

Preface

The theory of dynamic games provides important instruments for economic analysis. At the same time, the progress of this theory and the associated analytical and numerical methods is largely driven by problems arising in dynamic economic considerations. With the aim of promoting and facilitating the development of optimal control and dynamic games and their applications in economics, the Vienna University of Technology founded a conference series named “Viennese Workshop on Optimal Control, Dynamic Games and Nonlinear Dynamics” (abbreviated as VW), in which specialists in optimal control, dynamic games and dynamical systems gathered with economists, demographers, and social scientists. The research covered by the 12 VWs organized to date ranges from “strange and chaotic behavior” (in the first few workshops) to games involving stochastic dynamics that dominate the dynamic games component (in the last VW).

The present book originates from the most recent, 12th VW, held in Vienna between May 30th and June 2nd, 2012. However, the aim of the editors was to collect papers that present, together, a broader view of the state of the art of dynamic games in economics. Therefore, along with contributions of selected participants in the 12th VW, the book includes several additional contributions by specially invited distinguished scientists in the area. Each chapter consists of a single contribution (paper) and the chapters are ordered alphabetically according to the name of the first author.

The first chapter (“Robust Markov Perfect Equilibria in a Dynamic Choice Model with Quasi-hyperbolic Discounting”) deals with intergenerational game setup with an infinite (countable) number of descendants (copies) of an agent as players against Nature in which each copy represents a generation. The utility of each generation depends on its own choice as well as on the utility of consumption of all descendants. Unlike existing publications, in which the transition probability function is completely known, in the present chapter this function depends on uncertain parameters. The chapter applies the concept of quasi-hyperbolic discounting to an infinite horizon stochastic game and proves two existence theorems for a robust Markov perfect equilibrium.

Chapter “Stochastic Differential Games and Intricacy of Information Structures” deals with the analysis of information structural problems in the context with two-

player zero-sum stochastic dynamic games. First, the chapter recapitulates results for constructing saddle point equilibria (SPE) for stochastic games with a noisy measurement channel, especially through the concept of certainty equivalence. The innovative part of the chapter extends existing results for the construction of SPE to a case in which the noisy measurement channel fails intermittently. The general analysis of the information structural problem is illustrated by the complete solution of a two-stage zero-sum game.

The main contribution of chapter “Policy Interactions in a Monetary Union: An Application of the OPTGAME Algorithm” is the analysis of a small nonlinear two-country macroeconomic model of a monetary union in which the governments control the fiscal policy while the central bank controls the monetary policy (the central bank sets monetary instruments). It is assumed that the players have different objective functions and the conflict is analyzed using concepts of dynamic game theory. The chapter follows a numerical approach based on a previous study (forthcoming) in which the authors have described the algorithm OPTGAME. The algorithm proved to be flexible enough to accommodate several scenarios and four game strategies (one cooperative and three non-cooperative).

Chapter “The Dynamics of Lobbying Under Uncertainty: On Political Liberalization in Arab Countries” presents an extension of a topical lobbying differential game between a conservative elite and a reformist group by introducing uncertainties to the model; the conservative elite pushes against political liberalization in opposition to the reformist group. It applies a rarely used approach of differential games that introduces multiple equilibria in different kinds and through a different mechanism.

Chapter “A Feedback Stackelberg Game of Cooperative Advertising in a Durable Goods Oligopoly” analyses a deterministic infinite horizon hierarchical game, in which the manufacturer as the leader decides strategically what fraction of retailers’ advertising expenditures will be recompensed/subsidized. The retailers, themselves, determine as followers their individual advertising strategy. Postulating durable goods the authors use the concept of feedback Stackelberg equilibrium to compute optimal advertising policies and subsidy rates for various setups, for example, in case of N identical or in case of two non-identical retailers. In the case of a retail channel with two retailers, the authors explore the impact of cooperative advertising on channel and supply chain coordination.

Chapter “Strategies of Foreign Direct Investment in the Presence of Technological Spillovers” focuses on the effects of technological spill-overs, generated by foreign direct investments, have on the evolution of the technology gap. More specifically, a differential game is employed to model the dynamic strategic interaction between two competing firms located in high and low-tech countries, respectively. Due to the highly non-linear structure, numerical methods are utilized to characterize the Markov perfect equilibria of the game.

Chapter “Differential Games and Environmental Economics” provides a review of several publications (including such by the author) that aims to explain several concepts and techniques in the differential games and their applications to environmental and resource economics. However, it is more than a simple compilation of

results. The chapter moves from the basics of differential games to recent scientific outcomes in the resolution of two very well-known examples: the game of international pollution and the lake game. The chapter presents the main questions and results in a unified framework. These examples are simple enough to have some analytical solutions, but rich enough to capture the principal techniques and the informational difficulties when solving differential games. The chapter makes it clear that differential games are not a simple and straightforward extension of optimal control problems to the case of several agents.

Chapter “Capacity Accumulation Games with Technology Constraints” considers a dynamic bilateral monopoly of two firms, one of which is the provider of input to the other, where the firms must work together to obtain surplus. Taking the strategy of the other firm into account, the firms decide on their own investment strategies in order to gain higher individual payoffs. A crucial point of the chapter is that, given overall technology constraints, technology interdependences are allowed. The authors investigate how different types of contracts (based on input quantities and on final revenues, respectively) affect efficiency and market power. In a framework of a linear-quadratic non-cooperative deterministic two-player dynamic game example, the authors numerically derive Markov perfect equilibria and point out the influence of the two types of long-term contracting.

Chapter “Dynamic Analysis of an Electoral Campaign” considers a deterministic differential game, in which political parties as players invest in order to maximize their individual aggregated benefits resulting from their particular patronage of voters over a finite planning horizon. The scientific work of this chapter investigates, which impact political parties’ strategies and the number of political parties have on the social optimum. The social optimum is defined as to minimize the number of non-voters in a cooperative solution of the game. The main result is that a political party will have lesser votes in its noncooperative optimum than will have in the cooperative case, as long as its campaign is aggressive enough to destroy political rivals’ consensus substantially. Further the chapter shows that in the social optimum (cooperative game) the optimal number of political parties is lower than the number of political parties that gain a positive share of consensus (votes) in the noncooperative game.

Chapter “Multi-agent Optimal Control Problems and Variational Inequality Based Reformulations” deals with multi-agent dynamic games, the novelty of which is that each player’s cost functional and strategy set are dependent on her rivals’ decisions. In this context, a publication in the journal *Mathematical Programming* studies a reformulation of the game as a system of differential equations constrained by parameterized variational inequalities, along with some boundary conditions. This chapter of the book extends this reformulation to stochastic multi-agent dynamic games in which the state dynamics is noisy.

Chapter “Time-Consistent Equilibria in a Differential Game Model with Time Inconsistent Preferences and Partial Cooperation” studies differential games with time-inconsistent preferences. Non-cooperative Markovian Nash equilibria are derived as a benchmark. Time-consistent solutions under partial cooperation—in which players can cooperate at every instant of time—are also obtained. Cooperation is partial in the sense that, although players cooperate at every moment t

forming a coalition, due to the time inconsistency of the time preferences, coalitions at different times value the future in a different way and are treated as different agents. Finally, Markovian subgame perfect equilibria in the cooperative sequential game are derived.

Chapter “Interactions Between Fiscal and Monetary Authorities in a Three-Country New-Keynesian Model of a Monetary Union” presents important issues concerning the macroeconomic policy coordination of fiscal (governmental) and monetary (central bank) authorities in the European Monetary Union in the presence of different types of economic shocks. The authors have used continuous-time linear-quadratic differential games based on a multi-country New-Keynesian monetary union framework to investigate strategic interactions of n heterogeneous countries that are both cooperative or in conflict with the (single) central bank. The novelty of this chapter is that the authors consider various types of coalitions including non-cooperative regimes, partial fiscal cooperations, full fiscal cooperation of all countries, and the grand coalition (including the central bank). Numerical simulations for different types of shocks reveal some interesting results, including unexpected main results and policy suggestions, and the fact that full cooperation without an appropriate transfer system is not a stable configuration.

The final chapter (“Subgame Consistent Cooperative Provision of Public Goods Under Accumulation and Payoff Uncertainties”) deals with discrete-time dynamic games, in which both state dynamics and payoffs are uncertain. In detail, the authors consider noisy stock accumulation dynamics and derive subgame consistent cooperative solutions for n asymmetric players, who try to optimize distributed expected future payoffs gained from public goods. To ensure subgame perfect solutions upon optimality principle, the authors develop a suitable payoff distribution procedure.

We are confident that the material presented in this book will be appreciated by researchers and graduate students in applied mathematics and economics. For the latter group especially, we recommend chapters “Policy Interactions in a Monetary Union: An Application of the OPTGAME Algorithm,” “A Feedback Stackelberg Game of Cooperative Advertising in a Durable Goods Oligopoly,” “Strategies of Foreign Direct Investment in the Presence of Technological Spillovers,” “Differential Games and Environmental Economics,” “Dynamic Analysis of an Electoral Campaign,” and the first two sections of chapter “Multi-agent Optimal Control Problems and Variational Inequality Based Reformulations.”

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