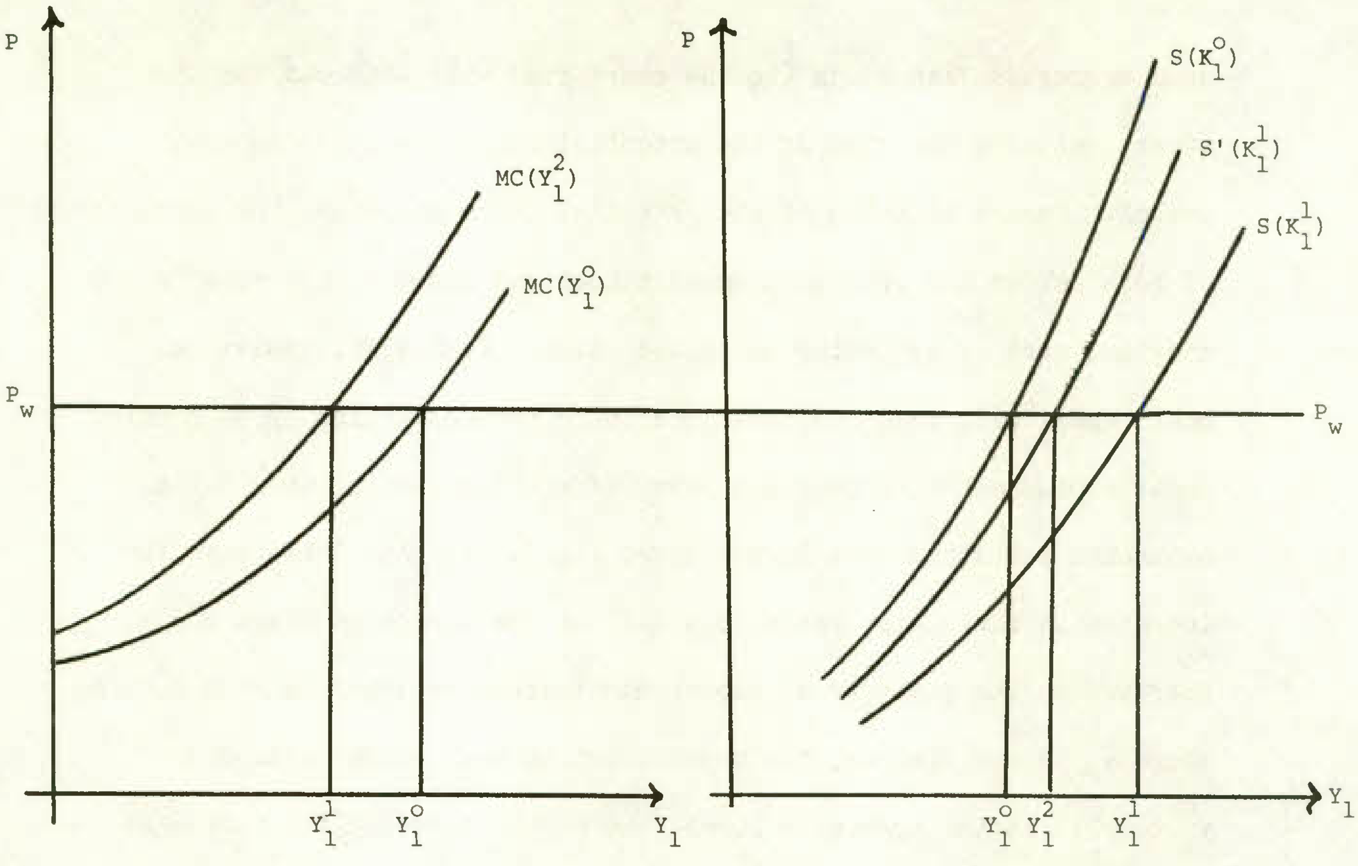
a) Boat Subsidies and Licensing

It is readily shown from our discussion in Chapter 2, Section C, that as long as the crowding externality is not excessive, an expansion in the number of fishing vessels in either sector will increase the output of both the sector and the industry. At the same time, more boats will require more fisherman. Since the inshore fishery utilizes a more labour intensive technology, it would seem that an expansion of the inshore fishing fleet offers the best way to simultaneously improve industry performance (i.e. output) and employment. Such reasoning seems to be implied by the pattern of boat subsidies offered to the Newfoundland fishery.

For some time now both the Federal and Provincial governments have been active in subsidizing boat construction as well as providing complementary shoreline infrastructure. From the Federal government the major subsidies come in the form of low interest subsidized loans for boat construction. Most of these have been directed toward longliner construction (boats between 35 and 65 feet in length) and have totaled over $9 million in 1976-77. The Provincial government has supplemented this programme in various ways. Longliner construction is eligible for direct provincial support of $200 per m. tonne, up to

15% of the overall cost. Smaller inshore boat construction (undecked boats of 18-35 feet) and the rebuilding of existing boats over 12 years old are eligible for a direct subsidy of 35%. On the other hand, it is unclear to what extent shipbuilding subsidies are subsidies to the fishery as opposed to the shipbuilding industry. The magnitude of construction subsidies suggests that the intent of these programmes is to encourage the development of a local shipbuilding industry. The construction subsidy allows local Canadian builders to price their vessels competitively with foreign builders. But whether or not shipbuilding subsidies have actually increased the size of the inshore fleet, offshore expansion has temporarily stopped. Recently, the Federal government has more or less frozen all new trawler construction through its reluctance to issue new licenses. Thus in relative (if not absolute) terms, government policy appears to be directed towards an expansion of the inshore fishery. The remainder of this section traces through in some detail the likely consequences of such a plan.

The effect of an increase in the size of the inshore fishing fleet on the size of individual and sectoral catch can be seen by refering to Figure 3.1. In this diagram the industry and the firm are assumed to be in initial equilibrium at the levels of output Y_1^0 and y_1^0. An increase in the number of inshore boats from K_1^0 to K_1^1 will increase the inshore fishing harvest to Y_1^1 (by shifting outwards the aggregate supply curve from $S(K_1^0)$ to $S(K_1^1)$) under the assumption that the productivity of individual fishing vessels has remained unaltered. It is apparent from our model, however, that this assumption can not be maintained. A larger number of inshore boats, each exploiting the



Graphical Representation of the Effect of Fleet Expansion

Figure 3.1

same aggregate fish stock (in the short run) will thin out the fish stock, reducing the size of the potential catch available to each vessel. Such a thinning of the potential catch decreases the productivity of both labour and gear used on each boat and results in a rise in the marginal cost of achieving any sized catch. Similarly, individual boat owners will react to these declining productivities by decreasing their employment of labour and gear (offsetting part of the initial expansion resulting from larger fleet size). In both these ways the increase in fleet size leads to a fall in average catch sizes and a decrease in the quantity of substitute factors employed on each fishing vessel. In our diagram, the representative boat catch falls from y_1^0 to y_1^1. At the aggregate level, the supply curve shifts back. As long as the crowding and intersectoral externalities are not excessive, the net effect on sectoral output will be an intermediate sized catch of Y_1^2.

It is important to remember that the representative characteristic of our model does not permit adequate representation of the degree of intersectoral rivalry produced by non appropriable fishing rights (see footnote 7 to Chapter 2). As the fleet size grows, the implicit private cost of leaving (undersized, for example) fish in the ocean rises as each vessel realizes only an increasingly smaller ($1/K_1^1$) share of the resulting benefits. For this reason we would expect an additional efficiency loss as internal competition is intensified among inshore fishermen.

If fish stocks (particularly cod) did not migrate, the inshore sector could be analyzed in isolation. However, it is well established (although the magnitudes remain in doubt) that groundfish do move seasonally between the inshore and offshore fishery. From this it follows that any expansion in the inshore fishery will necessarily reduce the size of the available fish stock offshore.

As the size of the annual outmigration of ground fish decreases, the productivity of boats, gear and labour used in the offshore fishery will fall. Given the specific nature of the capital embodied in trawlers and gear, these inputs have only low valued alternative uses, at least in the short run. For this reason, internal contraction will impinge most heavily on labour employment; although the limited range of technical substitution possibilities will tend to spread this influence slowly through time. In the period of transition, declining productivity offshore will translate into abnormally low fishing incomes.

What is even more serious for the industry as a whole is that with only slightly reduced offshore catches the combined catch of both sectors will be larger. As inshore and offshore fishermen alike struggle to maintain their previous income levels, the rate at which the common stock is harvested will rise. This results in lower levels of sustainable yields and offers the prospect of even lower levels of productivity and income (in both sectors) in the future.

To briefly summarize our argument, a government sponsored programme to raise aggregate employment by expanding the fishing fleet in either sector tends to ignore the complicated set of offsetting changes induced by this programme. Even in the short run an expansion of effort will directly lower productivity across both sectors tending to undercut the initial stimulous to employment given by expansion. More fish will be caught by more vessels, each employing fewer fishermen. Moreover, to the extent that the programme is successful, earnings per fisherman will fall. Finally the programme tends to ignore the long run interactions between fishing sectors and the combined effect on future fish stocks. Such considerations suggest that further expansion in fleet sizes will impose social costs that are greatly in excess of the benefits derived from higher employment, particularly if the industry is at or near the competitive equilibrium. It should be recognized, however, that the expansion of one sector relative to another generates a redistribution of fishing income between sectors. If such a redistribution is desirable on equity grounds, our analysis should be interpreted as outlining the social costs of achieving income redistribution in this way.

In more recent years an increased awareness of the consequences of open access has led to a consideration of restrictive boat licensing as a way of restricting and/or reversing access to the fishery. By reducing the number of boats with access to the fishery, it is argued, competition will not lead to the rent dissipation that characterizes the open access solution. Positive rents will be earned within the fishery, average earnings will rise and the restriction in resource use will allow the industry to approach the Pareto solution.

At best the use of vessel licensing to induce a more efficient rate of resource utilization is a third best solution to the problem at hand. As we have seen, the problem of excessive utilization of the Newfoundland fish stock does not arise from the characteristic of open access, but rather from the absence of a mechanism to internalize (to the individual) the future benefits of leaving fish in the ocean. The traditional means of internalizing this externality, i.e. through private property rights, is believed to be unfeasible in the fishery because of the prohibitive costs of delineating and enforcing these rights (see, however, our discussion in Chapter 5). Thus failing a mechanism to bring private fishing incentives into line with their social counterparts, and failing a mechanism to impose consideration of this interdependence by regulating catch sizes directly, resource conservation must be practiced indirectly by restricting access. It is perhaps obvious but nevertheless important to emphasize that the depletion of fish stocks arises not from the excessive use of one particular factor of production but from the simultaneous over-extension of all fishing inputs. Yet all inputs are not equally amenable to administrative control. Thus the case for controlling access to the fishery by licensing fishing vessels rests on the prohibitive administrative and policing costs associated with restricting all factor uses. By reducing the number of fishing vessels, it is expected that the use of all complementary factors of production will be reduced correspondingly. The advantages that are expected to be derived can be found by reversing the chain of reasoning set out in the first part of this section.

The reason that vessel licensing has not proved to be as successful as anticipated is apparent from our description of the original rationalization of the programme. Because vessel licensing does not, in itself, apportion fishing rents to particular agents or factors, any success in restricting access leaves in tact the individual incentives to capture rising industry rents by expanding along any and all uncontrolled margins. Moreover, the prohibitive costs of monitoring and policing these margins suggests that boat owners will expand to take advantage of these opportunities. The result is that the inability to control rent seeking behaviour will lead to the dissipation of fishing rents in ways that are more costly than in the original situation.

The experience of the Pacific Coast Salmon Fishery provides us with a case in point.[1] In 1969 access to the British Columbia salmon fishery was restricted by the creation and enforcement of specific salmon fishing boat licenses. To further reduce fishing effort and raise the net value of the salmon catch, this programme was supplemented by a licensing "buy-back" scheme. Yet despite its success in reducing the number of fishing vessels, the programme has not been successful in achieving its ultimate objective -- that of reducing the aggregate use of capital and labour in the industry. Initially, fishermen circumvented the restrictive intent of the programme by replacing the vessel covered by the license with new vessels that were, in some cases, three times the size of the original vessel. When the licenses were altered to specify a tonne-for-tonne replacement ratio, fisherman responded by increasing the capital intensity embodied in each fishing tonne. As licenses become increasingly broad in their coverage, fishermen become increasingly inventive in their attempts to circumvent these restrictions. Pearse and Wilen conclude their evaluation of restrictive boat licensing as a means of controlling the excessive use of labour and capital in the following terms:

> In view of the flexibility of technology ... and the enormous variety of dimensions of fishing effort, we suspect that a successful rationalization program of this type would be so complicated as to be unmanageable.[2]

b) Quotas

The concept of an optimal economic yield from the Newfoundland fisheries implies a steady state fish biomass consistent with production costs, prevailing discount rates and capital costs. From this an optimal sized annual harvest or net recruitment rate can be determined. Traditionally, resource management has been exercised by setting annual aggregate quotas per fishing region, where the recruitment rate has been estimated through such techniques as MSY (maximum sustainable yield) or, more recently, the $F_{0.1}$ rule.[3] Sometimes, however, badly depleted fish stocks have evoked even stronger responses and access to certain regions or species has been completely closed. Such was the case in 1978, for example, when the North East corridor was closed to all offshore trawlers.

In Newfoundland, quotas have typically been assigned on an area basis (i.e. not per boat) and implemented only in relation to the offshore fishery. By and large, the inshore fishery has been left to adjust as best it can to the residual left by the offshore fishery. Given this programme of stock management, the question arises whether or not the imposition of offshore quotas will be sufficient to induce efficient resource use when the inshore sector is left untrammelled.

To focus on this question, let us assume that the long run steady state existing in the Newfoundland fishery is described by the competitive equilibrium outlined in equations (2.15) through (2.26) in Chapter 2. As compared with this solution, the optimal sized fishery is described as the solution to equations (2.28) through (2.38). Given these differences, one way that the Federal government can exercise optimal resource management is to set as quotas the optimal sized sectoral catches consistent with the biomass solved for in (2.38). Let us assume, however, that the Federal government can impose an effective quota only as the offshore fishery and thus sets the optimal offshore quota implied by the optimal solution. In this context we can ask if the incentives created for the inshore sector will complement or offset resource conservation in the offshore fishery.

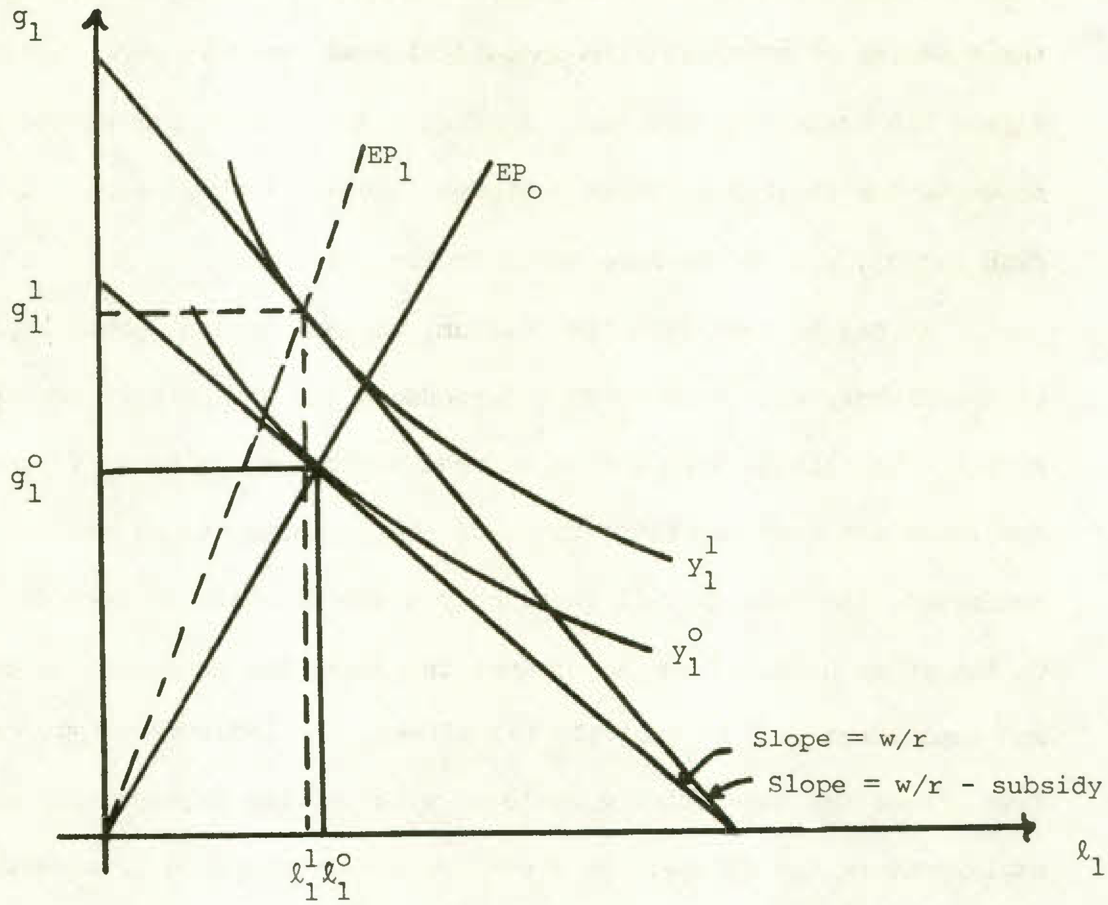
As the offshore fishery is contracted by the restrictive quota, the annual summer migration of fish inshore will rise. Moreover, to the extent that the offshore quota is successful in reducing the aggregate industry catch, fish stocks will begin to recover. For both these reasons the potential catch available to each inshore boat will rise, raising the productivity of all inshore factors and average inshore fishing incomes. Because the inshore sector remains uncontrolled, however, the emergence of newly created fishing rents will lead to entry and further expansion within the inshore fishery. More labour, more boats and more gear will be used until the rents created by offshore contraction are once again dissipated. It should be emphasized that if the number of inshore boats is held constant, or even reduced to the optimal number implied by equation (2.32), optimality will not result. The incentives created by non appropriated fishing rents will lead to increased fishing effort and catch sizes through the extension of labour and gear use. For the lot of the average inshore fisherman, offshore quotas will create only temporary gains. While the inshore sector expands so that aggregate earnings inshore rise, fishing productivity and incomes will fall back to their pre-existing low levels. To prevent the dissipation of fishing rents and to preserve a dwindling biomass, quotas (or equivalently, per unit taxes) must be imposed on the inshore fishery. In the absence of joint control, aggregate earnings will be redistributed but not increased.

Finally, while the judicious use of sectoral quotas can be successful in controlling the intertemporal and between sector externalities that exist in the fishery, such aggregate quotas cannot correct for the internal sectoral externality that also arises. Indeed, to the extent that sector quotas are successful this externality will be heightened. As potential fishing rents rise, each individual boat owner will try to realize as much of the aggregate rent as possible. The redundancy of fishing effort induced by the neglect of this potentially significant externality forms the basis of our case for private fishing rights, advocated in Chapter 5.

c) Gear Subsidies

The Provincial government of Newfoundland has two direct gear subsidization programmes. One is the Fishing Gear Supplement Programme paid to "full-time" fishermen through the boat owner in the form of a price subsidy per pound of fish landed. The magnitude of the programme was $1.4 million in 1977-78. The other programme is the Inshore Fishing Gear Cost-Shared Programme under which inshore boats entering developing fisheries or converting from small boats to longliners have their gear costs subsidized.[4] In 1977-78, $0.3 million was paid out under the provisions of this programme. As well as these direct supports, the Provincial government subsidizes in indirect ways. Fuel and many other fishing related expenditures are exempted from provincial sales tax.

The efficiency and output effects of a specific gear subsidy can be illustrated by referring to Figure 3.2. In this diagram the representative inshore boat is drawn in a position of initial equilibrium, producing a level of fishing output y_1^0 and employing g_1^0 units of gear and ℓ_1^0 units of labour. At current factor prices, the output of the representative boat would expand along the expansion path EP_0. The introduction of the gear subsidy produces two major changes in this initial equilibrium. The result is drawn in dashed lines on the diagram for easy reference. First, by lowering the private cost of gear use for the fisherman, the government alters the relative price ratio and induces the boat owner to substitute gear for labour. This can be seen by the rotation of the relative price line around the



The Effect of a Gear Subsidy on a Representative Boat

Figure 3.2

isoquant curve and the generation of a steeper (dashed) expansion path EP_1. Second, by lowering the private costs of boat operation below their social counterpart, the individual boat owner is encouraged to expand his scale of operation. In Figure 3.2, the output effect is shown as the ability to reach a higher isoquant curve (realize a larger fish catch), y_1^1, at the same total factor cost.

As can be seen from the diagram, whether or not labour employment in the fishery will rise or fall depends on the strength of the output effect. Yet little hope can be offered along these lines. If gear subsidies are combined with quotas so that fishing stocks may be conserved, the subsidy will cause only a substitution of gear for labour. On the other hand, if quotas are not in place, the stimulus to output and employment will be strictly transitory. As industry output expands, fish stocks are more quickly depleted with falling productivity and employment in the future. In a sector already hampered by excessive labour and capital use, gear subsidies only exacerbate the problem by further reducing social (as opposed to private) productivity.

Finally, if gear subsidies led to an increase in individual labour incomes the subsidy could be advocated for equity, if not efficiency, reasons. Our analysis of the characteristics of the Newfoundland labour market, however, suggests that any intended income supplement in this manner will be unsuccessful.[5] The coventuring form of labour contracts combined with a relatively high degree of labour mobility into the inshore fishery means that individual labour incomes cannot rise in the long run. Rather, any restriction on the inshore fishery through boat licensing and/or quotas is more likely to lead to a renegotiation of the sharing provisions in the boat owner's favour.

As a result, it is our opinion that gear subsidies should be eliminated.[6] In both the inshore and offshore fisheries gear subsidies distort production efficiency. If entry is controlled, they redistribute wealth in favour of boat owners; and if fleet expansion is possible, they encourage the further over expansion of industry output and the more rapid depletion of the resource base.

d) Price Supports

The subsidies discussed in the previous section are directed towards the supply or production side of the industry. In the recent past, the industry has also experienced intervention on the demand side in the form of direct price supports during periods of low demand. For example, a subsidy on landings of ground fish of 2¢ per pound, called the ground fish Temporary Assistance Program (TAP), was in effect from late 1974 through the summer of 1978. The cost of this programme in 1977-78 alone was over $10 million.[7]

The use of price supports was prevalent in agriculture in the 1950's as a way of providing direct income supplements. In agriculture, however, price supports were generally accompanied by crop restriction programmes to prevent the expansion of industry output from undermining the feasability of the programme. Farmers already in the relevant industry received their share of the output quota on a historical (status quo) basis.

No such 'crop restriction' occurred during the period of TAP in the inshore fishery.[8] The result was that price supports encouraged the inshore sector to expand in a period of depressed market conditions and bad harvests, with adverse long run consequences. It is only through good fortune that the 200-mile limit occurred. By permitting a contraction of foreign offshore catches, the resource base has been allowed to regenerate.[9]

One interesting feature of a comparison of the fishery with agriculture concerns the position of marketing boards. In agriculture, a well established general principle is that marketing boards create market power, and through this generate often substantial welfare losses. This results from the marketing boards ability to monitor and enforce industry inputs so that it can simultaneously reduce industry output and raise market prices. What is only an impediment to the efficient allocation of resources in agriculture can be an advantage to resource management in the fisheries. As we have seen, the fundamental deficiency in the competitive fishery is the inability to appropriate the resource stock and thus exercise consistent decision making. From this perspective, then, the development of a fish marketing board may provide a mechanism than can simultaneously provide biomass control through quasi-sole ownership and income support through the control of entry.

Two words of caution must be added. First, and most obviously, the record of state controlled processing and marketing organizations both within and without the fishery has not been particularly successful. By being isolated to some extent from the market, management decisions can be influenced by special interest groups of all kinds. Through changing the form in which rents can be appropriated, we change only the way in which rent dissipation will tend to arise.

Second, it should be recognized that the indirect control of harvesting through the control of industry processing and marketing necessarily cuts across areas of different governmental jurisdiction. This would not be an insurmountable problem were it not for fish migration. In the absence of migration, separate inshore and offshore quota could be set with Federal management of the offshore and Provincial management of the inshore. With the existence of migration, however, both sectors are necessarily tied together. The maximization of global fishing rents thus requires the simultaneous coordinated control of both sectors. This is unlikely to be achieved by placing administrative control in two separate levels of government. For this reason there seems little alternative to Federal management and control of the fishery.[10]

Conclusions

Most of the problems of the Newfoundland fishery are fundamentally resource stock problems stemming from lack of property rights. The competitive expansion of the industry beyond the optimal level has resulted, in some cases, in income levels that are lower than desirable.[11] Attempts at income supports have interfered with resource management and theory indicates that they generally lead to an increased output with more fishermen and not higher salaries. Some programs such as gear subsidies along with quotas are at cross purposes.

Income support programs then should not be attempted if they represent a trade-off with resource management. The laws of nature are irrefutable and such programs will fail. Instead, a reasonable approach would be to coordinate income support and resource management. This would mean licensing and quotas for both fisheries. Both licenses and quotas could be auctioned and the proceeds, effectively the rent from the resource, could go into provincial coffers for lum sum income support, R&D in the fishery, or whatever.

Management of the inshore fishery could be administered through a marketing board. Processing could also be state operated (as suggested in a provincial white paper, 1979).

The special concession given to (inshore) fishermen, but not available to other sectors (such as farmers) is treated in detail in the next chapter. This arrangement, devised to circumvent the lack of an employer/employee relationship would be unnecessary if there were a cooperative marketing board which could act in the role of employer. Otherwise the use of the unemployment insurance act to effect an income supplementary programme seems perverse.

The fact remains that the inshore fishery is seasonal, as is farming, and the offseason in fishing is not a period of unemployment. The reason that the sector has been isolated for support is not because it is seasonal, since it is no more seasonal than professional baseball, but because the income levels are low. Past attempts to raise incomes have not seemed successful. Proper resource management could raise incomes in this sector to a satisfactorily high level.

An area where government policy is possibly optimal concerns risk. It is observed that many institutional arrangements peculiar to the fishery exist because there is more uncertainty and it must in some sense be shared. Risk, and the corresponding government policies, are considered in a later chapter.

NOTES

1. For a more extended discussion see G.A. Fraser (July 1979) and P.H. Pearse and J.E. Wilen (July 1979).
2. P.H. Pearse and J.E. Wilen, "Impact of Canada's Pacific Salmon Fleet Control Program", (July 1979), 769.
3. For an explanation of the $F_{0.1}$ rule see G. Munro (this Reference).
4. The success in improving biomass control by redeploying boat resources into developing regions or to longliner technology will depend completely on the degree of fish migration. However, if longliner technology implies better quality output from the same resource base, this form of subsidy may merit consideration.
5. The reader is referred to the extended theoretical and empirical investigation of this point in Chapter 4.
6. A possible exception to this general rule might be made with respect to quality. See footnote 4 above.
7. Since 1976 the Federal government has also provided financial encouragement to trawlers to explore waters not traditionally exploited by the Canadian fleet. The usual form of this subsidy entailed a minimum guaranteed trip payment.
8. Quotas were introduced in parts of the offshore fishery but the inshore fishery had none. Moreover, the entry of new boats through licensing control has only recently been enforced.
9. It is, perhaps, not insignificant that the ability to keep TAP temporary was the one time arrival of extended jurisdiction. Without the rise in fishing incomes that followed the contraction of foreign fishing effort, the political pressure to maintain this programme would have been much more intense.

10. See, however, our discussion in Chapter 5 where we advocate major reforms in the way the Federal government manages the fishery.

11. According to the Hon. Marc Lalonde (1973, Tables 9, 11) the expected annual salary from a minimum wage job in Newfoundland in 1973 was $2,912 compared with $3,240 in annual benefits from social assistance programmes.

Chapter 4

The Supply of Labour

The model developed in the first section of this report is useful in illustrating the general context of the Newfoundland fishing industry. It formally isolates some of the important interdependencies that exist within and across different sectors of the industry and highlights the tendency towards overexpansion and the accompanying phenomena of declining productivity and resource depletion. On the other hand, the model oversimplifies some of the most basic and persistent problems facing Newfoundland by suppressing supply side considerations in the factor markets, particularly through the assumptions of homogeneous factors and costless factor mobility. Nowhere are these assumptions more misleading than in the case of labour. Fishing, particularly in the inshore fishery, is tied to a complex of community and cultural values that inhibit the free flow of labour throughout Newfoundland. While this way of life has generated substantial benefits -- embodied in the independence and self-sufficiency of the Newfoundland character -- it has also increased the costs of adjusting to changes in the economic environment.

The purpose of this chapter is to focus in more detail on the work-leisure choices faced by a representative fisherman. The first section sets out the determinants of occupational choice from the perspective of the representative fisherman. The individual analysis is then enclosed within a competitive environment to determine the characteristics of sectoral equilibrium in the absence of government intervention. The conditions governing entry, the determination of the length of the fishing season and the solution for the coventuring formula all fall out of this analysis. The second section of the chapter begins by describing the details of the Unemployment Insurance Act as it applies to the inshore fishery. It proceeds to analyze the way in which the availability of special seasonal benefits influences individual choice and hence productivity, employment and internal migration within the economy. Some quantitative estimates of the effects of unemployment insurance are then presented. The chapter closes by considering alternative income supplementing programmes available to the government.

I. Occupational Choice in the Fisheries

(a) Individual Choice

Inshore fishing is a seasonal occupation involving relatively short intervals of intensive fishing activity and longer "idle" periods when weather and fishing conditions encourage the suspension of fishing activity. In these latter intervals, however, fishermen are not idle; using their free time either to supplement their money incomes through various non fishing alternatives (e.g. forestry, agricultural and part-time non-primary employment) or to engage in a variety of non-market activities (such as gear and vessel repair, home improvement and self-sufficient agricultural production). Moreover, life in the outport offers income supplementing opportunities to dependent family members that complement seasonal fishing. For example, the fish glut that arises in the summer months gives rise to seasonal fish-processing employment opportunities for the fisherman's wife and dependent children. It is apparent, then, that in choosing employment in the inshore fishery, a fisherman will take into account far more than just the income he can earn through fishing. Aggregate family income will be the relevant income variable in the decision over occupational choice.

If the complex of activities included in the term inshore fishing represented the only occupational alternative facing the inshore fisherman, the only choice open to the individual would be how to allocate his time between these competing activities. To simplify this analysis we make the following assumptions. First, there are three sources of income available to the inshore fishing family: fishing income by the family head, dependent family fishing related income, and non fishing pecuniary and non pecuniary earnings by the family head. Second, non fishing activities can be converted into dollar equivalents (reflecting the fisherman's subjective evaluation of this type of work relative to fishing) and this evaluation is independent of the time devoted to that activity. Third, dependent family earnings are strictly separable from the fisherman's personal sources of income, and the disutility of family work does not affect the utility function of the fisherman. Finally, the fisherman has a utility function with the arguments aggregate family income and leisure, where leisure stands as a short hand term for the complex of non work activities available to the fisherman in the outport.

If leisure had no value to a representative inshore fisherman, the sole objective of the fisherman would be to maximize family income. Figure 4.1 presents diagrammatically the income possibilities facing a fisherman. On this diagram the three sources of family income are measured by the height of the three curves DD, FF, and NN in dollars. DD represents dependent family income and is independent of time, FF represents fishing income and NN represents non fishing income, both of which are dependent on the time devoted to these activities. Because fishing and non fishing income are mutually exclusive alternatives for the fisherman, they must be read in opposite directions along the time axis. Hence any point on the horizontal axis, such as t*, represents a division of total time (52 weeks) between fishing activities (t* weeks) and non fishing activities (52 - t* weeks). The FF curve is drawn to reflect diminishing marginal productivity as more time is devoted to this activity. This implies that time on the horizontal axis is not chronological but ordered from more to less productive fishing intervals. The marginal evaluation of non fishing work is assumed constant so that DD is linear.

From the three curves a total family income curve can be derived by adding together the income possibilities for each division of work time. This is represented by the YY curve. Family income is maximized at Y* which implies t* weeks of fishing activity and 52 - t* weeks in non fishing work. The fisherman will allocate his time between the competing alternatives such that the marginal evaluation of work in the two activities is equalized. This will occur when the slope of FF is equal (but of opposite

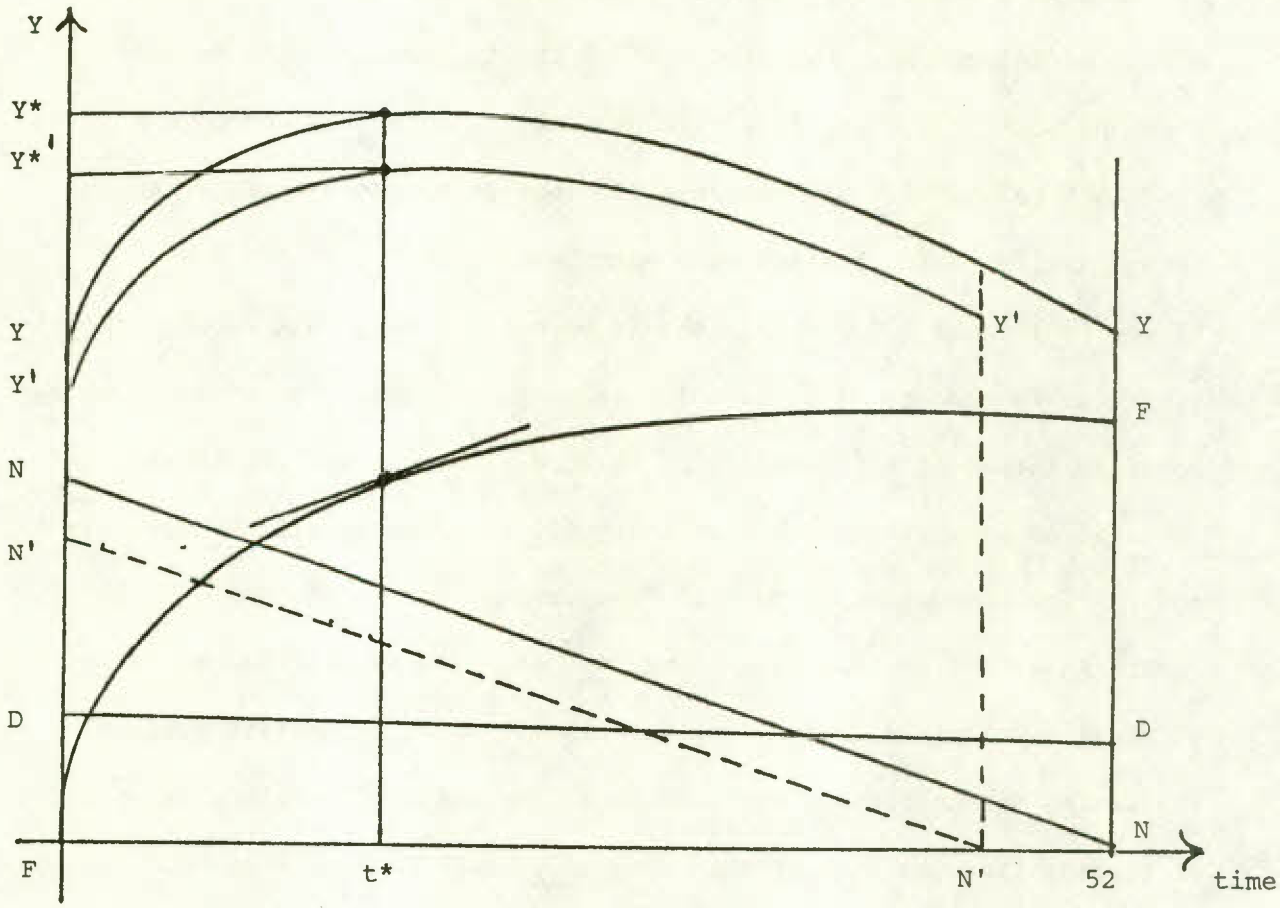


Figure 4.1

sign) to the slope of NN.

In general, however, leisure will have value to the fisherman and not all of the fisherman's time will be devoted to working activities. By decreasing the total amount of time allocated to work, the total set of income-leisure possibilities open to the fisherman can be determined. A second possibility is illustrated in Figure 4.1 by the dashed set of lines N'N' and Y'Y'. In this case Y*' represents the aggregate family income available to the fisherman when leisure (work) consists of 52 - N'(N') weeks. Two things should be noticed from this construction. First, as the amount of leisure increases total family income falls at a constant rate over early ranges of leisure. Second, as leisure increases and work falls, the work that will be given up will be entirely in non fishing activities. The amount of time allocated to fishing will remain invariant as long as some non fishing work is undertaken. Both of these conclusions follow from our assumption of a constant marginal evaluation of non fishing work. Because the value of the marginal product of fishing rises as less time is devoted to it, the choice of working less in non fishing activities will always dominate the alternative of less work in fishing.

The opportunity set constructed from this analysis forms the constraint delimiting the technically optimal alternatives available to the representative fisherman. This is represented by the PP opportunity set in Figure 4.2. The individual then maximizes his objective function subject to this opportunity locus. In the example shown in Figure 4.2, the fisherman chooses to work t_0 weeks in total, t* weeks in fishing and t_0 - t* weeks in non fishing part-time work activities. Total family income will be Y_0 and 52 - t_0 weeks will be occupied in non work (leisure) activities.

While the analysis describes the problem of optimal choice within the inshore fishing sector, the inshore fisherman must also consider the occupational alternatives of offshore fishing and full time, non fishing employment. Aside from their pecuniary advantages, however, these alternatives have a number of non-trivial disadvantages relative to inshore fishing. For example, both of these alternatives will require the fisherman and his family to leave the outport and its traditional way of life; in addition, the higher average earnings of outside employment must be discounted by the higher probability of unemployment. For both these reasons, then, an individual may choose to remain in the outport despite the existence of higher average earnings elsewhere. To weight the argument as much as possible against the inshore way of life, however, let us assume that the fisherman has no particular attachment to life in the outport and is neutral in his assessment of risk. Under these conditions occupational choice will be based on the expected income-leisure opportunities available in alternative employments and tastes of individuals for income as opposed to leisure.

As can be seen by referring to Figure 4.2, the possibility of higher outside earnings will not necessarily lead the inshore fisherman to reject his traditional employment. Offshore fishing, by requiring constantly long time periods out on the banks, offers the fisherman higher total

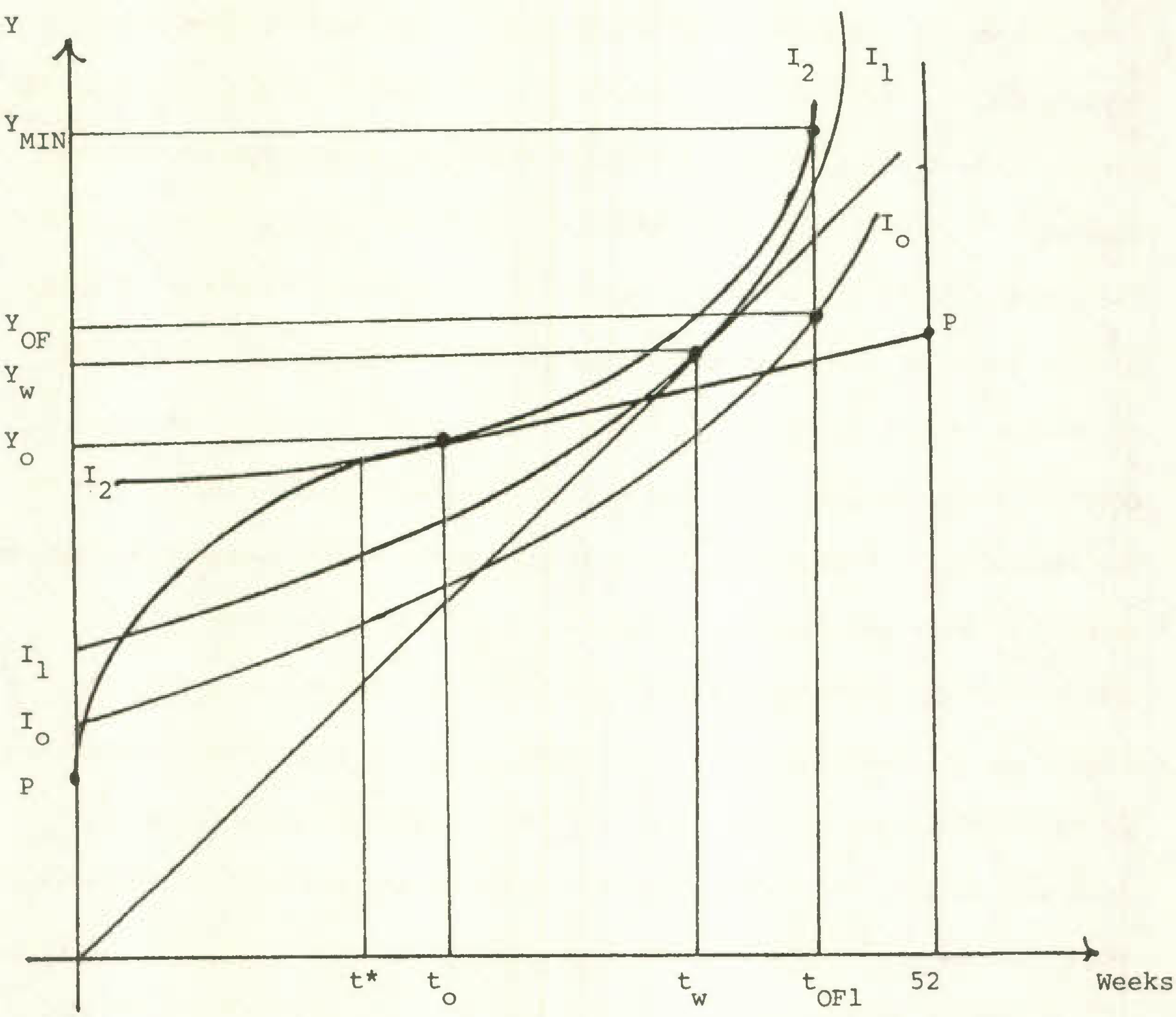


Figure 4.2

earnings only at the cost of drastically reduced leisure. The discrete choice, represented by the point OF on the diagram, is an all or nothing choice for the fisherman. He must compare the total utility of the bundle Y_{OF}, t_{OF} to that represented by inshore fishing. For an individual with tastes such as those drawn on the diagram, a minimally acceptable level of income, Y_{MIN}, would be necessary to induce the inshore fisherman to adopt this way of life. It follows that substantially higher earnings in the offshore fishing sector are not necessarily a sign of intransigence in the labour market. In equilibrium the difference in total family income will be a measure of the premium necessary to induce the fisherman to willingly adopt the inconvenience and isolation of offshore fishing life.

The third alternative available to a fisherman is the possibility of full time, non fishing employment. As with offshore fishing, full time employment imposes a certain minimum requirement of work attendance, although this is likely to be much less stringent than in offshore fishing. Figure 4.2 can again be used to represent this alternative. Full time, non fishing employment offers an expected wage rate that exceeds the marginal part-time wage rate, if the number of weeks worked exceed some minimally acceptable level, such as 45 weeks. Optimal choice with respect to this wage result in a family income, Y_W, that exceeds the level of income earned in inshore fishing, Y_0. Nevertheless, the fisherman will reject the prospect of higher earnings for the opportunity to exploit the increased range of leisure possibilities offered by the inshore way of life.

When ranked by total family income, inshore fishing stands as a poor third to offshore fishing and full time wage employment. Yet as illustrated in Figure 4.2, it is possible for inshore fishing to dominate the others in terms of occupational choice. In this analysis the preference results from individual tastes for income versus leisure given the possibilities offered by the three occupational alternatives. It implies that one need not assume an attachment to the inshore way of life in order to explain income differences. Subjective attachment will no doubt explain part of income differential that exists between the inshore and other sectors of economic life; on the other hand, it is a sufficient but not necessary condition for the original emergence of such a differential.

(b) The Competitive Market Solution in the Inshore Fishery

Thus far we have considered the problem of occupational choice solely from the perspective of the isolated individual. In this we have assumed that the production function in the inshore fishery and the income possibilities in offshore fishing and non fishing employment are invariant to individual choice. While this assumption may be appropriate for the individual, it cannot be maintained for the sector as a whole. Consider, for example, the situation represented in Figure 4.2. The higher level of utility received by the representative fisherman in inshore fishing means that inshore fishing dominates occupational choice. Labour will be attracted into inshore fishing from the other two sectors, and, through entry, the income possibilities in the inshore sector will fall relative to the other sectors. Moreover, as we have seen in Chapter 2, the competition provided by labour mobility forces the individual to work longer than he would otherwise choose to work. The problem of individual choice must then be placed in the context of the overall labour market.

In order to simplify our analysis, let us assume that changes in the size of the inshore fishery will always be small relative to the size of the overall Newfoundland economy. This implies that the income possibilities at the prevailing wage rate in the non fishing sector can be considered as parametric, thus providing a benchmark for our analysis. Consider now a representative individual. If this individual worked in the non fishing sector he would choose to work the number of weeks that will maximize his total utility.[1] That is, he would

$$(4.1) \qquad \max_{\ell} L = U(Y, 52-\ell) + \lambda (w\ell - Y)$$

The first order conditions for a maximum state that the individual will increase his weeks worked until

$$(4.2) \qquad \frac{U_\ell}{U_y} = w ,$$

that is, until the marginal rate of substitution between work and leisure equals the wage w. This implies an optimal number of weeks worked, ℓ_w, an optimal income, $Y_w = w\, \ell_w$, and hence the maximum level of utility

$$(4.3) \qquad U_w = U(Y_w, 52-\ell_w)$$

Given this benchmark, entry or exit will take place in the inshore fishing sector until, for the representative labourer, $U_F = U_W$. This condition, maintained by the mobility of labour between sectors, forms an important constraint on the work-leisure choices of fishermen and the profit maximizing behaviour of boat owners.

Consider now a representative boat owner. In order to maximize the rent he receives from the fishery, the boat owner can alter three variables: his share of the aggregate catch as boat owner, r; the length of the fishing season (the number of weeks each fisherman must work), ℓ; and the number of fishermen on his boat, n. Since the boat owner cannot conscript labour, however, the number of fishermen he can attract will depend upon the coventuring formula and length of the season he sets, together with the opportunities fishermen can earn elsewhere. That is, for any r and ℓ set by the boat owner, fishermen will enter or exit until the utility earned in inshore fishing equals the utility gained in the next best alternative. Competition among potential fishermen, then, continually maintains the condition

$$(4.4) \qquad U\left\{\frac{(1-r)f(\ell,n)}{n}, 52-\ell\right\} - U_W = 0$$

where in equation (4.4) the constant, competitive price of fish allows us to interpret the production function in value terms.

The continual maintenance of equation (4.4) means that for any r, ℓ combination a unique number of inshore fishermen can be found. Hence,

$$(4.5) \qquad n = n(\ell, r)$$

and this can be substituted back into the boat owner's maximizing problem. Moreover, since competition maintains equation (4.4), its partial derivatives with respect to r and ℓ will also equal zero. Hence,

$$(4.6) \qquad U_y \left\{ \frac{-f}{n} + \frac{(1-r)f_n n_r}{n} - \frac{(1-r)f\,n_r}{n^2} \right\} = 0$$

and $$(4.7) \qquad U_y \left\{ \frac{(1-r)(f_\ell + f_n n_\ell)}{n} - \frac{(1-r)f\,n_\ell}{n^2} \right\} - U_\ell = 0$$

With this background, the competitive inshore fishery solution is now interpretable. The problem facing a representative boat owner is to choose the r, ℓ combination that will maximize profits subject to the continual maintenance of the constraint in equation (4.4). That is,

$$(4.8) \qquad \max_{r,\ell} L = r\,f(\ell, n(\ell,r)) + \lambda\{U \left[\frac{(1-r)f(\ell;n(\ell,r))}{n(\ell,r)}, 52-\ell\right] - U_W\}$$

The first order conditions for a maximum are:

$$(4.9) \qquad \frac{\partial L}{\partial r} = f + rf_n n_r + \lambda\, U_y \left\{ \frac{-f}{n} + \frac{(1-r)f_n n_r}{n} - \frac{(1-r)f\,n_r}{n^2} \right\} = 0$$

$$(4.10) \qquad \frac{\partial L}{\partial \ell} = r(f_\ell + f_n n_\ell) + \lambda \left[U_y \left\{ \frac{(1-r)(f_\ell + f_n n_\ell)}{n} - \frac{(1-r)f\,n_\ell}{n^2} \right\} - U_\ell \right] = 0$$

$$(4.11) \qquad \frac{\partial L}{\partial \lambda} = U \left[\frac{(1-r)\,f\,(\ell,n(\ell,r)}{n(\ell,r)}, 52-\ell \right] - U_W = 0$$

The first order conditions can be simplified by recognizing that (from equations (4.6) and (4.7)) the terms in the script brackets are zero. Hence equations (4.9) and (4.10) become

(4.12) $$f = -rf_n n_r$$

and (4.13) $$f_\ell = -f_n n_\ell$$

Equation (4.12) states that the boat owner will set his share of aggregate catch such that the marginal gain in profits that would arise from increasing his share are offset by the marginal loss in profits that would arise from the exit of fishermen from his boat. Equation (4.13) is easily recognizable as the condition that the value of the marginal product of labour on both margins must be equalized. That is, the boat owner will keep lengthening the fishing season until the value of the marginal gain due to a longer season equals the value of the marginal loss due to the exit of fishermen.

By substituting the first order profit maximizing conditions back into equations (4.6) and (4.7) we can determine the marginal conditions faced by the representative individual in competitive equilibrium. Substituting (4.12) into (4.6) we find

(4.14) $$f_n = \frac{(1-r)f}{n}$$

This is the condition that for any given length of the fishing season, entry will take place into the inshore fishery until the value of the marginal product produced by the last entrant falls into line with his share of the aggregate catch. Similarly, substituting equations (4.13) and (4.14) into equation (4.7) we find

(4.15) $$\frac{U_\ell}{U_y} = \frac{f_\ell}{n}$$

This condition states that, in equilibrium, the marginal rate of substitution between work and leisure for the representative worker will equal the value of his marginal product. In the absence of the externalities discussed in Chapters 2 and 3, this solution would be efficient. The marginal cost of extending the length of the fishing season is brought into line with the value of additional output.

It should be noted, however, that the "efficient" solution outlined in this section differs from the individual solution presented in Section A. In the absence of competition among potential fishermen, the individual would choose to work only until the point where his private share of the marginal product equalled his private cost; that is, only until

$$(4.16) \qquad \frac{U_\ell}{U_y} = \frac{(1-r)}{n} f_\ell$$

This is illustrated diagrammatically in Figure 4.3. In the presence of labour market competition, the representative fisherman is constrained to work ℓ^* weeks, $\ell_0 - \ell^*$ weeks longer than he would choose to work under unconstrained conditions. While the total income earned, Y_F, exceeds the unconstrained level, Y_0, the additional income does not compensate the individual for his lost leisure (i.e. $U_w < U_0$).

It should again be emphasized, however, that while fishermen as a group could be moved to a more preferred position simply by the removal of potential competition, society as a whole would lose by such a readjustment. The removal of potential competition by freezing the number of inshore fishermen at n* will decrease the length of the fishing season to ℓ_0 and raise the total utility of the representative fisherman from U_w to U_0. In the short run, the gain to fishermen will represent a redistribution from consumers and boat owners to fishermen. But, in addition to the distribution effect, there is an efficiency loss to society as a whole. As the aggregate fish catch falls, the marginal cost of producing the catch falls below its value to society. Alternatively, productivity in the inshore fishery rises above the productivity level in other sectors. In either case the divergence represents foregone earnings.

Finally, it should be noted that the solution represented by Figure 4.3 has the marginal product of labour in the competitive solution J equal to the marginal product of labour in the non fishing sector. This conclusion results from our assumption of a representative individual (in effect, identical individuals). In the presence of costless labour mobility and identical tastes, the income-leisure opportunities across all sectors will be equalized. In a more general analysis, where tastes are allowed to differ across individuals (not attempted here), different sectors will specialize in the income-leisure bundles offered to individuals. Hence an individual with a strong preference for leisure may choose to work in the inshore fishery because it provides him the best combination of leisure and income. This conclusion can be made independently of the other variables, such as the alternative income sources in the inshore community.

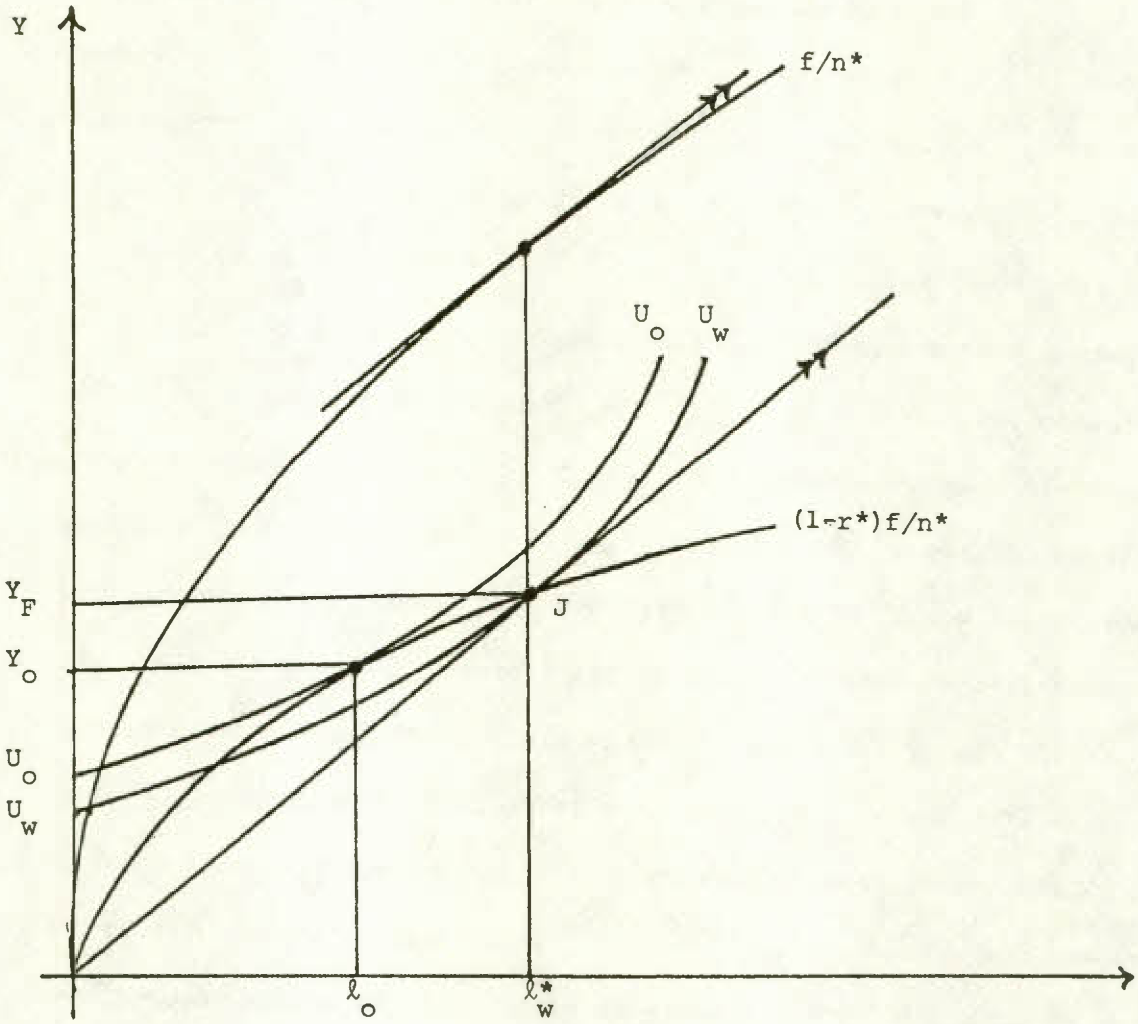


Figure 4.3

II. The Impact of Unemployment Insurance on Occupation Choice

Unemployment Insurance is a subsidy paid by the government to individuals who have worked but are presently not working. Like most subsidies, unemployment insurance can be expected to produce both income (equity) and substitution (efficiency) effects: individuals who receive its benefits become wealthier, and by lowering the cost of unemployment individuals are induced to buy more of it. Moreover, whether or not it was the government's intent to pursue these objectives, the programme has been remarkably successful in producing these results. Several billion dollars a year are currently redistributed from the employed to the unemployed, and evidence is steadily accumulating consistent with the hypothesis that increasing unemployment benefits does result in higher unemployment rates.[2] While recognizing the incentive effect of unemployment insurance, however, it must be observed that greater unemployment does not necessarily translate into greater inefficiency. If the private costs of job search exceed their social counterpart, unemployment insurance will increase efficiency at the same time it redistributes income.

While unemployment insurance alters the private trade-off between work and non work activities, it also discriminates between different types of work. Two general areas of discrimination across occupations deserve special attention because they form inherent problems in any unemployment insurance plan. First, unemployment insurance compensates the individual only for the pecuniary benefits lost upon becoming unemployed because all occupations differ in their mix of pecuniary and non-pecuniary benefit ratios. Second, any unemployment insurance programme must be written into law and the specific way it is written and interpreted will produce discrimination between occupations. One such example is illustrated by the fisheries. To qualify under the present Act for regular unemployment insurance benefits, an individual must experience an "interruption of earnings". Such an event is defined as a lay-off or separation from employment; requiring, in turn, the prior existence of an employer-employee (master-servant) relationship. Given the prevalence of coventuring and self-employment in the inshore fishery, an "interruption of earnings" cannot be established and fishermen cannot qualify for regular unemployment insurance benefits. Unless there were compensating changes made elsewhere in the Act, the interpretation of the Act would discriminate between different types of fishing.

The effect of unemployment insurance on the occupational choice of the inshore fisherman thus requires an analysis of the characteristics of both the job choices and the Act. As we have seen, the choices available to the inshore fisherman do differ by their pecuniary and non-pecuniary benefits. In the following section we will set out some of the special seasonal unemployment insurance benefits available to the inshore fishery.

(a) Unemployment Insurance Provisions for Fishermen

The absence of an employer-employee relationship in much of the fishing industry has led to the development of a special set of regulations with respect to fishing (Unemployment Insurance Regulations: Part VII). By and large, the purpose of these regulations is to convert the heterogeneous activity of fishing into an employer-employee, wage paying, weekly hiring contractual basis so that the Unemployment Insurance Act can be applied. Section 195 and 196 convert the share earnings from a catch to a weekly salary. In Sections 206 and 207, however, two different types of fishermen are defined, and it is in this latter Section that the regulations go beyond the simple act of conversion. Section 206 serves the purpose of converting the regular unemployment insurance qualifying conditions into its fishing equivalent -- the year round (essentially offshore) fisherman. Section 207, however, creates a special category of benefits for the fishing industry; it permits seasonal fishermen to qualify for and collect unemployment benefits.

The importance of Section 207 to the inshore fishery cannot be exaggerated. Without this special provision seasonal fishermen (like seasonal farm or forestry workers) would be unable to qualify for benefits: both because it is difficult in seasonal work to put together the minimum number of work weeks in the qualifying period; and, more importantly, because the seasonal worker is not "between" jobs in the sense that he is unwilling to accept alternative employment. Section 207 allows the inshore, seasonal fisherman to qualify for a maximum of 26 weeks of unemployment insurance annually. Because of the importance this provision has in influencing productivity and occupational choice, this category of benefits will be detailed at length. It should be noted, however, that the following discussion includes the amendments to the Unemployment Insurance Act of 1971 brought about by Bill C-14. The dates at which these sections were implemented are included in brackets at the end of the relevant sections.

An inshore (seasonal) fisherman will qualify for special seasonal unemployment benefits if:

1. He fails to qualify for regular or year-round benefits (Section 207, 1(a)).
2. He has the minimum number of weeks of insurable employment (10-20) depending on the regional unemployment rate and previous unemployment insurance benefit collections (Act, 17(2) to (4), July, 1979) in his qualifying period.
3. A week of insurable employment must now include a minimum of 20 hours of work or earnings of at least 30 per cent of the maximum insured earnings (Act, 4, (3), (h), January 1, 1979), and the qualifying period is the shorter of the number of weeks since the previous March 31 or since the start of the last benefit period (Section 207, 1(b)).
4. To qualify the fisherman need not prove an interruption of earnings (Section 207, 2).

Once the fisherman meets these requirements he is entitled to the following benefits:

1. Benefits at the same rate as any other claimant, i.e. sixty per cent of the average weekly insurable earnings during the qualifying period (Act 24, January 7, 1979).
2. The initial period of benefits runs for five-sixths of the number of insurable weeks of employment since March 31 or since the start of the last benefit period (Section 207, 7).
3. In addition, extended weeks of benefits can be collected based on regional unemployment rates (Section 207, 12, 13; Act 35).
4. The total number of weeks of benefits, however, is constrained by the condition that benefits cannot be claimed before the week in which November 1 falls or beyond the week including next May 15 (Section 207, 1, 4).
5. Moreover, there is a two week waiting period before benefits can be collected in the benefit period November 1 through May 15.

(b) An Example of Seasonal Fishing Unemployment Insurance Benefits

Suppose that a fisherman works as an inshore crew member in the cod fishery for the fifteen week summer period May 20 through September 1. Let us assume that his share of the catch translates into a steady stream of $200 in weekly earnings. What are the benefits that can be derived by this inshore fisherman?

1. Given that the Newfoundland unemployment rate exceeds 11½ per cent, the minimum number of weeks in the qualifying period is 10. Hence the fisherman qualifies for seasonal benefits. (Note: should the unemployment rate fall below 11½%, the qualifying period will vary depending on Unemployment Insurance benefits collected in the previous year. See Act 17, 2 through 8).

2. Premiums paid: 15 weeks x \$2.71 (1979 premium table)

   = \$40.65

3. Benefit rate: 60% x 200 = \$120.00 per week

4. Length of Benefits: (a) Initial Period = 5/6 x 15 = 13 weeks

   (b) Extended Period: 32 weeks (assuming regional unemployment rate exceeding 11½%).

   However, (c) benefits can be collected only between November 1 and May 15 = 28 weeks less the two week waiting period.

   Therefore, (d) Number of benefit weeks = 26 weeks.

5. Total Benefits = 120.00 x 26

   = \$3120.00

6. Net Benefits from Unemployment Insurance = \$3120 - 40.65 = \$3079.35

7. Ratio of Benefits to total earnings = 3079.35/3000 = 1.03.

(c) <u>An Example of Unemployment Insurance Benefits Within the Seasonal Processing Industry</u>

The existence of a large disperse seasonal fishing sector combined with the necessity of immediate processing has led to the development of a large seasonal processing industry in Newfoundland. Furthermore, with an employer-employee relationship established within this sector employees can qualify for regular unemployment insurance benefits. These benefits have the additional feature (as compared to seasonal fishing) that the length of unemployment insurance benefits are not restricted to the twenty-six week total. Let us then suppose that an individual in an inshore community works the same fifteen week interval at the same average of $200 per week. What are the benefits derived by this individual?

1. Premiums paid: 15 weeks x $2.71 (1979 premium table)

   = $40.65

2. Benefit rate: 60% x $200 = $120.00 per week.

3. Length of Benefits: (a) Initial period = 15 weeks

   (b) Extended Period = 32 weeks (Regional UR = 11½%)

   Total Number of weeks claimable = 47 weeks.

4. Total Benefits = 120.00 x (52 - 15 = 37)

   = $4,440

5. Net benefits from Unemployment Insurance = $4,440.00 - 40.65 = $4,399.35.

6. Ratio of Net Benefits to total earnings = $4,399.35/3,000 = 1.46.

It is immediately apparent from this example that individuals working within the seasonal processing industry typically will qualify for more weeks of benefits that they can use on a recurring annual basis. They are not subject to the constraint on the maximum number of benefit weeks faced by seasonal fishermen. For this reason individuals will have strong private incentives to work only the minimum number of qualifying weeks and to work these weeks only at the height of the fishing season (to maximize weekly benefit rates). It is then not surprising to find that unemployment insurance has a major influence on the ability of processing plants to attract and retain qualified workers.[3] These retention problems can be expected to be more severe for seasonal as opposed to year-round processing plants and, perhaps south coast, as opposed to more northern fishing areas, where the fishing season is longer. The recent extension of the minimum qualifying period through Bill C-14, should the unemployment rate fall below 11½%, could diminish somewhat the labour problems in seasonal processing. Finally, it should be recognized that seasonal fishing and seasonal processing are not independent activities as indicated in Chapter 3. For the present we will restrict our analysis to the fishing sector.

(d) The Analytical Effects of Seasonal Unemployment Insurance on Individual Work Incentives.

Seasonal unemployment insurance affects productivity and occupational choice within the fishery by changing what are perceived to be the private benefits of inshore fishing relative to its alternatives. In the absence of unemployment insurance the individual's private returns from fishing are represented only by his share of the product value generated in fishing. This return is illustrated by the FF opportunity locus in Figure 4.4. The introduction of seasonal benefits alters this locus by producing a divergence between the share value of the fish catch and the total money income arising from fishing. What is now perceived to be the private benefits of inshore fishing is represented by the FGHF' locus in Figure 4.4. It arises in the following way.

If an inshore fisherman chooses to fish fewer than ten weeks, unemployment benefits cannot be earned so that the private return from fishing corresponds only to his share of the catch value captured in the FF locus. As soon as ten weeks are worked, however, the fisherman qualifies for twenty-six weeks of unemployment insurance benefits. His total money

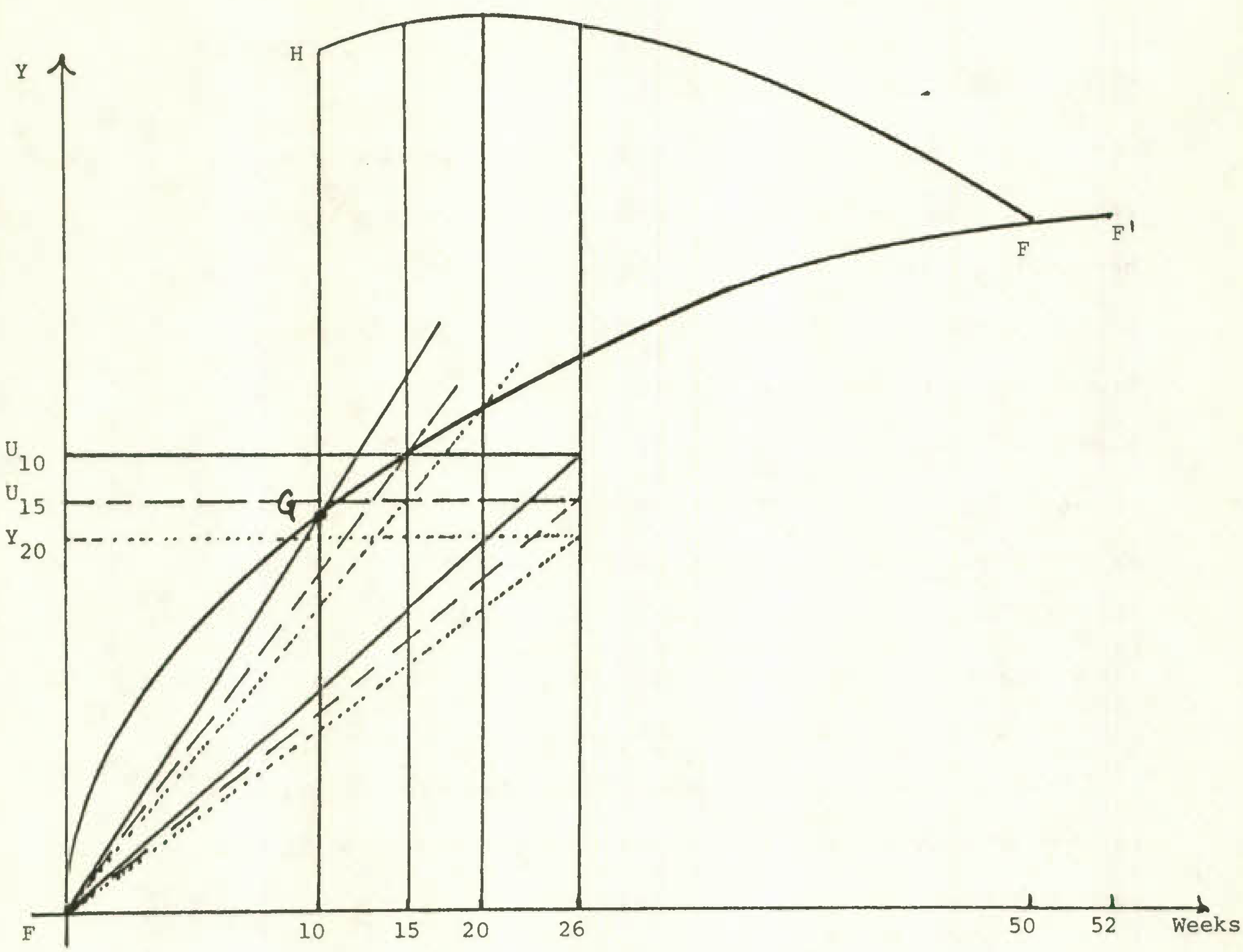


Figure 4.4

income from fishing now becomes his share earnings plus unemployment insurance benefits. A discontinuity thus arises in his perceived opportunity locus; total benefits increase (at ten weeks) by sixty per cent of average weekly earnings times twenty-six weeks.[4]

As the inshore fisherman extends his work beyond fourteen weeks into the ten to twenty-six week period, additional fishing will produce two effects on his total income. First, fishing income rises by his share of the additional value of the fish catch (represented by the marginal increment along the FF locus). On the other hand, the marginal value of additional work falls, thus reducing the fisherman's average earnings over the whole period and hence his total unemployment insurance benefits. The net result of these opposing effects may be positive or negative. What must be true, however, is that even if the total private benefit locus rises, the slope of the locus must be less than the corresponding point on the FF locus. By reducing the total benefits received from unemployment insurance, the marginal value of additional fishing diminishes. Finally, as the fisherman works beyond twenty-six weeks, one full week of unemployment benefits must be surrendered for each additional week worked. The FGHF' locus must then turn downward and approach the FF' locus at fifty weeks.[5]

By placing the revised inshore fishing income locus FGHF' back into Figure 4.1 and going through the conceptual experiment conducted in that context, we can construct a total family income locus for representative inshore fisherman. This is illustrated in Figure 4.5 below as PQRP'.

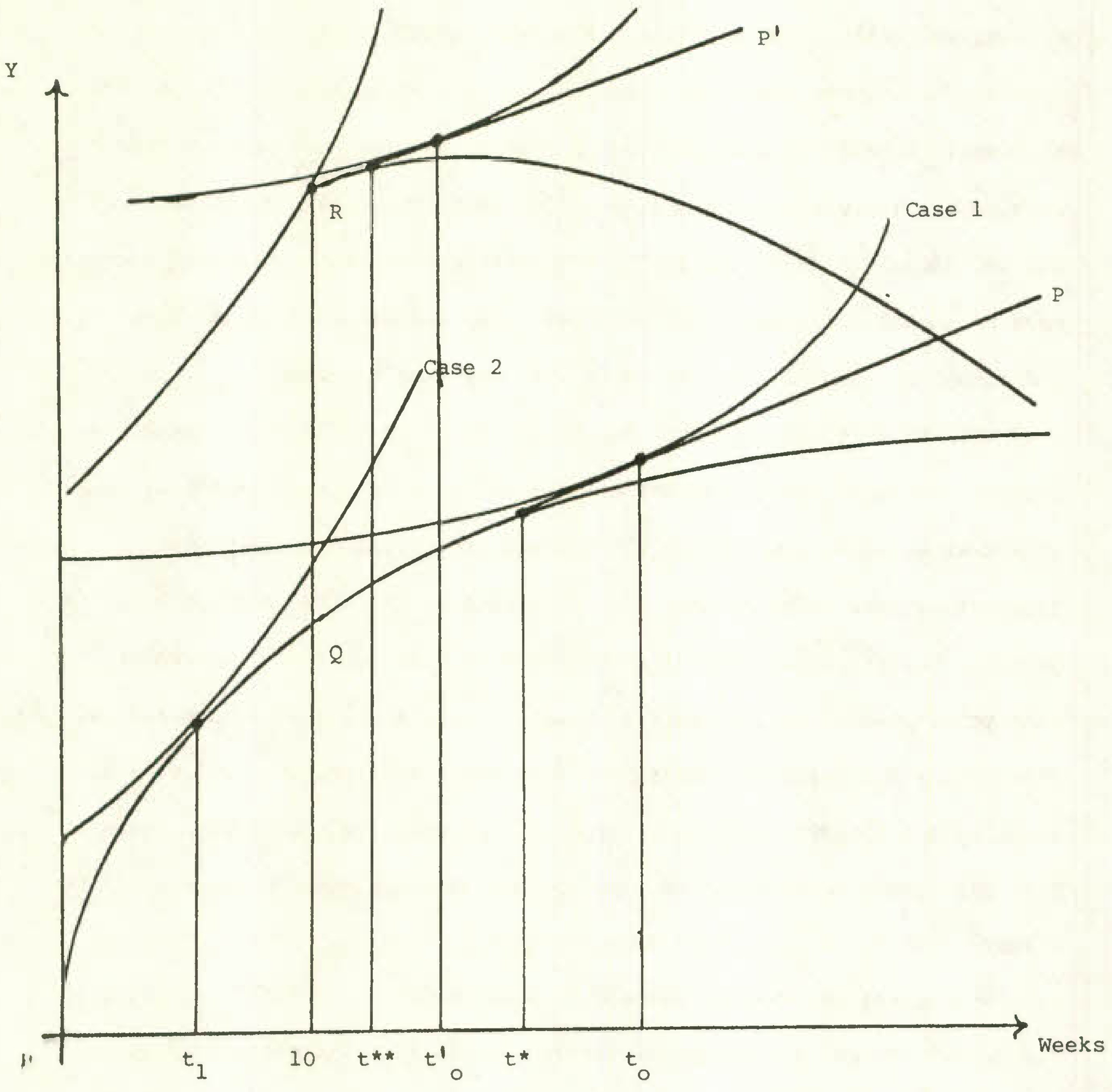


Figure 4.5

Given the constant (and unaffected) marginal product of non fishing work in the inshore sector, the maximum amount of time that the fisherman would devote to fishing declines. This conclusion comes from the fact that the net marginal benefits with unemployment insurance are everywhere (beyond 10 weeks) below those that would be earned in the absence of insurance. As a result, the point at which the inshore fisherman will switch into non fishing work (t** as opposed to t*) comes sooner under unemployment insurance. Hence if the fisherman devoted the same number of weeks to work, a greater proportion of his time would be spent in non fishing work activities.

The amount of time devoted to work, however, is unlikely to remain constant in the presence of the seasonal unemployment insurance plan. The fisherman now chooses that level of work activity that maximizes his utility subject to the revised opportunity locus PQRP'. Two different cases arise, however, where unemployment insurance has opposing effects on work activity.

In the first, and perhaps most general case, the existence of unemployment insurance will decrease both the total amount and fishing component of work activity. Let us consider, for example, an individual who in the absence of unemployment insurance would have work $t_0 > 10$ weeks in total: t* weeks in fishing, and the remainder, $t_0 - t^*$ weeks, in non fishing work. The emergence of unemployment benefits produces both an income and substitution effect; both, however, work in the same direction.

As long as leisure is a normal good, the income effect produced by the upward shift of the opportunity locus will induce the fisherman to choose less work in total. The indifference curves become steeper as income rises (work held constant at t_0). Moreover, the flattening of the opportunity locus in the range between 10 weeks and t_0 induces a substitution effect. The decreasing marginal benefit of work leads the fisherman to choose less work and more leisure. For both these reasons, then, the total amount of work undertaken by a representative fisherman will fall. The total amount of time devoted to fishing has also fallen as unemployment insurance has decreased the marginal return of working in the fishery.

In the second case, however, unemployment insurance increases the amount of individual fishing. Consider, for example, an individual whose tastes are such that in the absence of fishing he would have worked only $t_1 < 10$ weeks in fishing. The presence of unemployment benefits now allows the individual a significant rise in income, but only if he works the requiredminimum number of weeks. Given the sharp and significant discontinuity in the total income locus (the fact that the fisherman can approximately double his total money earnings from fishing by fishing the minimum time period), almost all of the fishermen in this class will choose to work more to qualify. Utility is maximized by choosing the corner solution at R. Only those individuals who find work particularly distasteful (so that their indifference curve rises virtually vertically before 10 weeks) will be unaffected by the presence of the unemployment insurance plan.

Finally, it is apparent that whatever the effect of unemployment insurance on the amount of individual inshore fishing, the total return from inshore fishing rises relative to other occupational possibilities. Inshore fishing becomes relatively attractive compared to offshore fishing and outside wage employment. For this reason unemployment insurance will attract entry into and/or discourage exit from the inshore fishing sector. Moreover, as can be seen by the analysis of Section I, Part B, the individual decision to work less is constrained by the presence of labour market competition. In the final analysis, however, the disincentive effects of unemployment insurance will not be reversed by the existence of labour mobility. The labour subsidy lowers the private marginal returns below their social counterpart so that sector equilibrium will be characterized by more fishermen (and boats) and a somewhat shorter fishing season.

(e) The Effect of Bill C-14 in Amending the Unemployment Insurance Act

The effects of unemployment insurance on individual productivity in the inshore fishery can best be seen when basic changes are made in the provisions of the Act. The revision made by Bill C-14 provides us with a case in point. In Bill C-14 two changes were made that could affect our analysis: first, the minimum number of insurable weeks of employment required to qualify for unemployment insurance were made variable depending on the number of weeks of unemployment insurance collected in the previous year (from 10 to 20 weeks); and, second, weekly unemployment benefits were lowered from 66 2/3% to 60% of average weekly insurable earnings. The first change, however, has been waived for regions where the unemployment rate exceeds 11½% so that it is only the second change that need concern us. The effect of lowering maximum weekly benefits is illustrated diagrammatically in Figure 4.6 below. The pre-1979 income locus is represented by the curve PQ'R'S'.

As is apparent from Figure 4.6, the pre-1979 unemployment insurance provisions generate a total level of benefits (fishing earnings plus employment insurance) that exceed those provided by the 1979 revision (for all working weeks beyond ten). Because unemployment benefit rates were previously a larger fraction of average insurable earnings, the marginal benefits of additional fishing were smaller than they are now.[6] This implies that the previous total income locus not only dominated the present alternative but that the slope in the areas of all fishing work was flatter than at present. Again because the income and substitution effects work in the same direction, the movement to smaller total and marginal unemployment benefits will generate a longer optimal number of weeks spent in fishing for the representative inshore fisherman. The only exception to this rule may be some fishermen who were previously at the R' corner who now find it optimal not to fish enough to qualify for unemployment insurance benefits.

The effect on individual productivity can be seen by recognizing that the production function underlying fishing is unaltered by the change in

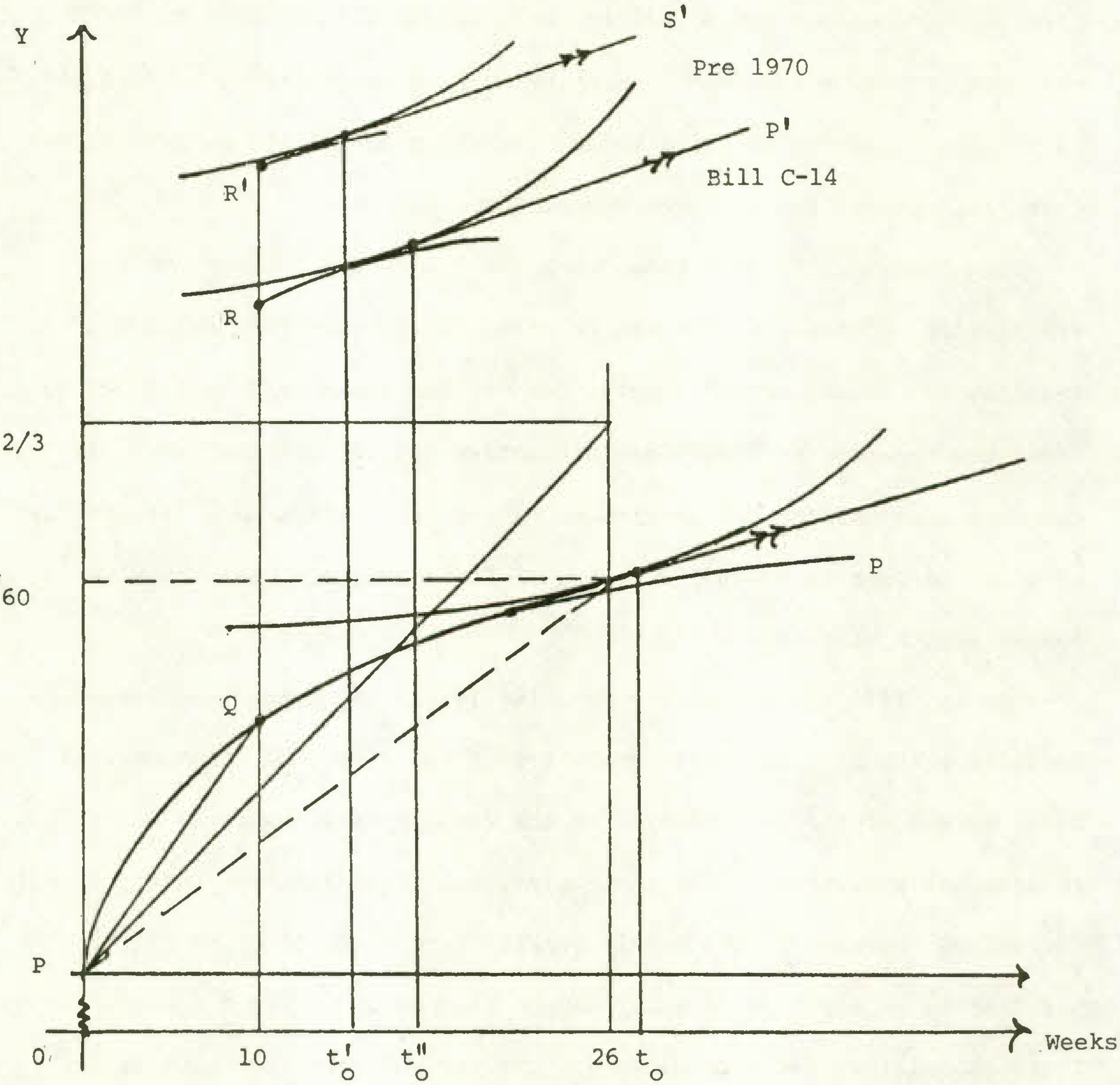


Figure 4.6

unemployment insurance benefits. Hence the rise in the number of weeks fished by the representative fisherman corresponds to a rise in the total fishing output and a fall in the value of the marginal product of the representative fisherman. Keeping this in perspective, however, total output per fisherman is still below, and the value of his marginal product still above, the no unemployment insurance case.

The lowering of total benefits in Bill C-14 also lowers the attractiveness of seasonal fishing relative to its competing employment alternatives. Hence, on the margin, inshore fishermen will be induced to leave the industry and seek more attractive outside alternatives. As the sector adjusts to the provisions of the Act, the inshore fishery will be characterized by a smaller number of fishermen, each of whom works a longer length of time.

In his 1977 article in the Canadian Journal of Economics, Samuel Rae Jr. provides a set of quantiative estimates of the effect on the number of weeks worked of the 1971 changes in the Unemployment Insurance Act relating to seasonal activities.[7] In particular, Rae finds that the thirty-three percentage increase in the weekly benefit rate (from 50 to 66 2/3%) resulted in an eight percentage fall in the number of weeks worked. Using these calculations as a rough guide, the ten per cent reduction in the weekly benefit rate should produce a two to three percentage rise in the number of weeks worked in the inshore fishery.

One last characteristic of unemployment insurance deserves mention. As can be seen from Figure 4.6, the existence of unemployment insurance will decrease the variance of total money incomes across fishermen in the inshore fishery. The higher are the weekly benefits and the shorter is the qualifying period, the tighter will be the grouping of individual tangencies about the peak in the discontinuity of the total income curve. In this context Bill C-14, by reducing the size of the income and substitution effects, can be expected to generate a rise in the variance of money incomes within the inshore sector. Should the variable entrance requirements also become effective in this region, the variance in money incomes will rise further.

(f) The Relative Effect of Unemployment Insurance in Areas of Differing Productivity

Because of differing climatic conditions, fish migratory patterns and annual stochastic influences on the fish stock, productivity differs across regions and between years in Newfoundland. For this reason it is of interest to see if seasonal benefits discriminate between areas of differing productivity. As we have first set up the problem in Figure 4.7, the analysis distinguishes between two fishing areas. Both areas are assumed to face the same production function for the prime period of summer fishing. However, the length of the peak summer period is assumed to differ between regions so that the areas with the shorter season experiences a faster fall off in its marginal productivity beyond t* weeks. To simplify our analysis we assume that this takes place before the ten week qualifying period.

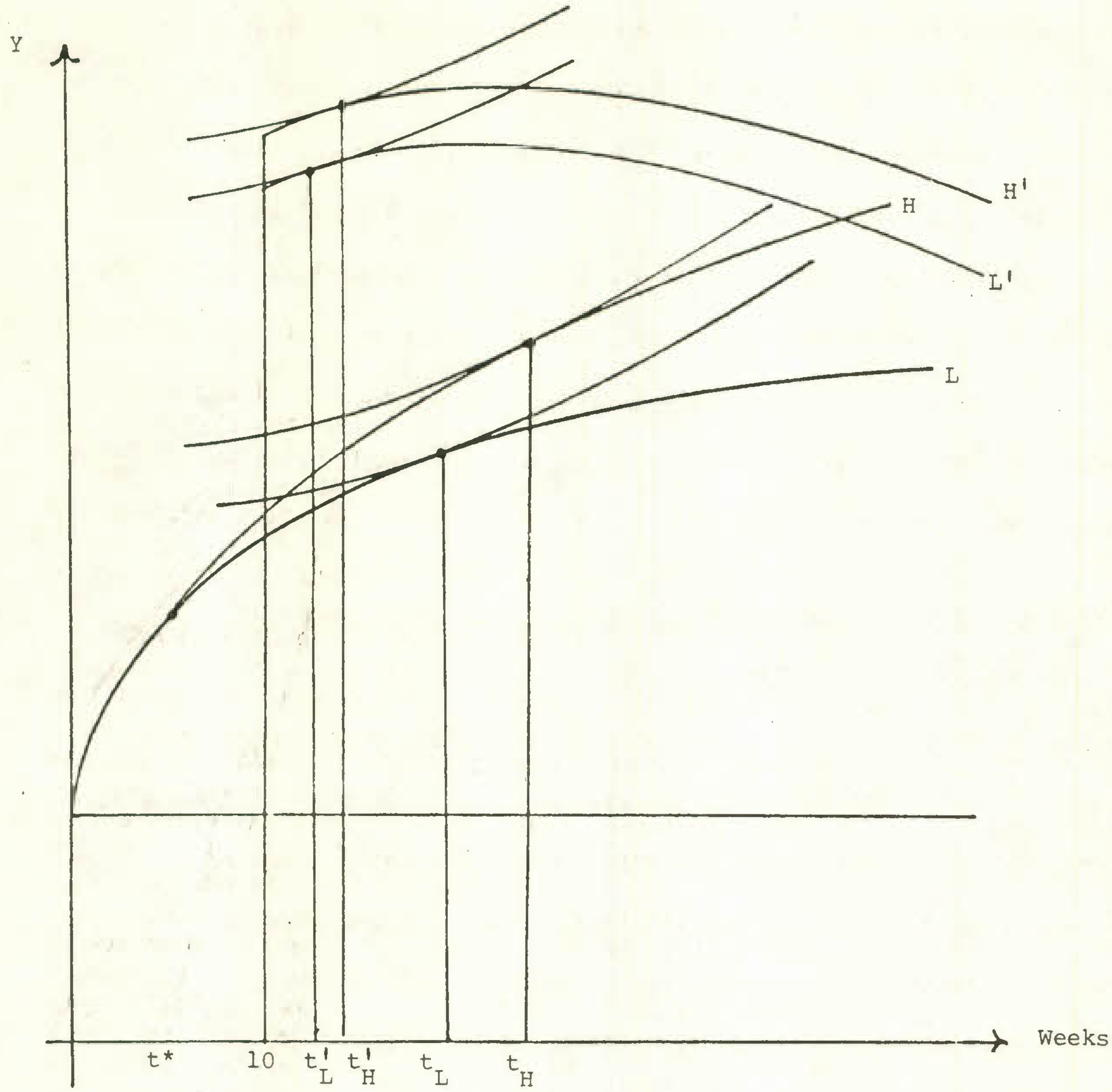


Figure 4.7

In both areas the emergence of unemployment insurance benefits will decrease the amount of time spent fishing, however, the disincentive effects differ in the two regions. Given that the shorter peak summer period causes a divergence in fishing productivity before ten weeks, the area with higher fishing productivity (H) will have a higher average product and hence receive higher unemployment benefits in total. The larger income effect leads the representative fisherman to opt for a greater amount of leisure. The effect on the marginal incentive to work, however, is in the opposite direction. Because the marginal product falls faster in the low productivity area (L), the larger will be the fall in the average product (relative to the high productivity area) and the greater will be the marginal disincentive to work. This implies that the slope of the adjusted total benefit curve in the low product area (L') will decrease less than its high productivity counterpart (H'). Relative to the high productivity region, then, the representative fisherman will choose to work more and consume less leisure. If, as is likely, the substitution effect dominates the differential income effect, the effect of unemployment insurance is to move closer together the number of weeks worked in the two sectors. This will unambiguously be the case when the production functions diverge beyond the ten week minimum qualifying period. In this case the size of the income effect at ten weeks will be identical for the two regions.

Thus far our analysis has assumed that the size of the fish stock facing the representative fisherman is constant through time and across regions. It is clear from any historical perspective on Newfoundland, however, that the fish stock varies across regions and through time. Some of these variations are, indeed, induced by changes in the endogenous variables in our model (e.g. number of fishermen, number of boats, amount of gear etc.), on the other hand, other variations take place because of exogenous changes that are at present only imperfectly understood. Moreover, changes in the fish stock shift the production function faced by the representative fisherman. In this last section of our individual analysis we investigate the effect of unemployment insurance benefits on the optimal work-leisure choice for changes in the fish stock.

The consequences of exogenous changes in the fish stock are represented in Figure 4.8. Assuming that the representative fisherman faces a total product schedule with constant returns to the fish stock (such as $Y = L^{\frac{1}{2}}N$), increases in the fish stock will shift upwards the total product schedule such that the marginal product of labour rises but falls faster as more labour time is used. As before, unemployment insurance reduces the time spent fishing, but it has a differential effect that depends on the size of the fish stock.

Given our assumption of the form of the production function facing the representative fisherman, the disincentive effects created by unemployment insurance increase with the size of the fish stock.[8] The income and substitution effects work in the same direction. Hence a rise in the fish stock will induce a decrease in individual work effort at the same time it increases the attractiveness of inshore fishing relative to its

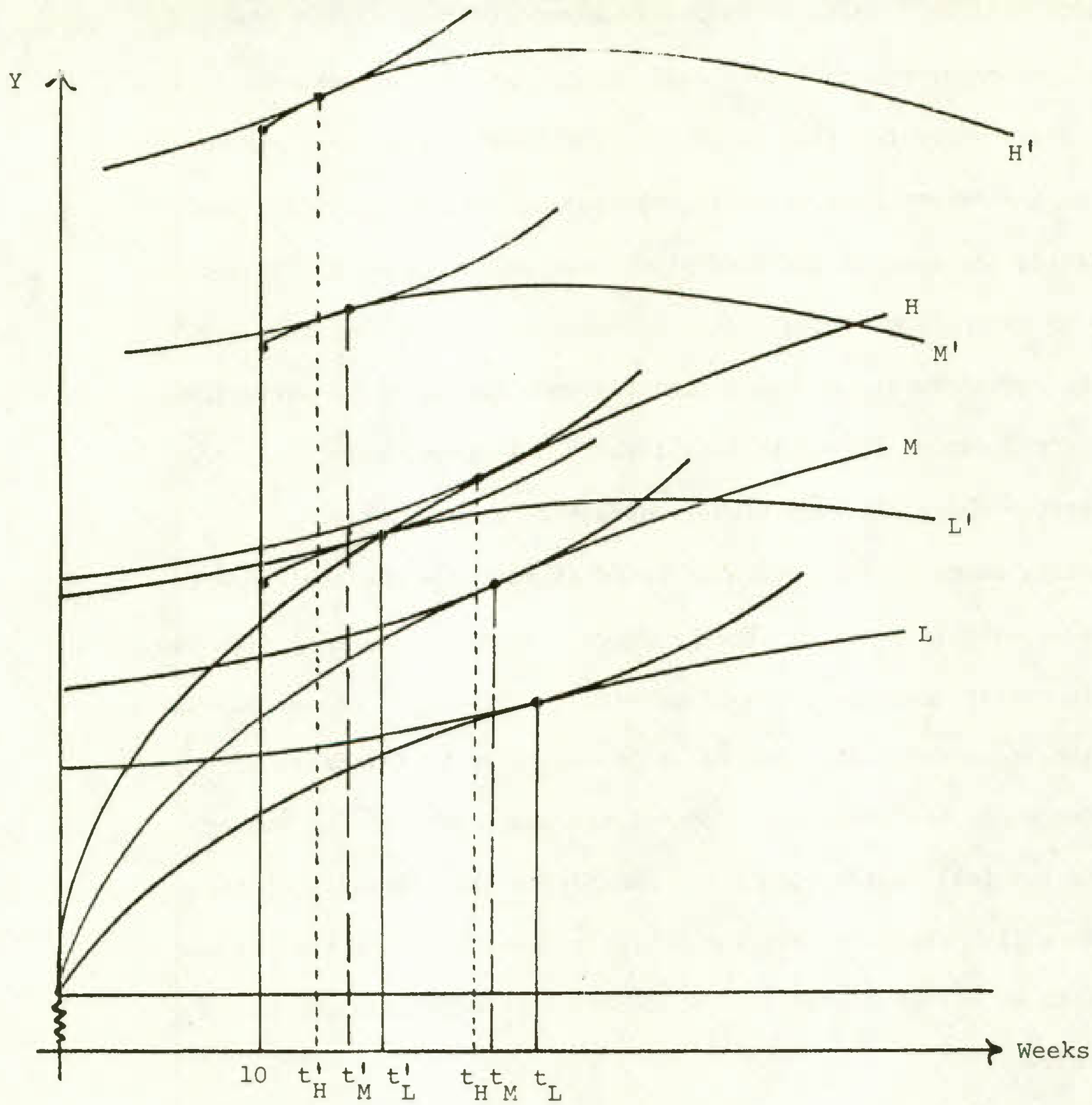


Figure 4.8

alternatives. This conclusion has two important policy implications. First, with similar fishing technologies across regions within Newfoundland, unemployment insurance will produce greater distorting effects in those areas where the fish stock is traditionally most productive. Second, to the extent that present conservation methods are effective in increasing the size of the fish stock, the magnitude of the distortion produced by unemployment insurance will increase rather than decrease. In effect, unemployment insurance directly counters other conservation and efficiency programmes in the inshore fishery. It results in an inshore fishing sector where too many fishermen each work too little.

Finally, unemployment insurance tends to increase the amplitude of exogenous cycles in the fish stock. Given that entry and exit from the fishery is costly and thus takes place with a lag, the increased incentive to work longer as the fish stock falls is magnified by the entry of too many fishermen at the past peak. More fishermen, each working longer, exacerbate the fall in the fish stock and deepen the magnitude of the cycle before fish stocks recover. Similarly, exit from the fishery and the incentive to work less as the fish stock recovers magnifies the upswing of the cycle.

(g) An Estimate of the Effect of Unemployment Insurance on the Size of the Inshore Fishery

From the perspective of the individual experiments described in Sections (d) through (f), unemployment insurance affects productivity and output in the inshore fishery by altering (decreasing) the optimal length of the fishing season. The higher incomes produced by unemployment insurance, however, raise the attractiveness of inshore fishing relative to its alternatives so that this conclusion must be modified. Entry, by shifting downwards the total product curve faced by individual fishermen, reverses part of the income and substitution effect of unemployment insurance benefits, once again raising the length of time spent fishing. The tendency to shorten the length of the fishing season is thus largely offset by the existence of entry. Overall, the final industry equilibrium is more accurately characterized by the larger number of inshore fishermen than by the shorter length of the fishing season.

Our ability to move beyond the qualitative predictions of theory and place quantitative estimates on the parameters affecting occupational choice is due to the pioneering work of Professor Parzival Copes. In his work for the Canada Council on Rural Development, The Resettlement of Fishing Communities in Newfoundland (1972), Professor Copes undertook the hazardous task of collecting, estimating and grouping the diffuse data on the fisheries by the broad categories - inshore and offshore. That problems exist with this data set cannot be doubted; for example, it is so difficult to tell who is actually working in the inshore fishery that the Statistics Canada publication Fishery Statistics Newfoundland stopped presenting its estimate of the number of inshore fishermen in 1973. Similar problems exist in attributing unemployment benefits and costs to the fishery, particularly after 1971 when fishermen could collect either regular or seasonal benefits. Nevertheless, Professor Copes' data base represents the most consistent time series available for the large number of variables used in our tests. Our own attempts to extend this series beyond the original time period has only increased our respect for time, care and experience required to produce it. The data used in the following regressions is also presented in the attached Appendix for more convenient reference. It covers the years 1956 through 1968.

The theory outlined in the above pages hypothesizes that occupational choice and hence the number of inshore fishermen will depend upon the total income available to an inshore fisherman and his alternative income possibilities in offshore fishing and outside, non fishing employment. To test this hypothesis a regression was run of the following form:

$$NIN = b_0 + b_1\ YIN + b_2\ YOFF + b_3\ EXPYND + \varepsilon$$

where NIN = number of inshore fishermen

YIN = (the total value of the inshore fish catch minus expenses plus net transfers to inshore fishermen)/NIN

YOFF = offshore earnings per fisherman

EXPYND = expected outside, non fishing income

= per capita income in Newfoundland times one minus the unemployment rate.

It should be noticed that an important component of total inshore income is missing from our regression. This is the possibility of non fishing, non market income in the inshore sector. Moreover, this component is frequently thought to represent a substantial portion (perhaps 25%) of total inshore income. For time series analysis, however, this omission will not be critical as long as the size of this component of total income has remained constant through time. This assumption is thus implicit in the regression equation.

When the regression was run for the 1956 to 1968 time period, the following result was found:

$$NIN = 8{,}116.0 + 10.18\ YIN + 3.81\ YOFF - 11.84\ EXPYND$$
$$\quad (2.18) \quad (1.65) \quad (3.96) \quad (2.59)$$

$$R^2 = .694 \qquad F = 6.8 \qquad DW = 1.62$$

where the t-statistics are included in brackets below the estimated coefficients. The general hypothesis advanced to explain occupational choice is, then, consistent with the data. Approximately seventy per cent of the variation in the number of inshore fishermen is explained by the regression and the overall hypothesis passes the F test at the 5% significance level. The Durbin-Watson statistic gives little evidence of the presence of serial correlation.

In terms of the individual predictions of the theory, both the YIN and the EXPYND coefficients have the expected signs and are significantly different from zero at the 10% significance level. The magnitude of the estimated coefficients suggests that a one dollar rise in inshore fishing incomes and a one dollar per capita fall in outside earnings will increase the number of inshore fishermen by ten and twelve respectively. The regression suggests that the inshore fisherman is more responsive to market incentives than might have been expected. Converting these coefficients into elasticities evaluated at their means, the elasticity of the number of inshore fishermen with respect to internal earnings is .445 and with respect to outside, non fishing income is -.565.

To assess the relevance of this finding in relation to the overall labour market in Newfoundland, we reran the regression in ratio form. The following regression equation was estimated

$$\frac{NIN}{NFLDLF} = \underset{(10.10)}{.118} + \underset{(4.66)}{.112} \frac{YIN}{EXPYND} - \underset{(4.06)}{.302} \frac{YIN}{YOFF}$$

$R^2 = .685$ DW = 1.79 SE = .007

This regression strengthens our previous findings on occupational choice. A rise in average inshore fishing incomes relative to expected incomes in the overall economy raises not only the number of inshore fisherman but also the ratio of inshore fishermen to the Newfoundland labour force (NFLDLF). The positive coefficient is significantly different from zero at well over the 1% significance level.

On the other hand, the coefficients of the offshore income variable in the first equation and the relative inshore to offshore variable in the second contradict the hypothesis that inshore and offshore fishing are occupational substitutes. Rather than accept the implication that inshore and offshore fishing are occupational complements, however, an alternative interpretation of these results can be suggested. A significant determinant of both inshore and offshore fishing incomes is the aggregate size of the fish stock, on which we have no independent observations. Moreover, in years when the fish stock is large, incomes in both sectors will be large; similarly, when the fish stock is low, incomes will be low. This suggests that the positive correlation between these two incomes may be explained by the omission of this third variable and that the role played by YOFF in the regressions is to standardize for variations in the fish stock. Under either of these interpretations, YOFF is an important explanatory variable that should be present in the regression. When it is removed, the predictive powers of the regressions, and their individual sub-components, fall substantially.

The effect of unemployment insurance on employment in the inshore fishery can be found by separating the net unemployment insurance benefits (UICNETIN) from the other components of inshore income. The separate effects of net value added per inshore fisherman (NETVALIN) and UICNETIN per fisherman can then be estimated. When this was done, the estimated regression equation found was:

$$\underset{}{NIN} = \underset{(4.01)}{11{,}235.3} + \underset{(.380)}{1.99}\ NETVALIN + \underset{(2.66)}{18.58}\ UICNETIN + \underset{(3.69)}{2.91}\ YOFF - \underset{(2.12)}{7.45}\ EXPYND$$

$$R^2 = .810 \qquad F = 8.5 \qquad DW = 1.65$$

Once again the overall regression findings are consistent with the proposed hypothesis on occupational choice and hence employment in the inshore fishery. The regression equation accounts for eighty per cent of the variation in the number of inshore fishermen and the hypothesis represented by the regression equation passes the F test at the 5%

significance level. The Durbin-Watson statistic still gives little evidence of serial correlation.[9]

Similarly, the individual coefficients are largely consistent with the predictions of the theory. A rise in the individual components of inshore earnings per fisherman and a fall in the expected earnings outside the fishing sector will lead to entry into the inshore sector. The estimated elasticity of number of inshore fishermen with respect to expected per capita outside earnings is -.357. Once again, however, the exception to the general finding of consistency is the effect on employment of offshore fishing income. A significantly positive rise in the number of inshore fishermen is associated with a rise in offshore earnings per fisherman through time.

The most interesting result of the regression is the finding that the two subcomponents of inshore income produce significantly different effects on the number of inshore fishermen and hence exit and entry into the inshore fishery. The coefficient of the NETVALIN variable has the expected sign but is insignificantly different from zero. On the other hand, the UICNETIN coefficient is both large (18.58) and significantly different from zero at the 1% significance level. That the coefficients should differ in this direction is consistent with the theoretical analysis. A rise in UICNETIN per fisherman leads the individual fisherman to opt for both more income and leisure. Entry will reverse part of the effect on leisure but will not eliminate it entirely. A rise in fishing productivity, on the other hand, tilts the total product curve facing the individual in the opposite direction, inducing the choice of additional income at the cost of foregone leisure. From the perspective of a potential entrant, then, a rise in income due to these two changes will not be equivalent. A rise in UICNETIN will be preferred to an equivalent change in NETVALIN.[10]

Using the size of the estimated coefficient as the best estimate of the effect on employment of a change in seasonal unemployment benefits, the regression attributes a significant role to unemployment insurance in increasing the size of the inshore fishery from 14,485 fishermen in 1955 to 18,310 in 1968. A one dollar rise in net benefits increases the number of inshore fishermen by eighteen. Alternatively, the employment elasticity of net unemployment insurance benefits, evaluated at their means, is .168. This implies that in the absence of the seasonal unemployment insurance programme, the number of inshore fishermen would have been considerably smaller than the mean number of 18,593. More specifically, over 3,100 additional fishermen were attracted into the inshore fishing sector by the benefits available under this programme.[11]

By attracting entry and swelling the size of the inshore sector, unemployment insurance also has an important effect on the productivity of the individual fisherman. A larger number of fishermen (using the same technology to catch a common fish stock) will decrease the size and value of the individual's share of the catch. To derive a quantitative estimate of the effect of unemployment insurance on productivity the following regression equation was estimated for the same time interval:

$$\text{NETVALIN} = \underset{(5.36)}{466.65} - \underset{(1.98)}{.733}\ \text{UICNETIN} - \underset{(1.16)}{0.54}\ \text{YOFF} + \underset{(2.76)}{.453}\ \text{EXPYND}$$

$R^2 = .610$ $F = 4.7$ $DW = 2.54$

YOFF and EXPYND are included in the regression as other determinants of entry and hence productivity.

While the overall regression explains only sixty percent of the variation in NETVALIN, UICNETIN does emerge as having a significantly negative effect on productivity. The coefficient suggests that a rise by one dollar in net unemployment benefits will decrease NETVALIN by seventy-three cents. Using this coefficient as our best estimate, the regression implies that net value added per fisherman in the inshore sector would be $123.31 higher in the absence of the unemployment insurance programme. Since the mean value of NETVALIN was $565.02 in this time interval, an elimination of net benefits would have raised individual productivity by 21.8%. To do so, however, would have reduced total inshore income per fisherman by more than $45.00.

Although the seasonal unemployment insurance programme is designed as a subsidy exclusive to labour, the full incidence of the subsidy will accrue to fisherman only if the subsidy does not attract additional fishermen into that sector. As we have seen, however, this empirical requirement is contradicted by the evidence. It follows from our model (see Chapter 3, Section e) that a rise in unemployment insurance benefits will increase the number of inshore fishermen relative to boat owners and hence weaken the relative bargaining position of fishermen. Competition among additional fishermen for scarce fishing positions will then lead to a reformulation of the coventuring contract, increasing the share of the catch going to boat owners. In this way the subsidy, while collected by fishermen, is shared among all inshore fishing participants.

The proposition that net unemployment insurance benefits are partially captured by boat owners can be tested by correlating the boat owners' aggregate share of the catch (SHAREIN) with UICNETIN.[12] A positive coefficient is predicted. When this was done over the 1956 to 1968 time interval, the correlation coefficient found was .689. In this time period, however, both SHAREIN and UICNETIN were strongly correlated with time, and although this finding is not inconsistent with the theory, it raises the possibility that the correlation may be spurious. To remove this influence we regressed SHAREIN against both UICNETIN and YEAR. The regression equation found was

$$\underset{}{\text{SHAREIN}} = \underset{(2.01)}{-8.60} + \underset{(1.82)}{.00027}\ \text{UICNETIN} + \underset{(2.06)}{.0045}\ \text{YEAR}$$

$$R^2 = .632 \qquad DW = 2.40 \qquad SE = 0.24$$

Even after removing the influence of time, UICNETIN retains its importance as an explanatory variable. The positive coefficient on UICNETIN is significantly different from zero at the five percent significance level. The evidence is thus consistent with the hypothesis that net unemployment insurance benefits are partially captured by boat owners as a group.

In the short run the number of boats and boat owners are fixed. The effect of the seasonal unemployment insurance programme is to attract additional labour, expand sector output and generate rents to present boat owners. Over the longer term, the existence of these rents will induce entry. Our analysis therefore implies not only an alteration of the sharing provisions but also an increase in the size and capital intensity of the inshore fishing fleet. In this way the initial subsidy to labour spreads its effect over other factors of production. By raising the perceived private productivity of complementary factors of production a further increase in fishing effort is produced. Finally, the increased fishing effort produced by the seasonal unemployment insurance programme results in a more rapid rate of resource exploitation and ultimate decline in future sustainable yields. This negative feedback on catch size must be kept in mind when interpreting the size of the UICNETIN regression coefficients.

Our ability to directly test the prediction of a larger fleet size is hampered somewhat by the lack of a unique boat type in the inshore fishery. A variety of boat types are used and considerable variation has taken place both within and across broad categories through time. To partially account for these problems, we formulated three alternative tests of this hypothesis. These results are presented in the following table. In the first two equations the total number of inshore fishing boats (BTOTIN) and the number of gasoline and diesel driven boats (GANDDIN) are regressed against NETVALIN and UICNETIN. Both these regressions give results that are broadly consistent with our findings for the number of inshore fishermen. The coefficients of NETVALIN and UICNETIN both have the expected positive sign, although the NETVALIN coefficients are insignificantly different from zero. As with the fishermen regression, the UICNETIN coefficients are significantly positive and significantly larger than the NETVALIN coefficients. The first regression equation suggests that net unemployment insurance benefits can explain the presence of approximately one half of the number of inshore fishing boats.

Regression Results for the Number, Capital Value,
and Capital Intensity of the Inshore Fishing Fleet

Dependent Variable	Constant	NETVALIN	UICNETIN	R^2	DW	SE
1. BTOTIN	10,205.8 (2.76)	2.59 (.487)	25.36* (2.86)	.451	.481	1694
2. GANDDIN	4,003.9 (1.66)	4.94 (1.43)	17.88* (3.09)	.501	.684	1104
3. BSTKIN ($ 1000's)	-7,761.1 (1.65)	19.37* (2.86)	31.66* (2.80)	.568	1.31	2159
4. KINTENSITY†	-326.1 (1.17)	1.13* (2.81)	1.30* (1.95)	.490	1.27	128

t statistics in brackets

* significant at five percent.

† the boat stock is valued in dollars in this regression as opposed to thousands of dollars in equation (3).

Our ability to interpret the significance of the regression coefficients, as we have done, is weakened by the pressure of serial correlation. The Durbin-Watson statistic in both equations is very low. This implies that although the coefficients are unbiased estimates, the variance of the estimate and thus the t statistics will be biased. Moreover, on strictly economic grounds, a focus on the total number of boats may be misleading if there are significant variations in the size composition of the total. Because of these problems we regressed, in equation (3), the total value of capital invested in inshore fishing craft (BSTKIN) against the same variables. In this equation both NETVALIN and UICNETIN have significant coefficients and the degree of bias in the estimated t statistics is significantly reduced. These results are then consistent with our earlier findings and increase our confidence in the existence of a significant link between net unemployment insurance benefits and the size of the inshore fishing fleet.

Finally, in equation (4), we tested the hypothesis that net unemployment benefits raise the capital intensity of the inshore fishing fleet. It should be mentioned, however, that the predicted rise due to complementarity among factors of production is strengthened by another characteristic of the seasonal unemployment insurance programme. Because the magnitude of unemployment benefits declines with the average product of fishing effort, there is an incentive to maximize the fish catch in as short a time period as possible (subject to the ten week minimum). To the extent that more capital intensive boats can accomplish this objective, both fishermen and boat owners have an incentive to substitute capital for labour time. Equation (4) presents the results of regressing the average capital value of the inshore fishing fleet (KINTENSITY = BSTKIN/BTOTIN) against NETVALIN and UICNETIN. Once again the coefficients of NETVALIN and UICNETIN enter with the expected sign and are significantly different from zero. The evidence is thus consistent with the hypothesis that seasonal unemployment insurance benefits have expanded both the size and capital intensity of the inshore fishing fleet.

In concluding this section we should again emphasize that these estimates must be used with considerable caution. Limitations in the availability of data mean that a number of important variables are missing from the regressions. Measurement errors are likely to exist in the data and the use of broad industry aggregates will ignore potentially significant differences among regions and changes in their composition through time. Nevertheless, the findings of this section cannot be ignored. The evidence is consistent with the theory presented in our model and reinforces qualitative interdependence of government assistance, productivity and employment suggested in that analysis. In the absence of controls, the common property and open access characteristics of the Newfoundland fishery mean that any income subsidy will be dissipated through industry expansion and declines in future yields. The evidence of this section suggests that in looking for reasons for the low level of productivity within the inshore fishery, one need not look much further than the existence of the seasonal unemployment insurance programme.

(h) The Effects of Income Taxation and a Guaranteed Income Programme

In the analysis thus far we have ignored the effect of income taxes on the work-leisure choice within the inshore fishery and its resulting effect on industry employment and productivity. In general, income taxes penalize market as opposed to non market activities and work (in the market) as opposed to leisure. It alters the private, but not social, trade-off between these alternatives. As a result, the proportional or progressive taxation of income will lead the individual fisherman to choose more leisure and more non market employment than he would otherwise. Fishermen will fish less, and to the extent the inshore fishery offers greater non market and leisure opportunities, entry will be attracted with its negative effect on individual productivity. In this, the introduction of income taxation compliments the seasonal unemployment insurance programme in its effects. Both work to decrease the amount of individual fishing activity while increasing the attractiveness of inshore fishing relative to its alternatives.

The interrelationship between the two is complicated slightly by the changing position of net unemployment insurance benefits with respect to taxation. Prior to 1971 net unemployment benefits were not taxed. A fisherman considering the extension of his fishing season by one week in these circumstances could not weigh one-for-one the loss of unemployment benefits (due to a falling average product of work) against the rise in fishing income. In effect, the non taxation of benefits represented a subsidy to the subsidy on leisure. The removal of this provision in the

1971 Act, then, eliminated the double subsidization of non work and hence reduced the size of the subsidy present in the seasonal unemployment insurance programme. The inshore fishery became marginally less attractive as a source of employment and the disincentive to work within the fishery was marginally lowered.

It is apparent from our characterization of the inshore fishery that the purpose of seasonal unemployment insurance must be to supplement fishing incomes rather than improve the allocation of labour within the sector. The function of unemployment insurance in lowering the costs of job search and facilitating the movement of labour from less to more efficient employment is clearly not relevant to a sector where benefits are collected only in a time period when seasonal employment is unavailable and outside job search is not required. The effects on efficiency and productivity are thus the costs of supplementing income in this way. However, if the purpose of the programme is to supplement inshore incomes, the question arises whether there are other ways of achieving this objective without producing the disincentive effects inherent in unemployment insurance. One suggested alternative is a guaranteed income programme.

The replacement of present income supplementing programmes within the inshore sector by a guaranteed income programme of similar size is unlikely to improve the situation in the fishery. A guaranteed income programme supplements incomes most highly at the lower levels of the income scale and reduces the size of the supplement as fishing incomes rise above zero. The disincentive effects on work effort are, then, not removed by adopting the new programme. Moreover, our theoretical analysis makes it apparent that the significant effect on sector productivity arises not so much from the effect on individual work incentives as from the entry induced by higher incomes. A guaranteed income programme that maintains existing levels of income will do nothing to reduce the magnitude of overemployment (and low productivity) in the fishery. In fact, this problem is likely to become worse. The removal of the present minimum work requirement to qualify for unemployment insurance raises the theory problem of who is a seasonal fisherman and who can qualify for the benefits. With little or no work required for the guaranteed minimum, the number of seasonal fishermen is likely to grow substantially.

On the other hand, if a guaranteed income programme is implemented across the whole province, the position of the inshore fishery will be improved. Although the programme will still discriminate in favour of the inshore fishery (with its greater opportunities for non market work and leisure) the magnitude of the distortion will be reduced significantly. The removal of a specific sector subsidy and its replacement by a general subsidy improves overall labour productivity by reallocating labour between sectors. From our perspective, fishing productivity in the inshore sector will rise as labour is reallocated to more socially productive alternatives.

NOTES

1. In order to facilitate the explication of the industry solution we will also assume that the inshore fisherman has no non fishing sources of income. While this greatly decreases the mathematical complexities of this section, it does not alter any of the fundamental conclusions. For example, equation (15) in the text will become

$$\frac{U_\ell}{U_u} = \frac{f_\ell}{n} = m \qquad (15)'$$

where m is the value of the marginal product in non fishing inshore employment.

2. J.E. Cloutier, "The Distribution of Benefits and Costs of Social Security in Canada 1971-1975", Discussion Paper No. 108, Economic Council of Canada (Feb. 1978), pp. 3-10, 36-48; and H.G. Grubel and M.A. Walker, Ed., Unemployment Insurance, The Fraser Institute, Vancouver, 1978.

3. See Derek Briffett, Interim Report No. 2, Fresh and Frozen Fish Processing Industry, pp. 20-25.

4. In this analysis we assume that a fisherman's average weekly earnings fall below the maximum insurable level so that benefits remain at 60% of average earnings. If inshore earnings exceed the maximum insurable, the maximum allowable level of benefits becomes an effective constraint and some of the slope properties of the FGHF' locus will be altered. In particular, the slope of the FGHF' locus will parallel FF' between 10 and 24 weeks before flattening. This change will modify but not reverse the conclusions derived in the text.

5. The point at which the FGHF' locus reaches its maximum will depend on the characteristics of the FF' schedule. In fishing areas where productivity falls off rapidly after ten weeks, the schedule may peak at ten weeks. In other areas where productivity is higher, however, the locus may peak in the ten to twenty-six week period or beyond.

6. The marginal benefit of additional fishing (for fewer than 26 weeks but above the minimum) is the value of the marginal product less the change in the value of the average product times the benefit rate times twenty-six weeks. As the benefit rate rises, the marginal benefit of additional fishing falls.

7. S.A. Rae Jr., "Unemployment Insurance and Labour Supply: A Simulation of the 1971 Unemployment Insurance Act", Canadian Journal of Economics, X (May 1977), 263-78. See, in particular, page 276.

8. Given the production function $Y = L^{\frac{1}{2}}N$, the decreasing marginal incentive to work following a rise in the fish stock (in the 14 to 24 week period) can be seen in the following way. With $Y = L^{\frac{1}{2}}N$, the average product labour is $AP_L = L^{-\frac{1}{2}}N$, so that $\partial(AP_L)/\partial N = L^{-\frac{1}{2}}$. This implies that the average product rises with a rise in the fish stock. Moreover, the average product falls as labour rises (i.e. $\partial(AP_L)/\partial L = -\frac{1}{2}L^{-3/2}N < 0$) and the rate at which it falls increases as the fish stock rises (i.e. $\partial^2(AP_L)/\partial N \partial L = -\frac{1}{2}L^{-3/2} < 0$). Finally, the marginal disincentive to work is sixty percent of the change in the average product times twenty-eight weeks. With a rise in the fish stock for any quantity of labour, not only will the initial value of the average product be higher with a larger fish stock, but the rate at which the average product falls will also be larger. With the 60% benefit rate constant along with the benefit period, the marginal disincentive accompanying unemployment insurance must rise. This is compounded by the income effect, i.e. as the AP_L rises, the total benefits received will rise.

9. Unemployment insurance has had relatively little effect on the offshore fishery as compared with the inshore fishery. As a sector, the offshore fishery has been a net contributor to the plan (i.e. UICNETOF is negative) and the absolute size of the net contribution per fisherman has been small (mean UICNETOF = \$-19.00). When the same regression was estimated for the offshore fishery we found:

$$\underset{(5.62)}{NOF = -260.0} - \underset{(.555)}{.015\ NETVALOF} + \underset{(1.76)}{4.44\ UICNETOF} + \underset{(11.82)}{1.15\ EXPYND}$$

$$R^2 = .981 \qquad DW = 3.45 \qquad SE = 39.2$$

The large Durbin-Watson statistic indicates severe serial correlation problems in the regressions and decreases our confidence in the significance of the estimated coefficients.

10. It should also be remembered that in this time interval (before 1971) unemployment insurance benefits were not subject to taxation. This further increases the preference for unemployment income over fishing income. See also Section (h) below.

11. The mean size of net unemployment benefits over this time period was $168.29 per fisherman. This implies that the seasonal unemployment insurance programme attracted (18.58 x 168.29) 3,126 additional fishermen.

12. An estimate of the aggregate size of the fish catch accruing to boat owners was derived by subtracting from the total catch value the returns to fisherman's labour. The share was found by dividing this value by the total value of the catch. The returns to labour includes "any returns to capital investment by fishermen in their equipment". See Copes, Table 21, Note 3, p. 194. The mean value of SHAREIN over this period was .274.

APPENDIX

Data Used in the Regressions of Part II, Section (g)

Table I

Year	NIN[1]	YIN[2]	YOFF[3]	EXPYND[4]
1956	14,485	667.25	2544.00	697.32
1957	15,904	772.89	2348.00	696.85
1958	17,802	635.38	2446.00	647.90
1959	17,909	812.94	2526.00	665.81
1960	17,849	869.12	2497.00	723.24
1961	18,290	743.19	2957.00	744.67
1962	19,341	793.70	3373.00	786.48
1963	20,828	811.46	3392.00	849.30
1964	21,953	825.40	4080.00	953.37
1965	20,875	781.22	4400.00	1023.60
1966	19,432	871.55	4744.00	1169.53
1967	18,735	1049.32	3925.00	1280.57
1968	18,310	934.03	4214.00	1338.61

Source: Parzival Copes, The Resettlement of Fishing Communities in Newfoundland, Canada Council on Rural Development, April, 1972.

1. Page 186, Column 5.
2. Page 194, Column 8 divided by NIN.
3. Page 196, Column 7 divided by Column 6, page 186.
4. Page 189, Column 2 times one minus Column 2, page 183.

Table II

INSHORE FISHING SECTOR
(1000's of dollars)

YEAR	CATCH VALUE[1]	NON LABOUR EXPENSE[2]	UICPAY[3]	UICBEN[4]	RELIEF[5]
1956	11,601	2295	0	0	504
1957	12,749	2909	57	1759	750
1958	8,984	2831	112	3472	1798
1959	12,424	3142	141	3436	1982
1960	13,698	3337	172	4037	1287
1961	12,080	3485	171	3639	1530
1962	13,717	3774	189	3944	1653
1963	16,151	4383	221	3567	1787
1964	17,376	4909	215	4323	1545
1965	16,105	4790	216	3897	1312
1966	16,908	4952	209	3842	1347
1967	19,374	5541	219	4075	1970
1968	17,296	5813	208	3601	2226

Source: Parzival Copes, The Resettlement of Fishing Communities in Newfoundland, Canada Council on Rural Development, April, 1972.

1. Page 194, Column 1
2. Page 194, Column 2
3. Page 194, Column 4
4. Page 194, Column 5
5. Page 194, Column 6

Table III

FISHING FLEET DATA IN THE INSHORE FISHERY

YEAR	BTOTIN[1]	GANDDIN[2]	BSTKIN[3] ($1000's)
1956	11,842	7,083	4,771
1957	12,867	7,909	5,441
1958	14,419	8,736	6,183
1959	14,693	8,700	6,701
1960	15,663	9,073	6,264
1961	16,159	9,411	6,477
1962	17,248	10,102	7,438
1963	17,930	10,811	8,481
1964	18,490	11,391	9,582
1965	18,611	11,573	10,548
1966	17,392	11,210	11,767
1967	16,413	10,916	13,096
1968	15,315	10,451	13,732

Source: Parzival Copes, The Resettlement of Fishing Communities in Newfoundland, Canada Council on Rural Development, April, 1972.

1. Page 219, Column 1
2. Page 219, Column 6
3. Page 220, Column 2

Chapter 5

Risk and Uncertainty

(a) Introduction

As even weekend fishermen can recognize, an analysis of the Newfoundland fishery cannot be complete without the recognition of risk. Risk permeates almost all aspects of fishing and results in important institutional and cultural characteristics designed to minimize the effects of risk on individual fishing participants. Moreover, the variability in fishing incomes that results from risk has historically played an important role motivating government intervention. Government assistance arises not just because fishing incomes are, on average, low, but because incomes can vary significantly both between years and across areas in any one year.

(b) Sources of Risk and Uncertainty

To some extent aggregate fishing risk arises because a number of important parameters affecting the size of the fish stock are either unknown or their quantitative significance is only imperfectly understood. At present, the conditions affecting groundfish migration fall in this category as do the reasons for seemingly wide variations in particular fishing stocks (such as squid). Equally important, but even less well understood, is the quantitative importance of climatic variations and preditor-prey relationships (such as cod-capelin) on the aggregate fish stock. While these types of problems are present in other natural resources, they have added significance in the fishery because of the unobservable nature of the fish stock. Unlike agriculture and forestry, the effect of parameter changes can be observed only indirectly through their net effect on annual yields. The specification problems presented by unobservable variables leads to decision making under uncertainty and increases the possibility of making costly errors.

To the extent that the acquisition and dissemination of information can reduce the risks inherent in fishing, a significant role for government can be advocated. The inability of individual fishermen to internalize the returns from acquired information (due to the externalities present in the fishery), and the free access and public good characteristic of information once acquired, argues that the individual incentive to invest in information will be well below its social counterpart. Moreover, in the absence of individual (as opposed to industry-wide) incentives to conserve fish stocks, the private production and use of information will be misidirected into privately as opposed to socially productive areas. Significant gains can then be expected from government or industry directed research into the biological and environmental factors influencing the fishery. By increasing the predictability of the size and migration of fish stocks, aggregate fishing risk and its associated cost will fall at the same time as productivity rises. It must be recognized, however, that government financed research represents a subsidy to the fishing sector beyond the net efficiency gain. The divergence between net private and social benefits is largely within the fishing sector. Since the benefits will accrue to the fishing sector as a whole, the divergence is not necessarily an argument in favour of financing the research by the outside community.

It is true, however, that if redistribution to this sector is desired because of the low level of productivity, scientific research is a particularly promising form of subsidy. It is so for two reasons. First, scientific research directly attacks one of the basic causes of low productivity and thus assists in eliminating the original need for the subsidy. Second, much of the needed research is once-and-for-all in nature so that at least part of the subsidy will be self-terminating. Unlike many types of subsidies, a continuation of funded research is not necessary to maintain private productivity at its higher level. It must be reiterated, however, that additional research must be coupled with some solution to the common property problem or the gains will prove to be strictly temporary. In the presence of open access, higher productivity will lead to expanded fishing effort with higher short run harvesting and lower long run sustainable yields. The gains from research will be dissipated. With this qualification in mind, then, the most socially valuable types of information would include ways to increase the quality of output from a given biomass, the locations of new fishing grounds (assuming migration is less than complete), improvements in longliner and gear technology as well as measures of fish migration patterns and species interaction.

Although additional research is likely to reduce some of the unpredictability associated with the fishery, some element of uncertain variability will always exist in the seasonal catch. Knowledge may become available too late to have commercial (as opposed to academic) value and the costs of adjusting even to known variations may exceed the benefits that can be derived. Moreover, even if uncertainty could be eliminated at the aggregate level, the particulars of time and place will continue to generate widely different returns across individual fishing enterprises. Individual fishing risk is then likely to remain an inherent part of the fishing industry. It results in two forms of business organization characteristic of the Newfoundland fishery.

(c) Methods of Pooling Risk

When the size of the aggregate catch is likely to be more predictable than the individual components of the total, greater predictability and more even production can be achieved through pooling arrangements. This is seen in the Newfoundland fishery through the vertical integration of parts of the primary fishing and processing industries. Particularly in the offshore sector, the large fish processing plants typically own and operate a fleet of offshore trawlers. This allows them to accomplish two objectives. First, by pooling the individual variations in catch, a more continuous and predictable harvest can be gathered. This allows for the more efficient operation of their processing plant and utilization of capacity. Secondly, their ability to pool individual fishing risks through fleet ownership gives them greater certainty in the overall profitability of the fishing side of their operations. Fleet ownership, then, provides a type of self-insurance from the individual risks facing any one fishing vessel.

In the inshore fishing sector, integration may take place in the opposite direction through processing cooperatives. Once again, the feasibility of building one plant to handle a predetermined rate and volume of fish comes from the ability to pool individual variations in catch. Variations in the aggregate catch, and hence profitability of the processing plant, are pooled among the participating fishermen. In this context the suggestion of a state controlled processing sector may have merit.[1] Although this problem is beyond the frame of reference of this study a few additional advantages can be briefly mentioned. If a single decision making unit were established for the processing sector, some activities that presently are external to individual processors would become internalized. In particular, the present cost in reputation and price to Newfoundland, due to its relatively poor product quality, would be a problem internal to a single sectoral processor. The processor would then have a larger market incentive to institute quality fishing premiums and monitor more closely individual fishing catches because the benefits could be captured in higher fishing prices. Similar gains can be expected from a single coordinated marketing policy. Finally, a provincially run processing sector provides an effective means of monitoring and policing individual harvesting quotas. By processing all of the catch, the provincial processor can enforce annual quotas and ensure the maintenance of optimal fishing stocks for future generations.[2]

The most distinctive institutional feature of the fishery is the coventuring contract formed between boat owners and individual fishermen. Yet in the absence of risk, as we have shown in Chapter 2, coventuring contracts are equivalent to fixed wage contracts in promoting the efficient use of resources. The superiority of coventuring contracts derives from its ability to share risk among market participants. Under a fixed wage contract the boat owner would receive the residual of catch value minus costs. All the risk associated with fishing would then be held by the boat owner. To avoid risk entirely the boat owner could rent his boat to fishermen, but in this case all variations in profitability would fall on fishermen. The distinctive feature of coventuring is that it proportions risk and uncertainty among individual participants. Moreover, by making individual rewards proportionate to the size of the aggregate catch, it increases the individual incentive to work (relative to the fixed wage) and decreases the costs of monitoring individual performance. In these two interrelated ways, coventuring contracts have evolved as ways of lowering the overall cost of fishing activity.[3]

While coventuring allows the risk associated with an individual enterprise to be shared among individual participants, it does not permit the elimination or reduction of individual risk made possible through pooling arrangements. For this reason it has often been suggested that crop insurance be instituted as a way of meeting unexpected variations in income among individuals in one season and across seasons.

(d) Crop Insurance

In principle crop insurance could be used to supplement the incomes of those inshore fishermen whose catch, due to unfavourable occurences of nature, is below some historical average (or established quota). In this way random individual incomes could be made more uniform through time, reducing individual risk and raising the expected utility of sectoral income. Such a scheme has sometimes been suggested as a substitute for the unemployment insurance provisions currently available to fishermen.

Unfortunately, the government provision of crop insurance raises a number of difficulties. Any attempt to stabilize fluctuating incomes immediately raises the question of what level incomes will be stabilized at. The difficulty here is that purely income averaging schemes frequently become transformed into income supplementing programmes (as in the agricultural price support programmes). Such would be the case if insurance payments and/or overhead costs were financed from outside the fishing sector. One way of overcoming this objection is to insist that the programme be self-supporting. Over time aggregate payments must be matched by accumulated premiums.

The difficulty with imposing such a self-financing insurance programme on the inshore fishery comes from the recognition that private crop insurance has been rejected by the market. In principle the risk to income of bad weather or fish non-appearance is an insurable risk in the same way that fire or flood damage is and thus could be provided by the market. The reason for the non-existence of crop insurance in fishing as in agriculture or in many other income generating activities is the problem of moral hazard. That is, once insurance against the loss of income is available, individuals are motivated to behave in ways that alter the probability distribution of possible outcomes against the viability of the programme itself. Thus if it proves to be impossible to identify the reasons for insurance claims - whether they are due to bad luck or non-performance - individuals are motivated to choose insurance collections over fishing effort. The existence of moral hazard, then, explains the preference for self-insurance over private group insurance in the fishing industry. This implies that a voluntary government sponsored, but internally financed, crop insurance programme would find few willing participants after the first year. A compulsory programme, on the other hand, would impose on the industry the additional burden of detecting widespread shirking, the cost of which would not be insignificant.

We have now come full circle in our argument. Should a compulsory crop insurance programme be instituted, outside financing will almost certainly become a political necessity. Given this political reality, what would be the effect of this form of subsidy on the industry? Unlike a simple income supplement, a subsidy of the crop insurance programme would not tend to raise fishing incomes even in the short run. Rather, fishermen could claim benefits only to the extent that their fishing incomes fell below some arbitrary standard. Thus the magnitude of the subsidy through time would effectively measure the payments received by fishermen not to fish. What the subsidy purchases is fish in the ocean, but it does so inefficiently. To claim from the programme fishermen must continue fishing. Thus the conservation produced by decreased fishing effort is achieved by decreasing effort across all fishermen rather than reducing the number of fishermen. A policy of restricted licensing combined with the buying back of individual licences would accomplish this objective both more equitably and more efficiently. Finally, in the absence of entry limits, subsidized crop insurance will attract entry. Even the short run conservation aspect of the plan will be lost in the long run.

It might be suggested, however, that crop insurance should guarantee fishermen's prices rather than harvest size in order to buffer individuals from the whims of the world market.[4] In this case another form of moral hazard may arise. With a fixed money price guaranteed, inshore fishermen have an incentive to shirk on quality standards necessary for the world market.[5]

(e) Unemployment Insurance and Uncertainty

It is frequently observed in the policy statements of both governments that the unemployment insurance provisions reward those fishermen with high incomes due to successful harvests more than those who have been 'unlucky', because the benefits are aligned with realized incomes. In this way the present unemployment insurance programme exacerbates fluctuations in income due to risk and uncertainty. While the merits of this argument must be acknowledged, the inability to distinguish the reasons for good or bad harvests hamstrings the attempt to deal independently with the problem of risk. Any attempt to break the tie between higher incomes and higher benefits generates a cost in efficiency by removing the incentive to produce higher incomes. Relative to a crop insurance programme, then, unemployment insurance rewards productivity and penalizes bad luck; it encourages fishermen to be lucky, whereas crop insurance encourages bad luck. Given the intractable nature of the moral hazard problem and recognizing the possibility of self-insurance by fishermen (i.e. saving in good years to offset deficits in bad) unemployment insurance seems to be the more desirable alternative.

(f) Governments and an Uncertain Environment: A Case for Property Rights in Fish

In many sections of this report we have considered the ways in which governments have helped the fishery to cope with the problems of risk and uncertainty. These programmes include the provision of rewards for new exploration (both in new technology and in new fishing grounds), cooperation in risk producing arrangements and the gathering and dissemination of information not provided by the private market. However, it is also true that the intensive involvement of governments in the fishery is itself a major source of uncertainty. Uncertainty over the direction of future governmental action combined with the existence of often contradictory programmes and the conflicting objectives of different levels of government increase the costs of individual decision making and deny the private sector the security of a stable long run environment.[6] This tends to bias private investment towards short term investments and thus discourages the scale economies associated with long term investments. In addition, the belief that government policies can be influenced for redistributional advantage induces strategic market behaviour and results in dead weight losses. In general, the more simple and predictable is government policy, the more likely it is to evoke the desired market response. Government decision making should be directed towards providing this type of environment.

From the perspective of the government agencies overseeing the fishery, however, consistent and predictable decision making is often impossible because of the lack of accurate information on many of the key policy parameters. Policies are pursued on a trial and error basis and once in place prove difficult to remove. Moreover, in the presence of a common property resource and the implied absence of an alternative market mechanism, decision makers are denied the luxury of a non-decision; for the absence of an explicit government policy means open access and the eventual squandering of the potential offered by extended jurisdiction. The necessity of decisions and the absence of information implies the possibility of costly mistakes imposed by government policy. Consider, for example, the present problem faced by the federal government in allocating the aggregate groundfish catch between the inshore and offshore fisheries. The lack of accurate information on the degree of groundfish migration and the relevant social costs in the two sectors makes the determination of the relative size of the two fisheries problematic. The government is then faced with the following dilemma. To opt for a maintained or expanded inshore fishery means foregoing the possible advantages of new trawler technology and competitive world harvesting costs. On the other hand, to drastically reduce the size of the inshore fishery imposes considerable hardship on inshore fishermen, while creating an irreversible investment in possibly inefficient technology. The real danger is that the political costs of any active decision by government will produce a passive acquiescence in overall expansion and dissipation of the rents coming from extended jurisdiction.

In the context of the difficulties faced by government decision makers an alternative approach to the allocation of market shares merits consideration. As we have seen, an inherent difficulty with the present institutionalized decision making process in the fisheries is that the decision makers are different from those who bear the ultimate economic consequences of these decisions. This tends to produce passive acquiescence by decision makers as a way of avoiding the political costs of difficult decisions. The following approach argues that many of the decisions made within the fishery can and should be made by those who are most directly affected - the fishermen themselves. While overall responsibility for the aggregate size of the catch must be retained by the federal government, decisions concerning the composition of the total and thus the optimal way of producing this total could be made by fishermen if there existed a mechanism by which individual shares of the catch could be traded among individual fishermen. Such a mechanism would exist if private property rights were established in the shares of the annual aggregate quota.

The economic reason for government intervention in the fisheries is the externality created by common ownership (domestically) of the fish stock. Individual fishermen have no mechanism by which they can appropriate the future benefits of leaving fish in the ocean and thus are led to over-fish the fish stock. At present there appears to be no feasible way for governments to create a private mechanism to internalize their external cost. Government delineation of private property rights in fish and their future offspring becomes impractical because of the insurmountable difficulties of observing stocks and thus enforcing these rights. The alternative way of establishing private property rights in fish indirectly by establishing private fishing rights in areas of the ocean is similarly inefficient since fish stocks wander across boundary limits. Even if fish did not wander, the costs of policing the many boundary limits would probably be prohibitive. For these reasons, then, overall federal responsibility for the intergenerational externality seems to be a continuing necessity. Government enforcement of the annual size of the fish catch appears to be the only practical way of preventing the ultimate rent dissipation that would occur in this common property resource.

Suppose, however, that while retaining the right to set the aggregate annual quota, the federal government delineated private property rights in individual shares of the annual quota. Exactly how the federal government should allocate these shares to fishermen is a question of how the fishing rents created by government control of the intergenerational externality should be distributed among the concerned governments and fishermen. It is a question of politics as well as economics and would merit much more serious attention if this proposal were to be instituted. At one extreme, a federal auction would return the expected rents to the federal government, while an historical allocation would allow fishermen to appropriate these rents. Let us assume, however, that these rights were allocated across fishermen by granting individual boat owners a share of the annual quota on the basis of their historical share of the total annual catch. What would be the consequences of such an act?

Once property rights to the annual quota were delineated and the exchange of these rights were permitted, a market for shares of the annual quota would develop. If the rights were perceived to represent permanent allocations, the market value of the shares would initially reflect the present value of the average rents that would be realized from that continuing share of the annual quota. The existence of a market, however, permits the exchange of these rights and if fishing units differ in productivity, trade will arise. More efficient producers will buy away the right to fish from less efficient producers. Such a transaction is desirable for the low cost fishing unit because the present value of the profits that it would make by owning the fishing right exceed the cost of acquiring that right. On the other hand, the high cost producer is willing to surrender his right to fish because the potential profits he could make by utilizing his right are less than he could make by selling it. In the market all transactions are voluntary. Trade will arise only if gains can be made by both parties.

One advantage, then, of instituting private property rights in the annual quota is that the market will resolve the problem of how to allocate the catch both within and across sectors. If it turns out to be the case that the inshore fishery is more efficient than the offshore, expected rents will be higher in that sector and inshore fishing units will buy fishing rights away from the offshore fishery. On the other hand, if new freezer trawlers seem to promise greater efficiency in the offshore fishery, private property rights require them to pass a market test. To increase the relative size of the offshore fishery, market shares must be purchased away from the inshore fishery.

A second advantage of the private property right solution is in the area of equity. Two points deserve special emphasis. First, the existence of uncertainty means that under both government and market allocations mistakes will inevitably be made. Under the market solution such mistakes will arise in the context of voluntarily entered contracts so that the cost of the mistkae will fall on the erroneous decision maker. In this way the market penalizes incorrect decision makers by having the cost of their mistake fall on them. Under government decision making, however, the economic cost of their mistakes falls on others. As a question of equity as well as efficiency, it seems desirable to have the decision maker bear the full consequences of his actions. Second, government regulation necessitates no market compensation for changes in imposed reallocations between sectors. A government decision to reduce the size of the inshore fishery through licensing, for example, disposes some inshore fishermen of their fishing rights without providing compensating payments. Even if this solution coincided with the market's evaluation of the direction of change, the property right solution will have equity advantages. First, the willingness-to-sell principle established in the market ensures that those inshore fishermen who exit do so willingly. Second, the necessity of buying out inshore fishermen provides the inshore fisherman with market compensation for his lost fishing right. The individual fisherman can himself decide whether the capital provided by the sale of his fishing right is sufficient to compensate for the costs of starting up an alternative way of life. It is frequently on the grounds of fairness that objections arise to attempts to restructure the fishery in the direction of greater efficiency. Given the initial delineation of property rights, the voluntary nature of market exchange diminishes the force of these complaints.

Finally, the establishment of private property rights in the annual quota would increase the effectiveness and decrease the costs of the government's primary fishing responsiblity - ensuring the conservation of fish stocks. Under this arrangement, optimal sustainable yields can be maintained by enforcing the individual catch limits implied by the aggregate harvest. This can be done at low cost by monitoring individual catch limits at their arrival at the relatively small number of fish processing plants. In the absence of individual catch limits, the government is forced to conserve fish stocks indirectly by regulating fishing effort. What begins as a seemingly simple matter - restricting the total number of fishing licenses - quickly accelerates into a process of increasing regulation as individuals adjust along all unregulated margins. Without originally meaning to, governments find themselves increasingly drawn into the day-to-day operation of the fishing industry to enforce an ever growing number of regulations (such as gear quantities and types, mesh sizes, boat construction and fish quality standards). The cost of effort regulation, then, becomes increasingly onerous in terms of frustration, red tape, loss of independence as well as dollars. Relative to this, the enforcement arrangements under the private property right system stand as a model of economy and simplicity.

NOTES

1. See for instance Setting a Course, Volume 1B.

2. Clark and Munro (February 1979) have suggested instances in which a sole processor will be in a position to optimally manage the resources when harvesting is competitive.

   At present the Province licences processing facilities and the Federal government polices harvest size (except that the inshore fishing is not subject to quotas). If inshore boats are licenced and a catch/boat quota assigned, then the sole processor could monitor the harvest of each boat.

3. For a more extended discussion of coventuring or sharecropping contracts see, Steven N.S. Cheung, The Theory of Share Tenancy, (Chicago: University of Chicago Press, 1969).

4. The Temporary Assistance Program (TAP) served as an insurance policy against a combination of bad harvest and poor world markets except that there were no insurance premiums.

5. Export of fish products are federally inspected.

6. Examples include the frequent fluctuations in government's attitude towards the inshore/offshore fisheries and the policy objectives and future direction of inshore licensing. In the offshore sector, trawler subsidies exist alongside output quotas; and the government's position vacilates between the total prohibition and active encouragement of new trawler construction.

Appendix

A Model of the Work-Leisure Choices of a Representative Inshore Family

In this appendix, various hypotheses representing work-leisure choices of a household in an inshore community will be analyzed. A simple model will be introduced to represent basic choices. This model will be extended to encompass more realistic options and to include present income supplementing institutional arrangements (such as Unemployment Insurance) and other hypothetical supplementing programs (such as a guarantee of incomes, or income insurance).

(a) The Basic Model

The basic model is a variation of a well-known labour-leisure choice model. The basic assumption is that of a single wage earner allocating the 52 weeks of the year between income generation (Y) and leisure. It is assumed he will work L_1 weeks as an inshore fisherman generating income $F(L_1)$, he will spend L_2 in other income generating activity (like farming, boat repair or part-time work) with income $N(L_2)$ and that there will be income earned by other members of his household, for instance working in an inshore processing plant (or in salting cod) of value $D(L_1)$.

Two comments must be made. Note that the number of weeks devoted to processing coincides with the fishing period. It is important that there be this interrelationship between the fish processing period L_1 and the fishing period. This vertical link between family income sources may cause a premature cessation of the fishing season (or a prolongation) which will possibly be aggravated when consideration is taken of the effects of income supplementing programs.

A basic difference between the inshore fishing labour/leisure choice problem and that associated with other industries is the flexibility. An office worker in St. John's may work 50 weeks a year because his job has a minimum number of work weeks per year of 50. He may reasonably desire 36 weeks of work but is forced into a 50 week year by the type of job he chooses. The remaining 2 weeks he may devote to household production $N(L_2)$ or leisure.

And so, in the absence of government interference (such as unemployment insurance, or income taxation) the typical household will face the following problem:

(3.7) $\max_{Y,L} \quad \upsilon(Y, 52-L)$

subject to the following definitions and constraints:

(3.8) $Y = F(L_1) + N(L_2) + D(L_1)$

(3.9) $L = L_1 + L_2$

(3.10) $L_1 \geq \tilde{L}_1$

Equation 3.8 represents income generation as defined above, Equation 3.9 represents the decomposition of his total number of weeks worked per year L, and the inequality 3.10 is included to represent the costs to the householder of a minimum requirement on number of weeks worked. This will be explained later.

Using the method of Euler-Lagrange introduce the Lagrangean expression:

(3.11) $\mathcal{L}(Y_1 L_1 \tilde{L}_1, L_2, \lambda_1, \lambda_2, \lambda_3) = \upsilon(Y, 52-L) + \lambda_1 [F(L_1)+N(L_2)-D(L_1)-Y] + \lambda_2 [L-L_1-L_2] + \lambda_3 [\tilde{L}_1 - L_1]$

First order conditions for a maximum imply:

(3.12) $\upsilon_1 - \lambda_1^* = 0$

(3.13) $\upsilon_2(-1) + \lambda_2^* = 0$

(3.14) $\lambda_1 [F^1 + D^1] - \lambda_2 - \lambda_3 = 0.$

(3.15) $\lambda_1 N^1 - \lambda_2 = 0$

(3.16) $\lambda_3^* \; L_1^* - \tilde{L}_1 = 0$

(3.17) $L_1^* - \tilde{L}_1 \geqq 0$

(3.18) $\lambda_3^* \geqq 0$

From (3.12) and (3.13) $\frac{\upsilon_1}{\upsilon_2} = \frac{\lambda_1^*}{\lambda_2^*}$. This represents the house-

holders trade-off between income Y and leisure (52-L). Similarly,

$\frac{\lambda_1^*}{\lambda_2^*}$ should be interpreted as the equilibrium weekly salary.

Let us assume for the time being that there is no imposed minimum employment period $\tilde{L}_1$ so that $L_1^*-\tilde{L}_1 > 0$ and from (10) $\lambda_3^*=0$. Then from (3.14) and (3.15).

(3.19) $(F^1+D^1) = \frac{\lambda_2}{\lambda_1} = N^1$

Equation (13) gives the allocation of 52 weeks into a fishing period L_1^*, a work period L_2^* in other production, and leisure $(52-L^*)$. In equilibrium the values of marginal products of an extra week in fishing $(F^1 + D^1)$ will equal that of a week devoted to other income sources N^1, will equal the subjective evaluation of a week of leisure $\frac{\lambda_2^*}{\lambda_1^*}$

We can now illustrate the benefits to this inshore household of this flexibility. Suppose that the choice L_1^* is 36 weeks but there is a binding rule that the minimum employment period is $\tilde{L}_1$ equal to 40 weeks. Family income will rise by

$$L_1 = \int_{36}^{40} \{F'(L_1) + D'(L_1)\} dL_1$$

but will be reduced by $\int_{L_2^*}^{L_2^{**}} N(L_2)dL_2$,

and the number of leisure weeks may rise or fall. But most significantly household welfare will fall. λ_3^* represents the marginal cost to the household of this minimum employment constraint.

When the trade-off is between employment offshore for perhaps a minimum of 48 weeks (L_1^*) at a high salary $F(L_1)$ the option seems attractive, but must be weighed against the option of no minimum employment period in fishing but more freedom to enjoy leisure and to work at other jobs. Obviously many fishing families choose the second option.

This minimum employment period associated with most jobs becomes relevant in the inshore fishery as soon as the present unemployment insurance structure is introduced. In order to qualify for the special unemployment insurance package available to fishermen a minimum work period (currently 10 weeks) is required. This will probably result in fishermen working longer periods than socially desirable at least during bad seasons and may have devastating consequences on the fish stock. Moreover, unemployment insurance benefits are related to the value of average output during the fishing season and as such will affect the decision on number of weeks worked.

It is clear that the UI Act as it now exists will have qualitative effects on employment choices and on the number of weeks worked. As a corollary it will clearly affect the state of the fish stock (for example, such as by encouraging overexploitation). It would be interesting to know the magnitudes involved. As well, it would be interesting to know if the present UI Act;

a) is more distorting in periods of bad harvests such as in Newfoundland in

1974-76 and b) is more distorting than some reasonable alternatives, such as income insurance, or income maintenance.

(b) An Extended Model

The purpose of this extension is to include unemployment insurance benefits as an income option or addition. In order to simplify the analysis the production function for inshore fishing will be assumed to be $F(L_1,\bar{N})=L_1N$ and hence the value of the average product of labour will be constant as a function of effort, but parametrized by the fish stock. Let us represent this function as $\alpha(N)$. This will mean that the AP_L will be high during the 'season' when cod (squid, capelin) migrate inshore but will be lowered as stock is depleted and/or begins migration back to the offshore.

Assume unemployment insurance benefits are x percent of the value of the average product of labour (where for example x = 0.6 averaged over the last 10 weeks according to Bill C41) and that benefits may be obtained by qualifying fishermen for a maximum period of $\bar{\bar{L}}_1$. (At present $\bar{\bar{L}}_1$ is 26 weeks.) Weekly Unemployment insurance benefits for qualifying fishermen will be of size $(\alpha \times L_1)$ up to a maximum benefit period of 28 weeks.

Assume further that the component of the family employed in processing will have coincidental employment period, with value of average product β. Benefits may be obtained for longer than 26 weeks for these individuals employed in processing. As a matter of fact, it is well known that fishermen prefer to qualify for U.I. benefits outside of the special fishing provision where possible.

The significance of this set-up is that in order for there to be a viable processing activity in the outport community, inshore fishing must occur.

The decision regarding number of weeks worked will follow the same pattern as in the previous section with the additional complications imposed by unemployment insurance. Specifically, the possibility of gaining income by being unemployed must be incorporated into the model.

Assume initially that a representative fisherman chooses to work less than the full season, i.e., $L_1 < \tilde{L}$. Then income is defined by

$$(3.20) \quad Y = \alpha L_1 + \beta L_1 + N(L_2) + \alpha x(52 - L_1) + \beta x(52 - L_1)$$

under the assumption that fishing is the only employee income source for which Unemployment Insurance benefits accrue and that $(52 - L_1) \leq 26$, or $L_1 \geq 26$.

$$(3.21) \quad Y = (\alpha + \beta) \left[L_1 + x(52 - L_1)\right] + N(L_2)$$

The Kuhn-Tucker-Lagrangean expression corresponding to (3.11) is

$$(Y, L_1, L_2, \gamma_1, \gamma_2) = U(Y, 52 - L) + \gamma_1 \left[\alpha L_1 + \beta L_1 + \alpha \delta x(52 - L_1) + \beta x(52 - L_1) + (1-\delta)26\alpha x + N(L_2) - Y\right] + \gamma_2 \left[L - L_1 - L_2\right] + x\gamma_3(\tilde{L}_1 - L_1)$$

where $\delta = 1$ if $L_1^* > 26$

$\delta = 0$ if $L_1^* < 26$

and $x = 0$ if $L_1^* < \tilde{L}_1$ where $\tilde{L}_1$ is the minimum qualifying period (at present 10 weeks).

Solving the first order conditions yields

(3.22) $U_y - \gamma_1 = 0$

(3.23) $U_L - \gamma_2 = 0$

(3.24) $\gamma_1 \left[(\alpha + \beta) - \alpha\delta x - \beta x \right] - \gamma_2 - x\gamma_3 = 0$

(3.25) $\gamma_1 N^1 - \gamma_2 = 0$

Then $\frac{U_y}{U_L} = \frac{\gamma_1^*}{\gamma_2^*}$ represents the trade off between income and leisure (as previously). But if $L_1 > \tilde{L}_1$ then $\gamma_3 = 0$ and if at least 26 weeks are worked (so $\delta = 1$) then

(3.26) $(\alpha + \beta)(1 - x) = \frac{\gamma_2}{\gamma_1} = N^1$

Comparing (3.26) to (3.19) where $(\alpha + \beta)$ is equivalent to $(F^1 + D^1)$ indicates that the existence of an unemployment insurance rate of x distorts the labour/leisure choice in favour of more L_2. That is, more time should be devoted to non-fishing income generating activity and (perhaps) more to leisure.

In summary, an individual who would have worked at least 26 weeks would have an incentive to work less in fishing. Note that this does not imply that there will be less employment in the sector, nor that the representative fisherman will work less in total. The latter issue will depend upon the income effect.

Since $\frac{\gamma_1^*}{\gamma_2^*}$ is higher than $\frac{\lambda_1^*}{\lambda_2^*}$ in the presence of unemployment benefits, there are welfare benefits to being an inshore fishing family. If fewer than 26 weeks are worked, and $10 < L_1^* < 26$ then $\delta = 0$ and (3.24) becomes $\gamma_1 \left[(\alpha + \beta) - \beta x \right] = \gamma_2$

hence

(3.26) $(\alpha + \beta) - \beta x = \frac{\gamma_2^*}{\gamma_1^*} = N^1$

and there will still remain an incentive to work less than if there were no unemployment benefits. But now the reason is because of the unemployment benefits paid to members of the household involved in processing.

If $L_1^* < 10$ then $\gamma_3^* < 0$ and the constraint imposed by the qualifying period requirement becomes relevant. (Note that $\delta = 0$) Moreover $x = 0$. In this case (18) becomes $\gamma_1 \left[(\alpha + \beta)\right] - \gamma_2 - \gamma_3 = 0$ and

(3.26) $\frac{\gamma_2^*}{\gamma_1^*} = (\alpha + \beta) - \frac{\gamma_3^*}{\gamma_1^*} = N^1$

Since $\gamma_3 < 0$ the fisherman will want to work more at fishing except in the circumstances where his tastes are very perverse. If leisure is a strongly desired good then we may find him not reacting to the U.I. incentive.

The other cases warrant comment. For instance if he would ordinarily work beyond $\tilde{\tilde{L}}_1$, a period defined as "the end of the season" -- when cod migrate offshore, we are interested in whether U.I. would change this behaviour.

In the first place, his AP_L would drop (as illustrated in Figure A.1) and so then would his U.I. benefits.

One would assume that the 26 week benefit period is not random but meant to more or less coincide with the termination of the productive season. It seems to be true that severely declining marginal products (and hence declining average products) will increase the incentives described in (3.26) for the fisherman to shorten his fishing season.

Equation (3.26) is meant as an upper bound. We could conclude that even if the value of average product of fishing were constant, there would be an incentive in the U.I. Act for fishermen to fish for a shorter season. In the region of declining average product, the effect of this incentive is increased.

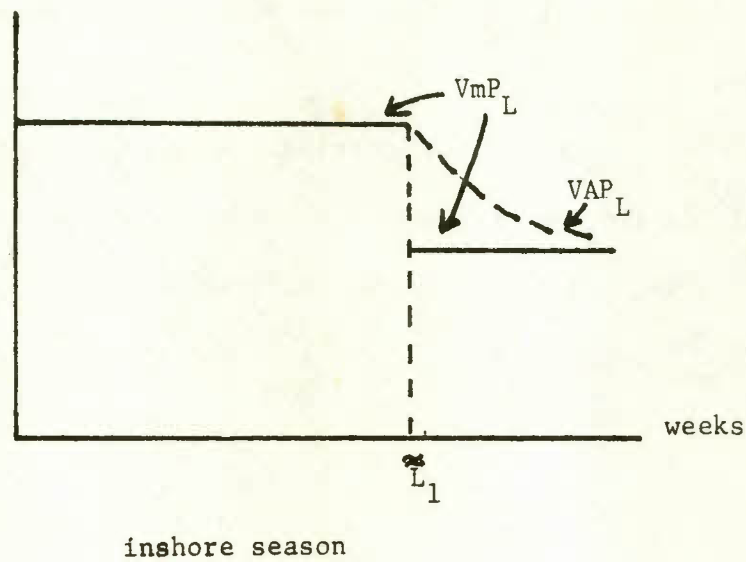


Figure A.1

There is another point worth considering. As with other subsidies, the income subsidy cannot be effective as long as coventuring (share-cropping) occurs. Boatowners, realizing that labourers salaries are subsidized and that competition for jobs occurs at the prevailing wage, can use share bargaining to raise their share of catch and to reduce incomes of workers to the prevailing wage. If there is licencing, the boatowner will capture the 'rent'. If not, the industry will expand with stock depletion.

Labourers, however, can anticipate this consequence and will react. They will realize that if they do not take advantage of the possibility of reducing the season without (significant) salary loss they will be worse off.

BIBLIOGRAPHY

Albrecht, F., Harry Gatzke, Abraham Haddad and Nelson Wax, "The Dynamics of Two Interacting Populations", Journal of Mathematical Analysis and Application, 1974, 46, 658-670.

Anderson, Lee G., "Optimal Economic Yield of a Fishery given a Variable Price of Output", Journal Fish. Research Bd. Canada, 1974, 31, 1119-1125.

Anderson, Lee G., The Economics of Fisheries Management. Baltimore, Maryland: John Hopkins University Press, 1977.

Anderson, Lee G., "The Relationship Between Form and Industry in Common Property Fisheries", Land Economics, May 1976, 179-191.

Anderson, Lee G., "Production Functions for Fisheries: Comment", Southern Economic Journal, January 1978, 661-666.

Bank of Montreal, "New Vistas for Canada's Fisheries", Business Review, July 1978.

Beddington, J. R. and D. B. Taylor, "Optimal age-specific harvesting of a population", Biometrics, 1973, 29, 801-809.

Beddington, J. R., C.M.K. Watts and W.D.C. Wright, "Optimal Cropping of self-reproducible natural resource", Econometrics, 1975, 43, 789-820.

Bell, F.W. "The Pope and the Price of Fish", American Economic Review, December 1968, 58.

Bell, F.W. et.al., "The future of the world's fishing resources", National Marine Fisheries Service, Working Paper, 1970.

Beverton, R.J.H. and S.J. Holt, "On the Dynamics of Exploited Fish Populations", Ministry of Agriculture, Fisheries and Food (London), 1957.

Blair, R.D. and David L. Kaserman, "Uncertainty and the Incentive for Vertical Integration", Southern Economic Journal, July 1978, 266-272.

Bradley, Paul G., "Some Seasonal Models of the fishing industry". In A.D. Scott (ed.), Economics of Fisheries Management - A Symposium, U.B.C., 1970.

Brown, Gardner, "An Optimal Programme for Managing Common Property Resources with Congestion Externalities", Journal of Political Economics, 1974, 163-174.

Chan, K.S., "The Economic Consequences of the 200-mile Seabed Zone: The Replenishable Resources Case", Canadian Journal of Economics, May 1978, 314-319.

Cheung, S.N.S., "Contractual arrangements and resource allocation in marine fisheries". In A.D. Scott (ed.), Economics of Fisheries Management - A Symposium, U.B.C., 1970.

Chiaramonte, Louis J. Craftsmen-Client Contracts: Interpersonal relations in a Newfoundland fishing community. Memorial University, 1970.

Christy, F.T.Jr. and A.D. Scott. The Common Wealth in Ocean Fisheries. Baltimore: Johns Hopkins, 1965.

Christy, F.T.Jr. Alternative arrangements for Marine Fisheries: An Overview. Resources for the Future, Washington, 1973.

Clark, Colin, "Economically optimal policies for the utilization of biologically renewable resources", Math. Biosciences, 1971, 12, 245-260.

Clark, Colin, G. Edwards and M. Friedlander, "Beverton-Holt model of a commercial fishery: optimal dynamics", J. Fisheries Research Bd. of Can., 1973, 1629-1640.

Clark, Colin, "Profit Maximization and the Extinction of Animal Species", Journal of Political Economics, July/August 1973.

Clark, Colin and G.R. Munro, "The Economics of Fishing and Modern Capital Theory: A Simplified Approach", Journal of Environmental Economics and Management, December 1975.

Clark, Colin W. and Gordon R. Munro. "Fisheries and the Processing Sector", University of British Columbia Working Paper No. 34, February 1979.

Clark, Colin W., Frank H. Clarke and Gordon R. Munro. "The Optimal Exploitation of Renewable Resource Stocks: Problems of Reversible Investment", Econometrica 47 (January 1979), pp. 25-47.

Clark, Colin. Mathematical Bioeconomics. Wiley, 1976.

Comitini, S. and D. S. Huang, "A Study of Production and Factor Shares in the Halibut Fishing Industry", Journal of Political Economics, 1967, 75(1), 366-372.

Copes, P. The Resettlement of Fishing Communities in Newfoundland. Ottawa: Canadian Council on Rural Development, 1972.

Copes, P. Fisheries Development in Newfoundland. Department of Regional Economic Expansion in Canada, 1972.

Copes, P., "Canada's Atlantic Coast Fisheries: Policy Development and the Impact of Extended Jurisdiction", Canadian Public Policy, Spring 1978.

Courchene, Thomas J., Migration, Income and Employment: Canada, 1965-68, C.D. Howe Research Institute, 1974.

Crutchfield, J.A. and A. Zellner, "Economic aspects of the Pacific halibut fishery", Fishery Industrial Research, 1962, 1(1), U.S. Department of Interior.

Crutchfield, J.A., "An Economic view of maximum sustainable yield". In P.M. Roedel (ed.), Optimal Sustainable Yield as a Concept in Fisheries Management. Washington, D.C.: American Fisheries Soc. Special Publ. No. 9, 1975.

Cushing, D.H. Fisheries Biology: A Study in Population Dynamics. Madison: University of Wisconsin Press, 1968.

deLury, D.B. "On the estimation of biological populations", Biometrics, 1947, 3(4), 145-167.

Environment Canada: Policy for Canada's Commercial Fisheries, May 1976.

Feldstein, Martin. "The Effect of Unemployment Insurance on Temporary Layoff Unemployment", AER 68:5, 834-46, December 1978.

Feller, W., "On the logistic law of growth and its empirical verification in biology", Acta Biotheoretica, 1940, 5, 51-66.

Fraser, G.A., "Limited Entry: Experience of the British Columbia Salmon Fishery", Journal of the Fisheries Research Board of Canada, 1977, 36 754-63.

Fullenbaum, R.F., "A Survey of Maximum Sustainable Yield Estimates on a World Basis for Selected Fisheries", Department of Interior, Bureau of Commercial Fisheries Working Paper 43, 1970.

Fullenbaum, R.F., Ernest Carlson and F.W. Bell, "On Models of Commercial Fishing: A Defense of Traditional Literature", Journal of Political Economics, July/August, 1972.

Garrod, D.J., "Management of multiple resources", Journal of Fisheries Research Board of Canada, 1973 30(12, Part 2); 1977-1985.

Gause, G.F. La Theorie Mathematique de la Lutte Pour La Vie. Paris: 1935.

Goh, B.S., G. Leitmann and T.L. Vincent, "Optimal Control of a prey-predator system", Mathematical Biosciences, 1974, 19, 263-286.

Gordon, H.S., "Economic theory of a common-property resource: The fishery", Journal of Political Economics, 1954, 62.

Gould, J.R., "Extinction of a fishery by commercial exploitation: a note", Journal of Political Economics, 1972, 80, 1031-1038.

Government of Canada, Lalonde, Hon. Marc. Working Paper on Social Security in Canada, April 1973.

Government of Canada, Department of Fisheries and Oceans. Resource Prospects for Canada's Atlantic Fisheries 1979-1985, Ottawa, 1978.

Government of Canada, Environment Canada. Policy for Canada's Commercial Fisheries, Fisheries and Marine Service, May 1976.

Government of Newfoundland and Labrador. Setting a Course: A Regional Strategy for Development of the Newfoundland Fishing Industry to 1985, Volumes I through IV and Executive Summary, Department of Fisheries, 1979.

Government of Newfoundland and Labrador, Department of Fisheries. Primary Landing and Distribution Centre Feasibility Study, St. John's, Newfoundland, March 1978.

Department of Fisheries (Canada), Discussion Paper, First Minister's Conference on the Economy, November 27-29, 1978: Canada's Fisheries: Profile, Prospects and Issues.

Government of Newfoundland and Labrador. White Paper on Strategies and Programs for Fisheries Development to 1985, St. John's, November 1978.

Gulland, J.A., "Manual of Methods of Fish-Stock Assessment", U.N. Food and Agr. Org. (Rome), 1969.

Gulland, J.A. and L.K. Boerema, "Scientific Advice on Catch Levels", U.S. Department of Commerce NOAA Fishery Bulletin, 1973, 71, 325-335.

Gulland, J.A. and M.A. Robinson, "Economics of Fishery Management", Journal of Fisheries Research Board of Canada, 1973, 30, 2042-2050.

Gulland, J.A. The Management of Marine Fisheries. Seattle: University of Washington, 1974.

Hannesson, R., "Fishery dynamics: A North Atlantic cod fishery", Canadian Journal of Economics, 1975, 8, 151-173.

Herfindahl, O.C. and A.V. Kneese. Economic Theory of Natural Resources. Merrill, 1974.

Huang, David S. and Chae W. Lee, "Toward a General Model of Fishery Production", Southern Economics Journal, July 1976, 43, 846-853.

Huang, David S., "Production Functions for Fisheries: Reply", Southern Economics Journal, January 1978.

Jones, R. and W.B. Hall, "A simulation model for studying the population dynamics of some fish species". In M.S. Bartlett and R.W. Hiorns (eds.), The Mathematical Theory of The Dynamics of Biological Populations. New York: Academic Press, 1973.

Larkin, P.A., "Interspecies competition and exploitation", Journal of Fisheries Research Board of Canada, 1963, 20, 647-678.

Larkin, P.A., R.F. Raleigh and N.J. Wilimovsky, "Some alternative premises for constructing theoretical production curves", Journal of Fisheries Research Board of Canada, 1964, 21, 477-484.

Larkin, P.A., "Exploitation in a type of predator-prey relationship", Journal of Fisheries Research Board of Canada, 1966, 23, 349-356.

LeBlanc, Romeo, Notes for Remarks at the Federal-Provincial Conference of First Ministers of the Economy. Ottawa: November 29, 1978.

LeBlanc, Romeo, Notes from a Speech to the Newfoundland Fishermen Food and Allied Workers Union. St. John's, Newfoundland: December 4, 1978.

Leung, A. and A.Y. Wang, "Analysis of Models for Commercial Fishing: Mathematical and Economic Aspects", Econometrics, 1976, 44(2), 431-436.

Lewis, Tracy, "Optimal Resource Management under Conditions of Uncertainty: The case of an Ocean Fishery", presented at Winter Econometric Society Meeting, Dallas, 1975.

Lewis, Tracy and R. Smalensee, "Nonconvexities and the theory of renewable resource management", Journal of Environmental Economics and Management,

Lotka, A.J. Elements of Physical Biology. Baltimore: Williams and Wilkins, 1925.

McCurdy, Earle, "Fish and the Fisherman: The Crisis in the Newfoundland Fishery", Canadian Dimension, 13(2), 24-33.

McEachern, D.J., "A New Look at the Groundfish Industry". In Canadian Fisheries. Ottawa: Environment Canada, 1975.

McRae, James J., "Optimal and Competitive Use of a Replenishable Natural Resource by Open Economies", Journal of International Economics, 1978, 29-54.

Mitchell, C.L., "The 200 Mile Limit: New Issues, Old Problems for Canada's East Coast Fisheries", Canadian Public Policy, Spring 1978.

Mohring, H.S., "The costs of inefficient fishery regulation: a partial study of the Pacific Coast halibut industry", (unpublished) University of Minnesota, 1973.

Munro, Gordon, "Economic Impacts of Extended Fisheries Jurisdiction" in Symposium Proceedings, Lee Anderson (ed.), Ann Arbour, 1977.

Munro, Gordon R. "Canada and Fisheries Management with Extended Jurisdiction: A Preliminary View", in Lee G. Anderson (ed.) Economic Impacts of Extended Fisheries Jurisdiction, Ann Arbor Science 1977, pp. 29-50.

Neher, P.A. "Notes on the Volterra-Quadratic Fishery", Journal of Economic Theory, 1974, 8(1), 39-49.

Osberg, Lars. "Unemployment Insurance Amendments", Canadian Public Policy, Spring 1979.

Oster, G., "Stochastic Behaviour of Deterministic Models". In S.A. Levin (ed.), Ecosystem Analysis and Prediction. Utah: SIAM-SIMS Conference Proceedings, 1975, 24-37.

Pearse, P.H., "Rationalization of Canada's West Coast Salmon Fishery" in OECD Economic Aspects of Fish Production. Paris: 1972, 172-202.

Pearse, P.H., and J.E. Wileu, "Impact of Canada's Pacific Salmon Fleet Control Program", Journal of the Fisheries Research Board of Canada, 1977, 36, 764-69.

Peterson, F.M. and Anthony Fisher, "The Exploitation of Extractive Resources: A Survey", Economic Journal, December 1977, 681-721.

Plourde, C.G., Diagrammatic Representations of the Exploitation of Replenishable Resources: Dynamic Iterations", Journal of Environment Economics and Management 6, 119-126 (1979).

Plourde, C.G., "A Simple Model of Replenishable Resource exploitation", American Economic Review, 1970, 60, 518-522.

Plourde, C.G., "Exploitation of common-property replenishable resources", Western Economic Journal, 1971, 9, 256-266. Reprinted in Economics of Natural and Environmental Resources, Vernon Smith (ed.), Gordon and Breach, 1974.

Plourde, C.G., "Exploitation of Replenishable Natural Resources in a Predator-Prey Relationship", (unpublished) University of Western Ontario, 1974.

Proskie, John. Cost and Earnings of Selected Fishing Enterprises, Atlantic Provinces, Economic Services, Department of Fisheries of Canada, 1964-68, Division of Economic Research, Bureau of Commercial Fisheries.

Quirk, J.P. and Vernon L. Smith, "Dynamic economic models of fishing", in A. D. Scott (ed.), Economics of Fishery Management - A Symposium. Vancouver: U.B.C. Institute of Animal Resource Ecology, 1970, 3-32.

Rapport, David J. and James E. Turner. "Economic Models in Ecology", Science, January 1977.

Reed, W.J. "A Stochastic Model for the Economic Management of a Renewable Animal Resource", Mathematical Biosciences, 1974, 22, 313-337.

Revised Statutes of Canada, 1970, Vol. VII Chapter 5 - 9/Y - 4 PIZ Noza (2).

Ricker, W.E., "Handbook of computations for biological statistics of fish populations", Bulletin of Fisheries Research Board of Canada, 1958, 119.

Rothschild, B.J., "An exposition on the definition of fishing effort", Fishery Bulletin, 1972, 70, 671-679.

Schaefer, M.B., "Some considerations of population dynamics and economics in relation to the management of marine fisheries", Journal of Fisheries Research Board of Canada, 1957, 14, 669-681.

Scherer, C.R., "Operational Management Models for Commercially Harvested Fisheries", (Mimeo) Engineering Systems Department, U.C.L.A.

Schmalensee, R., "A Note on the Theory of Vertical Integration", Journal of Political Economics, March/April 1973, 442-449.

Scott, A., "The Objectives of Sole Management", Journal of Political Economics, 1955.

Scott, A., Natural Resources: The Economics of Conservation. McClelland and Steward Ltd., 1973.

Scott, A., "Development of Economic Theory on Fisheries Regulation", Journal of the Fisheries Research Board of Canada, 1977, 36, 725-41.

Silvert, W. and W.R. Smith, "Optimal Exploitation of a multi-species Community", Mathematical Biosciences.

Slobodkin, L.B. Growth and Regulation of Animal Populations. New York: Holt, Rinchart and Winston, 1961.

Smith, J.B., "Exploitation of a Replenishable Natural Resource in a Stochastic Environment", Ph.D. dissertation, University of Western Ontario (1978).

Smith, V.L., "Economics of Production from Natural Resources," American Economic Review, 1968, 58, 409-43.

Smith, V.L., "On models of commercial fishing", Journal of Political Economics, 1969, 77, 181-198.

Smith, V.L., "General Equilibrium with a Replenishable Natural Resource", Rev. Econ. Studies, 1974 (August Supplement)

Smith, V.L., "Control Theory Applied to Natural and Environmental Resources: An Exposition", Journal of Environmental Economics and Management, 1977, 4, 1-24.

Solow, R.M., "The economics of resources or the resources of economics", American Economic Review, 1974, 64.

Solow, R.M., "Intergenerational equity and Exhaustible Resources", Rev. Econ. Studies, 1975 (Special Issue), 29-46.

Southey, Clive, "Policy prescriptions in bionomic models: the case of the fishery", Journal of Political Economics, 1972, 80, 769-775.

Spence, M., "Blue Whales and Applied Control Theory", Technical Report No. 108, Stanford University, 1973.

Tomlinson, J.W.C. and R. Vertinsky, "International Joint Ventures in Fishing and 200-mile Economic Zones", Journal of Fisheries Research Board of Canada, 1975, 32, 2570.

Turvey, R., "Optimization and suboptimization in fishery regulation", American Economic Review, 1964, 54, 64-76.

U.S. Department of Commerce, Basic Economic Indicators: Atlantic and Pacific Groundfish. Washington, D.C.: National Marine Fisheries Service, 1974.

Volterra, V. Lecons sur la Theorie Mathematique de la Lutte pour la Vie. Paris: Gauthier-Villars, 1931.

Vousden, N., "Basic Theoretical Issues of Resource Depletion", Journal of Economy Theory, 1973, 6, 126-143.

Walters, C.J., "A generalized computer simulation model for fish population studies", Translations of the American Fisheries Society, 1969, 98, 505-512.

Wang, A.Y. and K.S. Cheng, "Dynamic Analysis of Commercial Fishing Model", Journal of Environmental Economics and Management, 1978, 5, 113-127.

Waugh, G. and P. Calvo, "Economics of exhaustible resources: the fishery", Economic Record, 1974, 50, 423-429.

Williamson, Mark. The Analysis of Biological Populations. Unwin, 1972.

Wu, S.V., "The Effects of Vertical Integration on Price and Output", Western Economic Journal, March 1968, 18-34.