Abstract

In this dissertation, presented in three essays, we develop and apply the theory of dynamic games played over event trees. In such games, the stochastic process is exogenously given as an event tree, that is, the transition from one node to another is nature’s decision and cannot be influenced by the players’ actions.

In the first essay, entitled "S-Adapted Equilibria in Games Played Over Event Trees with Coupled Constraints", we consider a game where a set of players are engaged in a non-cooperative game over time, with some parameters being stochastic while the players face joint or coupling constraints. An example of such setting is an industry formed of a set of firms competing in a market described by a stochastic demand law, where a regulator is imposing a global cap on emissions of some pollutants by the industry. This setting presents some conceptual as well computational difficulties, which are due to mixed nature of the problem. Indeed, whereas the game is non-cooperative in its market competition aspect, it has a cooperative flavor as the players need to coordinate to satisfy the joint constraints at each period and each node of the event tree. The relevant solution concept in this context is the so-called normalized, or generalized Nash equilibrium. The main contribution of this essay is in the characterization of this equilibrium in the class of dynamic games played over event trees (DGPET).

The second essay addresses the main issue in cooperative dynamic games on how to sustain cooperation over time, that is, how to ensure that each player will indeed implement her part of the agreement as time goes by. In this article entitled "Incentive Equilibrium Strategies in Dynamic Games Played over Event Trees", we design incentive strategies to sustain cooperation. We characterize incentive equilibrium strategies and outcomes for the class of DGPET. We show that the coordinated solution that optimizes the joint payoff can be achieved as an incentive equilibrium, and therefore is self supporting. We focus on two popular classes of dynamic games in applications, namely, linear-state and linear-quadratic games.

In the third essay, entitled "Cost-Revenue Sharing in a Closed Loop Supply Chain Played over Event Trees", we consider a supply chain formed of one manufacturer and one retailer. As producing with used parts is more efficient than producing with exclusively new material, the manufacturer invests in green activities (GA) to encourage consumers to bring back their used products at the end of their useful life. Two scenarios are analyzed and compared, namely, a scenario where the retailer is not involved in GA, and a second where the retailer pays part of the GA cost. In return, the manufacturer reduces the wholesale price by an amount that depends on the return of used products. Both games are played non-cooperatively à la Stackelberg, with the retailer acting as leader and the manufacturer as follower. Also, in both games, we assume that the demand is stochastic.

Keywords: Dynamic games, Event tree, Uncertainty, Normalized equilibrium, Coupled constraint, Incentive equilibria, Cooperation, Closed-Loop supply chain, Pollution control.