Curriculum Vitae

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Ph.D. project "The application of production functions in bioeconomic models"

Introduction

The management of the common fish resource in the European Union has primarily been based on biological advice, through stock assessments and biological consequence calculations of different management possibilities. Economic aspects have to be included in order to broaden the foundation for management regarding the fishery.

In order for fisheries economics to contribute more extensively to the management of the fisheries, it is important to be able to quantify economic models in order to match the biological advice. An economic model can be described as "a very simplified summarisation of our (imperfect) knowledge about the economic connections and mechanisms", The Secretariat of the Danish Economic Council (1990, p. 3, translated from Danish to English).

However a traditional economic model does not take into account the influence of natural capital (i.e. fish stocks etc.) on the actions of the economic agent. This capital can be classified as renewable and non-renewable resources. However, only the former is relevant in relation to fisheries. According to Pearce and Turner (1990) a renewable resource has the essential feature that it is not fixed over time.

Setting up economic models in the area of resource economics therefore demands the inclusion of a sub-model, which describes the biological development in the utilised resource. In fisheries it is therefore necessary to include biological characteristics for the different fish stocks that the fishermen exploit. Leaving fish stocks out of the analysis would give an incomplete model, because the level and development of fish stocks restrict what the fishermen can catch, and therefore influence their earning capability.

With this in mind the economic models should be developed to bioeconomic models (e.g. Hannesson (1992), Clark (1990)). A bioeconomic model can as mentioned by Cunningham, Dunn and Whitmarsh (1985) be regarded as "a special kind of model for fisheries analysis to take account both of biological and of economic forces".

Production functions

The essential link between biology and economics is described by the harvest (or production) function, and one of the most important parts of a bioeconomic model is therefore to determine this link and quantify the production of a fishing vessel (e.g. Carlson (1975) Anderson (1986)). The level of harvest or production is important in relation to both the feedback to the biological model (i.e. if more fish are caught, the fish stock will usually decrease) and to the level of revenue and cost, which thereafter determines the level of profit. Improved specification of the fisheries production function can therefore assist both biologists and economists in improving the knowledge derived from the bioeconomic model, not the least in relation to the advice given on appropriate levels of Total Allowable Catch (TAC) in EU fisheries.

Economists use the theory of production and production functions to describe the process where some kind of output is produced (e.g. Hannesson (1983), Cunningham, Dunn and Whitmarsh (1985), Bjørndal (1989)). There is a large and well-developed literature on the theory of production (e.g. Quirk (1987), Doll (1988), Andersen (1999)). Basically, a production function can be defined as "... the technical relationship between the inputs and outputs of a production process" (Coelli, Rao and Battese, 1999, p. 12).

Generally, the production in the fishery can be described as being determined by the level of fishing effort and fish stock (i.e. natural capital). The fishing effort concept is often applied by dividing into two components, namely fishing time and fishing power. The latter is determined by the level of man-made capital and labour capital.

The traditional method, when estimating production functions, has been to estimate "average" production functions. These functions indicate the level of output for given levels of inputs that the average vessel has. However, some vessel may be above "average" practice, and what if all vessels increased their output to "best" practice? For estimating this two new methods have arisen, which estimate "frontier" production functions. These are called Stochastic Frontier Approach (SFA) and the Data Envelopment Analysis (DEA). The former uses econometric analysis, while the latter uses mathematical programming.

Comprehensive literature on the SFA and DEA has emerged during the last 10 years (e.g. Fried, Lovell, Schmidt (1993), Charnes, Cooper, Lewin and Seiford (1994), Coelli, Prasada Rao and Battese (1999)).

Specifying the production functions raises different issues that need to be addressed. One important issue is the level of analysis, which can be looked at in two different dimensions. The horizontal dimension sets the unit that the analysis is carried out for (i.e. individual vessel, sub-fleet level or total fleet). The vertical dimension on the other hand covers the time dimension of the analysis (i.e. trip, monthly or yearly). If time (in terms of years) were included, measurement of technological development for the analysed vessels would be facilitated.

Another important issue is which physical attributes to include in the production function. Usually measures such as fishing time, tonnage and horsepower have been used, but other measures could also be thought of, such as length, depth, width, vessel type, skipper skills etc. (e.g. Squires (1987a, 1987b), Pascoe and Robinson (1998)).

The inclusion of the fish stock demands specific attention in production function estimation. This is especially the case, if the analysed fishery, like the Danish, are characterised by multispecies exploitation. Often some kind of stock index must be developed in order to account for the resource utilised.

Indicative thesis aims

Considering that the reliability of the results from a bioeconomic model is very sensitive to how well the production part of the model can be specified, the first aim of this thesis is therefore to estimate production functions for the Danish fishery for several different types of fleets and fisheries. These estimations will be done using several of the different estimation methods outlined above, and also looking at the issues raised above.

The second aim of the thesis is to include the different estimated production functions in the bioeconomic model that has already been developed at SJFI (Andersen and Frost (2000)), although the model requires to be further extended. This will make it possible to discuss the effects of using different production functions in Danish Fisheries, and improve the possibilities for:

1) Calculating the economic consequences of different management methods/regimes and exogenous shocks that might influence the fishermen and the fishing sector
2) Forecasting the economic development in the fishing sector in relation to the rest of the economy

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