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Uncertainty and asymmetric information: An overview

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Abstract

This paper provides an overview of the literature on fisheries economics related to uncertainty and asymmetric information. It is argued that uncertainty is relevant in connection with present and future stock sizes and prices, while asymmetric information is important for cost functions, catches, catch per unit of effort, and effort. The literature on uncertainty and asymmetric information can be seen as providing the basis of an argument for using taxes in fisheries management. It is, therefore, surprising that over 55 countries regulate their fisheries with individual quotas, while taxes are not used at all.

Keywords: Asymmetric information; Uncertainty; Regulation

1. Introduction

In fisheries economic models, full certainty and perfect information have traditionally been assumed [1]. The models presented in the literature are designed to solve the open-access problem [2]. Under open-access, free entry and exit results in the expansion of fishing effort until average revenue equal average costs. As a consequence of open-access, the individual fisherman disregards resource conservation measures and, thereby, the effect that his harvest has on the harvest of other fishermen throughout the resource restriction. This is commonly referred to as a stock externality problem [3].

In order to solve the stock externality problem, taxes and individual transferable quotas (ITQs) have been proposed in the theoretical literature [2]. Under conditions of perfect information and in the absence of uncertainties, taxes and ITQs yield identical results. However, both regulatory approaches create huge information requirements. Both ITQs and taxes require that cost and growth functions are estimated, and a dynamic, non-linear control problem must be solved. The information necessary for regulating with ITQs and taxes is not always available and, therefore, informational problems may arise within fisheries. The purpose of this paper is to review sections of the economic literature on fisheries relating to informational problems in managing fisheries. The main criterion for selecting the literature reviewed is that it must be relevant for managing fisheries. In other words, only literature that makes a contribution to the regulation of fisheries is included in the paper.

As mentioned above, taxes and ITQs have been proposed in the literature on fisheries economics as methods of solving the stock externality problem. However, in practical fisheries management the idea of using taxes has been dismissed for at least three reasons. First, it is argued that the use of taxes creates substantial information requirements, making it difficult to calculate the optimal tax rate. Second, public appropriation of all or part of the resource rent through payment of tax revenue may be considered politically unattractive [4]. Third, the optimal tax rates may vary over time with variations in the stock size [5]. Therefore, optimal tax regulation may aggravate income fluctuations of the fishermen. These problems are considered to be so huge that tax regulation is not used at all within practical fisheries management, while individual quotas are used in over 55 countries [6].

However, these three arguments for dismissing taxes may be considered invalid. First, even though taxes create huge information requirements, exactly the same requirements

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arise with ITQs. For both taxes and ITQs a dynamic, non-linear control problem must be solved. Second, it is true that taxes result in public appropriation of part of the resource rent, but a tax mechanism can be so designed that a balanced budget is obtained or, alternatively, it is possible to transfer the tax revenue back to the fishing industry. Third, it is correct to say that the optimal tax varies over time with variation in the stock size, but the total quota in an ITQ system should also vary if the stock size changes. Thus, the extensive use of individual quotas and the absence of tax regulation may be considered surprising. Indeed, some recent literature on informational problems reviewed in this paper proposes taxes as a regulatory device that can solve informational problems. One of the main points made in these papers is that taxes, not ITQs, should be used to manage fisheries.

This paper is organised as follows. In Section 2 the types of informational problems that can arise are discussed from an intuitive viewpoint, while Section 3 reviews literature concerning uncertainty about stock size and natural growth functions. Asymmetric information with respect to costs is treated in Section 4, and literature concerning catches is introduced in Section 5. Section 6 discusses price uncertainties, while information problems regarding catch per unit of effort (CPUE) are treated in Section 7. Section 8 covers information problems with regard to effort, and Section 9 concludes the paper.

2. Types of informational problem

Two types of informational problem can arise within economics:

- uncertainty,
- asymmetric information.

These problems are relevant to the field of fisheries. Uncertainty exists when a regulatory authority (society) and the fishermen share the same information before decisions are made, but one variable, parameter or function is uncertain. It is often assumed that fishermen are risk neutral. Risk neutrality means that an economic agent is indifferent in the choice between a certain outcome and a gamble that gives the same expected payoff as the certain outcome. If fishermen are assumed to be risk neutral, it is then normally assumed that they will maximise expected profit, while society will maximise expected resource rent [7]. The possibility that fishermen are risk averse is also considered sometimes [7]. In this case the agent prefers a certain outcome over a gamble that yields the same expected payoff. In the case of risk aversion, fishermen maximise expected utility of profit.

A state of asymmetric information exists where the fishermen are better informed about a parameter, variable or function than society. Under asymmetric information, the concepts of moral hazard and adverse selection are important. Adverse selection describes the case where society has imperfect information about an exogenous parameter [8], while an endogenous variable is unobservable under moral hazard [9]. In analysing asymmetric information, a principal-agent approach can be adopted. In this approach, a principal (society) wishes to induce the agent (the fishermen) to do something that is costly to the fishermen, but society has imperfect information [10]. The purpose of the principal is to induce the agent to carry out optimal behaviour, and to do this the principal often makes use of an economic incentive scheme.

From the point of view of policy-making, the distinction between uncertainty and asymmetric information is important. With uncertainty, no direct conclusion can be deduced with respect to choices between prices and ITQs. In contrast, when a principal-agent approach is used, an economic incentive scheme is often recommended as regulatory device. This economic incentive is normally a tax/subsidy mechanism. Thus, uncertainty in itself leads to no direct policy conclusion, while asymmetric information often leads to the recommendation of taxes.

The following variables and functions are normally included in a fisheries economic model:

- stock size,
- natural growth functions,
- cost functions,
- catches,
- prices,
- CPUE,
- effort.

In the following sections we discuss the literature about uncertainty and asymmetric information concerning these variables and functions. We begin with the stock size and natural growth functions.

3. Stock size and the natural growth functions

There is a large literature on uncertainty or asymmetric information about stock sizes and natural growth functions, and this literature is often classified as stochastic bioeconomics (see [11] for an overview). Stochastic bioeconomics was developed in the seventies and eighties, and a body of literature based on stochastic bioeconomics has emerged recently on regulation under conditions of uncertainty or asymmetric information with regard to stock size and natural growth functions. In this section we sketch the results reported in two seminal articles within the field of stochastic bioeconomics [12,13], and also some results reported in the recent literature on uncertainty and asymmetric information about stock size and the natural growth function. Table 1 highlights important points in the literature that is surveyed.

In Section 3.1 we discuss adjustments of the golden rule [12], while Section 3.2 sketches optimal escapement