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Non-obvious aspects of modelling common resources and markets using dynamic games

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In this project, we shall work on mathematical methods of solving problems of exploitation of common resources and modelling markets using dynamic games. We shall propose a new method replacing the method used by now, which seems erroneous in the light of counterexample we have found. Large focus will be given to verification and completing proofs of results using new results of dynamic optimization. This will especially concern seminal papers in those fields, on which further research is based, imitating often also methodology, although in the light of knowledge then such a methodology did not have to result in correct results, while current tools to study such models are being developed now.

The research will encompass:

— Work on analytical methods used in class of nonzero-sum dynamic games, which contains dynamic games of common resource extraction and dynamic market models.

— Verification of models that belong to the "Fish Wars" class, starting from seminal paper of Levhari and Mirman.

— In-depth analysis of dynamic games models of markets using new tools.

— Analysis of models joining both applicational aspects, i.e. models of exploitation of common renewable resources in which participants meet at a common market.

The nature of many economic phenomena, including exploitation of common renewable resources and markets, joins three important aspects: optimization of each participant in order to maximize their own utility, interaction with the others and dynamics inherent to the problem. The only tool which encompasses all these three aspects are dynamic games.

In this field, there are many papers, but results are very partial. The reason is that in dynamic games calculation of anything is much more difficult than in analogous dynamic optimization problems—introducing additional interacting participants into a dynamic optimization problem with results that can be calculated, makes it much more complex. The class of games for which results can be computed, even only using numerical methods, is very small. When applicational aspects are considered, we can show that this class further decreases. For example, introducing any binding constraints, even if it is a trivial assumption that production is nonnegative or that exploitation does not exceed the amount of resource, changes the solution drastically. Besides, as our current research suggests, using some methods working perfectly in dynamic optimization problems, may result in errors while calculating equilibria.

Using new tools, we are going to enlarge the set of solved models of exploitation of common renewable resources and markets, and complete those which are incomplete by now. It is worth emphasizing the this class of incompletely solved models contains such classics of the fields as Levhari and Mirman on Fish Wars, while in modelling of markets Fershtman and Kamien's. So, being sure that results contained therein are correct, seems crucial for applications of dynamic games in those fields. It is also worth emphasizing that metodology of initial papers is often imitated in their continuations. Therefore, making sure that results proposed in such seminal papers are correct, is very important.