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Game theory and fish wars: The case of the Northeast Atlantic mackerel fishery☆

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ABSTRACT

Simple non-cooperative and cooperative game theory is used to explore the crisis involving the European Union (EU), Norway, Iceland and the Faroe Islands regarding the size and relative allocation of total allowable catches (TACs) in the mackerel fishery in the Northeast Atlantic. The analysis of the mackerel crisis is based on a statistical estimation of relevant functional relations, and the behavior of the players is explained using a fully specified empirical model. Simple, non-cooperative game theory shows that all players have an incentive to act non-cooperatively, a result that is robust to changes in basic assumptions regarding demand and cost functions. Thus, using the estimated parameters and functions, simple, non-cooperative game theory cannot explain the cooperative behavior of EU and Norway during the mackerel crisis. Simple cooperative game theory shows that no player has an incentive to enter a bargaining agreement by forming coalitions, a prediction that is consistent with the actual behavior of the EU, Norway, Iceland and the Faroe Islands between 2010 and 2014 when no bargaining solution was reached. Therefore, the fact that the EU and Norway entered a bilateral agreement in 2010 and that the EU, Norway and the Faroe Islands reached a bargaining solution in 2014 cannot be explained by simple cooperative game theory. However, actual behavior during the mackerel crisis can be explained by opportunity costs, including alternative fishing possibilities and regulations, rather than actual harvest costs, but we do not have information about the opportunity costs of harvesting mackerel.

1. Introduction

1.1. The policy problem

Until 2009, an agreement existed among the European Union (EU), Norway and the Faroe Islands regarding total allowable catches (TACs) for mackerel in the Northeast Atlantic Sea. According to this agreement, which was reached in 1999, each player received a fixed relative share of the yearly TAC (Iversen, 2002). However, in 2009, Iceland was officially recognized as a player in the fishery by the EU, Norway and the Faroe Islands, partly because of the dramatic increase in the Icelandic harvest of mackerel (The Icelandic Ministry of Fisheries, 2009; Table 1).

Table 1 shows that the harvest of mackerel by Icelandic vessels in the Northeast Atlantic increased dramatically during 2008–2012, and according to ICES (2010), this increase was mainly due to changed migration patterns of the mackerel. However, in 2013 and 2014,[1] the harvest of mackerel by Icelandic vessels began to decrease. Table 1 also shows that the harvest of blue whiting by Icelandic vessels decreased dramatically during 2006 and 2011 but increased again in 2013 and 2014. The decline in the harvest of blue whiting arose due to a considerable decline in recruitment for which two explanations can be cited. First, the amount of food for juvenile blue whiting was reduced (Hatun et al., 2009a). Second, the number of mackerel preying on juvenile blue whiting increased (Payne et al., 2012). In the Northeast Atlantic, blue whiting and mackerel are harvested by the same types of vessels thus giving Icelandic vessels the flexibility to shift between these fisheries. Indeed, Hatun et al. (2009a,b) and Andrews and Nichols (2013), claim that vessels previously fishing blue whiting shifted to fishing mackerel.

Due to this increase in the mackerel harvest, Iceland entered into negotiations with the EU, Norway and the Faroe Islands over the size and relative allocations of the TAC for the Northeast Atlantic mackerel, but no agreement among the players was reached. In

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[1] The harvest for 2014 is an estimated value.

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Table 1
Harvest of blue whiting and mackerel by Icelandic vessels in the Northeast Atlantic Sea, 1000 t.

	Blue whiting	Mackerel
2006	40,200	4
2007	39,200	38
2008	5560	112
2009	3624	116
2010	4873	121
2011	3871	159
2012	6579	149
2013	10,491	124
2014	12,130*	113[a]

Source: ICES (2013) and Anon (2013).
[a] Indicates estimated harvest levels.

2010, the EU and Norway entered into a bilateral agreement over their relative allocations of the TAC for a 10-year period (The Norwegian Ministry of Fisheries, 2010a). Despite this bilateral agreement, Iceland increased its harvest of mackerel by 23% in 2010 while the Faroe Islands increased its harvest by 15% (ICES, 2010). In total, the harvest in 2010 was approximately 930,000 t, which was 40% above biological recommendations (ICES, 2010). In 2010, the EU and Norway responded by banning landings of vessels from Iceland and the Faroe Islands (The Norwegian Ministry of Fisheries, 2010b). After 2011, several rounds of bargaining were attempted, all of which failed. However, in 2014, the EU, Norway and the Faroe Islands entered into an agreement regarding the size and relative allocations of the TAC covering the period from 2014 to 2018 (The Norwegian Government, 2014). According to this agreement, the relative shares of the TAC for the EU and Norway are reduced, while the share for the Faroe Islands is increased. Iceland, however, was not part of this agreement and continues to be sanctioned by the EU and Norway.

Behind the mackerel crisis lays a messy political process. The EU and Norway reacted strongly to the decisions of Iceland and the Faroe Islands to increase their mackerel harvests. The EU and Norway claimed that the mackerel stock had been within safe biological limits, as defined by ICES (2008), before the increase in the harvest but that the stock would eventually fall outside of safe biological limits as a result of the increased harvest (Andrews and Nichols, 2013). Therefore, the EU and Norway decided to ban landings by vessels from Iceland and the Faroe Islands in their harbors. This conflict intensified when a Faroese vessel (the Jupiter) was unable to land fish in a harbor in Aberdeen because Scottish fishermen had blocked entry to the harbor (Orebech, 2013). In the press, the skipper of the Jupiter claimed that the blockade cost him €400,000. However, a Scottish skipper, Ian Gatt, justified the blockade, saying, "It costs thousands of jobs in Scotland and drives the mackerel price down". In addition, Ian Gatt claimed that environmentally friendly consumers would substitute away from mackerel if the fish stock in the Northeast Atlantic fell below safe biological limits. Following the Jupiter event, the EU, Norway, Iceland and the Faroe Islands entered into negotiations in Oslo to find a solution to the mackerel crisis. However, these negotiations ended without an agreement. The EU then condemned the behavior of Iceland and the Faroe Islands, stating that an Icelandic application for full EU membership would be negatively affected by the crisis (Andrews and Nichols, 2013). In 2012, the mackerel stock was declared to be below safe biological limits by ICES (2012). Following this declaration, the EU and Norway imposed additional trade restrictions on Iceland and the Faroe Islands in 2013. The justification was again the increased mackerel harvest. As a Scottish politician stated in the press, "The mackerel crisis is about jobs, economics, sustainability, and fairness, and the acts by Iceland and Faroe Islands cannot be justified and are not sustainable". In 2013, Iceland declared that it was willing to reduce its harvest of mackerel by 15%, provided the EU and Norway reduced their harvests by the same amount. However, the EU and Norway rejected the Icelandic proposal, stating that the Icelandic share of the total harvest was too large (Andrews and Nichols, 2013). At the same time, the Faroe Islands threatened to take the EU and Norway to court through the United Nations over trade restrictions. In 2013, the EU declared that Iceland could not become a full member of the EU, in part because of the mackerel crisis (Orebech, 2013). Simultaneously, the EU, Norway, and the Faroe Islands entered into negotiations on a revised management plan for the Northeast Atlantic mackerel stock. However, before these negotiations began, ICES refused to deliver recommendations for a target stock size. Despite this, the three players concluded an agreement (ICES, 2014) that includes a target stock size for 2015 and relative allocations of the TAC over a 5-year period.

1.2. The main research questions

The mackerel crisis is an example of a situation in which strategic interactions occur among economic agents (countries). Economists study such interactions using game theory within which there are two main schools of thought. The first is non-cooperative game theory in which no communication, cooperation, or bargaining occurs among players (Friedman, 1979). The second school of thought is cooperative game theory, which involves cooperation (for example, bargaining agreements) among players (Hougaard, 2009). The purpose of this paper is to investigate whether the behavior of the EU, Norway, Iceland, and the Faroe Islands during the mackerel crisis can be explained using simple game theory. Specifically, the paper aims to answer the following three research questions:

1. Why did Iceland and the Faroe Islands decide to increase their harvests in 2010 while the EU and Norway entered into a bilateral agreement?
2. Why was no bargaining solution among the EU, Norway, Iceland, and the Faroe Islands concluded during the period from 2010 to 2014?
3. Why did the EU, Norway, and the Faroe Islands reach a bargaining agreement in 2014?

Non-cooperative game theory is applied to answer the first research question, while cooperative game theory is utilized to answer the second and third research questions. Answering these three research questions requires an empirical model of the mackerel fishery in the Northeast Atlantic, and such a model is presented in this paper.

1.3. Description of the game

When investigating the mackerel crisis, a negatively sloped demand function, and inclusion of a resource restriction are assumed. Therefore, strategic interactions occur due to both price effects and fish stock effects. In principle, the model presented in this paper should be solved as a system of several equations and unknowns (Arnason et al., 2000a). However, it is difficult to interpret the results derived from such a procedure, and a simpler solution method is employed. It is assumed that each player harvests a constant share of the fish stock in each period and that payoffs are determined by using the steady-state harvest levels reached by this procedure in the payoff function. With a negatively sloped demand function and a resource restriction, each player acts like a social planner under non-constant prices but without maximizing an objective function. Additionally, the implications of including only one type of strategic interaction have