SYDDANSK UNIVERSITET
Department of Environmental and Business Economics

Master's Thesis

Recovery of the Baltic cod fishery

(ICES subdivisions 25-32) -

perspectives revealed through bioeconomic modelling

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Abstract

The thesis describes the situation of Polish cod fishery in the Baltic Sea and its perspectives in the future. The paper sets up a general model and exemplifies it by simple functional forms taking its offset in the problem of overcapacity in Polish fleet causing lack of profitability of the sector. The viable control approach is used in order to determine dynamic compatibility with defined constraints when making an intertemporal decision regarding the regulations affecting the stock of interest and the economy of the sector. The paper illustrates how the dynamic optimisation methodology can be used to determine the Optimal Economic Intertemporal Path and reveals potential benefits of following it.

KEYWORDS: Atlantic cod, *Gadus morhua*, bioeconomic modelling,
viable control approach, fleet overcapacity, decommissioning programmes

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SUMMARY

The Master's Thesis treats the Baltic Sea Eastern cod stock (ICES subdivisions 25-32) and the management of this renewable resource in Poland. Cod is an important source of income for a number of the fishermen in the Polish coastal area, while having also an important structuring role in the ecosystem inhabited. Therefore, the significant decrease of this specie, which started in 1980s, gave a cause for concern and effective resource management was revealed necessary.

The bioeconomic modelling approach aim to combine biological and economic aspects of the fishery. The purpose is to find the balance between conservation and creating welfare for fishermen. The model of cod presented in this paper uses simple functional forms in order to describe dynamics of stock, profits associated with landings and pace of changes in the fleet size. The available data is used to determine parameters and define constraints for further application to the case. In the model, the steady-state relationship between stock and fleet size depends on effort level, which extreme cases correspond to minimum and maximum level of fleet for each biomass level. This set of states, bounded by minimum profitable biomass (constraint induced form minimum profit assumption), carrying capacity of the environment and minimum fleet size assuring continuation of fishery sector operation, is consider steady and includes points of particular interest: Maximum Sustainable Yield (MSY) and Maximum Economic Yield (MEY). The MSY is the set of steady states where the stock regeneration is maximised, whereas the MEY corresponds to maximum of Sustainable Economic Rent function where the total fleet profit is maximum. The latest available data (2009) indicates, that, according to the model, the current stock accounts for 70% of MSY and 63% MEY. In addition, the viable control approach is used to define viability kernel indicating states where there exist at least one intertemporal decision choice that will lead to steady-state without violating any constraint in infinite time.

The historical path presenting changes in cod biomass in the Baltic Sea and size of Polish fleet is shown to reach the viability kernel in 2008. Therefore, it is possible to indicate the Optimal Economic Intertemporal Path from this point. This is done by the present value of the revenues

maximization. The used methodology reveals potential benefits of following the optimal economic path as those results indicate significantly higher future profits, as well as gradual recovery of the stock of interest. The model outcomes shows possibility to reach 2,7 times bigger stock while increasing profits per vessel about 19 times if reducing the fleet size to 40% of current potential. For the purpose of comparison, the regulated open access showing the results of applying maximum effort for the whole available quota utilization is investigated as well. This system, based on scientific advices (ICES), but with final decision made within the European Union by the Council of Ministers responsible for fisheries shows the poor benefits which proves imperfection of current management regime.

The main conclusion of the model, however, is proven overcapacity of Polish fleet resulting in lack of efficiency in the sector. Therefore, the main recommendation for policy makers should comprise decommissioning scheme as an effective way of compromising stock conservation and positive returns from fishery. The optimal policy formulation designed for reaching the Optimal Economic Intertemporal Path is expected to bring positive revenues, as well as encourage investments in the living stock. The natural capital expenditure would lead to greater harvest and would be economically viable. Especially concerning recent increase of demand for cod, which import could be supplied by local market instead. Therefore effort into reasonable management would be beneficial, both for fish stocks and fishermen.

On the other hand, there is a big concern regarding applying this framework to the real life case as decrease of the Polish fleet would entail substantial losses of working places in the coastal zone. The local unemployment would constitute social problems as well as cost for municipalities affected by the decommissioning programme.

Taking into consideration all mentioned difficulties in cod management in the Baltic Sea, presented model gives an illustrative image of potential outcomes of certain policies applications. Its uncertainty regarding specific numbers may disqualify it for the strategic use in policy formulation in the present form, but it is a perfect tool for examination of the fleet overcapacity extent and highlighting the importance of reaching the Optimal Economic Intertemporal Path. The straightforward message arising from the model gives easy to understand call for system improvement and, promoted to the larger public, incentive to support management initiatives.