A policy assessment under uncertainty of fishery management and marine ecosystem: Japanese clam fishery collapse

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ABSTRACT

This study develops a fishery assessment model which will play an important role in facilitating policy design for the increasing real-world aquatic resource depletion and fishery collapse. The model considers economic and ecosystem uncertainties. Therefore, a dynamic computable general equilibrium model is formulated with the Gordon-Schaefer bioeconomic model and the Michaelis−Menten predator-prey model, and then the observation data is incorporated into the model for the statistical model estimation. The extended Kalman filter is applied for the model identification. Contrary to the conventional econometric model employing parameters of fishing vessels and fish equipments, the model defines the capital as those aggregates in a framework of the regional social accounting. This assumption cannot trace the substitutability between specific fishing elements, but gives a broader interpretation of not only the relation between the fishery and the rest of industry but also the global response over time. Especially, the identified model gives a comprehensive insight into the fishing effort of labor, the trend of technological change, trading markets, and the dynamics of marine ecosystem, i.e., predators and preys. Therefore, the model will provide information to get great performance out of policy mix when a specific resource management should be examined by the stakeholder.

An empirical study of the Japanese clam fishery collapse is performed by the identified model. The following results are obtained. The clam stock decreases by a little bit of overexploitation. The problem is the following feeding damage after the clam seedling releases with predators. The model predicts that the natural growth rate of clams gradually decreased to balance the clam reduction by feeding damage. This indicates that the resultant catch by fishing asymptotically approaches zero, i.e. the fishery collapse. According to the estimated input-output structure of the clam fishery, the growth accounting reveals excessive inputs of labor and capital even in the stable fishing period. In addition, the fishery output decrease can be explained by the total factor productivity.

From the analytical result, the fishery collapse occurs by the economic and ecological reasons; the weaken fishery in economic market over time and the drastic decrease of clam stock incurred by an ecologically improper seedling release. This study indicates that a certain policy mix, the economic policy to strengthen fishery and the ecological policy to recover the clam stock, should be sought as long as the clam remains a marine resource.