Game Theory and Strategic Decisions with Applications in Economics
M.Sc. in Finance and Banking
Athens University of Economics and Business
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What is this Course about: Purpose and Aims

Game theory studies strategic situations. It is the science of strategic decision making. It has been used to great effect in sciences as diverse as evolutionary biology and economics.

The chief purpose of this course is to enable the student to set up, study and solve games, especially games that arise in business and economics. To acquire a taste of the type of situations we would be interested in as well as the type of questions we would be asking, think of the following "real-life" situation:

"A company, say Coke, is considering entering the Russian market which is dominated by its principal rival, say Pepsi. Clearly, Coke's decision to enter or not will be judged on the potential profitability of such a move. This, in turn, depends upon the way Pepsi will react to such a business move by Coke. If Pepsi reacts aggressively (by launching, for instance, a big commercial campaign), then an entry by Coke will result to a loss of $2 billion for Coke and a loss of $1billion for Pepsi. If, on the other hand, Pepsi accommodates Coke's entry, then both Coke and Pepsi will be making profits of $1 billion and $2 billion, respectively. Finally, if Coke does not enter the market at all, then Pepsi will be making monopoly profits of $5 billion".

Question: What would you do if you were the CEO of Pepsi? Would you play aggressively or would you accommodate Coke's entry? What about if you were Coke's CEO? Would you enter the Russian market or would you not? How important the timing of the decisions made by the two companies is for the outcome of the game?

As said, this course is designed for people in business, for managers. It is as theoretical as necessary for providing an introduction to the science of game theory; and practical in that it offers many applications and case studies to make it attractive

to managers in both the commercial and non-profit sectors, as well as to students in business.

It is intended to help managers to expand the conceptual framework within which they operate and, in this way,

- to encourage them develop more powerful generic problem-solving skills;
- to resolve practical difficulties, when they occur, more efficiently and more effectively;
- to acquire a deeper understanding of incentives, conflicts, cooperation, threats, promises and timing of actions;
- to discover alternative perspectives on problems which, even when they do not offer clear-cut solutions, they, at worst, lead to a better understanding of strategic decision making;
- to comprehend better the nature of power in multi-person systems and in committee-like structures within organizations.

Having said all this, it should also be emphasised that game theory –and, certainly, this course- is not a panacea for the shortcomings of bad management. It is a tool which, like all others, is best used by those who reflect on their own practice and are prepared to seek ways and mechanisms for improvement. Chance favours a prepared mind and this series of lectures is intended for those who are seeking effectiveness as for those who have already found it.

It has been said, by way of an excuse for curtailing knowledge, that a person with two watches never knows what time it is! Unfortunately, managers cannot afford the luxury of such easy "way-outs". Research suggests that good managers are well informed, multi-skilled and flexible in their approach to problem solving. Organisations are increasingly complex places where managers must continuously balance opposing forces. Know-how of dealing with such tensions within his or her own organisation and among competing organizations is often what distinguishes a failing manager from a successful one. Game theory has clearly been successful in

describing what is to be a decision maker today and this course is for those who are willing to risk knowing more.

Teaching Material:

Notes of the Instructor: Those contain, besides theory, 60 solved Examples and 26 Exercises to be solved by students (as many of the exercises are actually groups of exercises, their actual number is 60). Students will solve these exercises in take-home assignments and will then be provided with their solutions.

The basic book that can be used in this course is:
Prajit K. Dutta, *Strategies and Games, Theory and Evidence*, MIT Press

Course Description:

The course will be organised on the basis of the following teaching units. It should be emphasised that each unit does not correspond to a lecture one-to-one.

Unit 1

Characteristics of Games

What is a game? We start by presenting the basic, common elements of any game, business game or otherwise.

Keywords: Players, Rules, Strategies, Outcomes, Strategic Interaction

Unit 2

Taxonomy of Games

Games can be distinguished from one another in a number of different ways. There can be games of cooperation and games of conflict. There can be games in which players act "today" with their eyes turned to the future and games in which they don't. A very important distinction between games concerns the quality of information players have regarding the economic environment in which they operate.

Keywords: Cooperative and Non-cooperative Games; Games of Perfect and of Imperfect Information; Games of Complete and Incomplete Information; Static and Dynamic Games

Unit 3

Description of a Game

Describing a game appropriately, by putting it in a form in which it can be studied, is the first and fundamental step one must take. Like in all problems, setting them up correctly consists of half the solution. There are two alternative ways of formatting a given game, each one being more conducive to certain game characteristics than the other. These two formats are closely related to each other.

Keywords: Extensive Form and the Game Tree (decision nodes and terminal nodes, actions, information sets, payoffs); Strategic or Normal Form (players, strategies, payoffs)

Case Study: Electing the UN Secretary General (Setting Up the Game)

Case Study: Art Auctions (Setting Up the Game)

Unit 4

Solution Concepts for Games in Strategic Form - Part I

Having learned how to set up a given game we now turn to the question of how we can predict its outcome, its solution. We start by discussing solution concepts for games in strategic form. This introduces us, among others, to better comprehend the concepts of strategic thinking and of strategic interdependence between the players of a game.

Keywords: Strict or Strong Dominance; Weak Dominance; Solution in Dominant Strategies; Iterated Dominance; Solution in Iterated Dominant Strategies

Case Study: Electing the UN Secretary General (Solving the Game)

Case Study: Art Auctions (Solving the Game)

<u>*Unit 5*</u>

Solution Concepts for Games in Strategic Form - Part II

We continue our discussion on solution concepts for games in strategic form by introducing the most fundamental equilibrium concept in game theory, that of Nash equilibrium. We investigate its relation with the solution concepts introduced in the previous teaching unit. We then turn to the issue of players' randomizing between their strategies and the related concept of Nash equilibrium in mixed strategies. We address questions such that "what does it mean that people choose strategies in a probabilistic way?", or, "do actually people behave like that?" We close this teaching unit by casting a fresh look on Cournot and Bertrand duopoly models.

Keywords: Nash Equilibrium (in Pure Strategies); Nash Equilibrium and Solution in Dominant Strategies; Mixed Strategies; Nash Equilibrium in Mixed Strategies

Case Study: Cigarette Television Advertising in the US (Based on F. Scherer, Industrial Market Structure and Economic Performance, 2nd edition, Boston: Houghton Mifflin, 1980)

Case Study: The "Every Day Sales" Policy of Sears (Based on H. Varian, "A Model of Sales", American Economic Review 70, 1980:651-659

Case Study: Random Drug Testing

Case Study: Today's OPEC

<u>*Unit 6*</u>

Solution Concepts of Games in Extensive Form – Part I

We turn our attention to the study of solution concepts in games in extensive form. This game form is more convenient for studying dynamic games. The fact that "today's" choices by any player may affect "tomorrow's" options and choices of all players offers a fertile ground to develop concepts such as "threats" and "promises". We start off by discussing the simplest variant of such games, namely games in which each player has perfect knowledge of the environment in which he or she operates. We develop the concept of sequential rationality that forms the building stone of the backwards induction method by which the Nash equilibrium of such games is computed. We relate this solution to that of dominance in strategic form games. We develop the concept of credible and non-credible threats as well as that of commitment. We discuss the importance of timing in the sequence of actions taken by players. We conclude this teaching unit by casting a fresh look on Stalkeberg duopoly models.

Keywords: Backwards Induction in Games of Perfect (and Complete) Information; Sequential Rationality; Backwards Induction and Dominance Solvability; Credible and Non-credible Threats; The Power of Commitment; The First Move Advantage or Disadvantage

Case Study: Patents on Innovations and New Products

Case Study: Poison Pills and Other Takeover Deterrents

<u>*Unit 7*</u>

Solution Concepts of Games in Extensive Form – Part II

We continue our discussion on equilibrium concepts in extensive form games, by considering now games of imperfect information. In particular, the imperfection of information stems from the fact that one or more players do not know the entire "history" of the game, i.e., how the game has been unfolding up to the point they are about to undertake an action. We develop the concept of a sub-game of a game and then combine that with the concept of group rationality to develop a fundamental equilibrium concept for dynamic games: that of sub-game perfect Nash equilibrium.

Keywords: A Sub-game of a Game; Sub-game Perfection in Games of Imperfect Information; Sub-game Perfect Nash Equilibrium

Case Study: Peace in the World War Trenches

<u>*Unit 8*</u>

Repeated Games

We move on to studying games which are repeated in time, when, that is, players come in repeated market or business conduct. One interesting feature of such games is that a cooperative behaviour may be established between players with otherwise conflicting interests. What binds them together in a pattern of "good" behaviour is the fact that "punishments" can be triggered otherwise. The concept of "trust" that characterises many market or business situations can be seen arising as an equilibrium outcome of such repeated games. We analyse the importance of a game being repeated finitely or infinitely many times and we relate that to market or business situations.

Keywords: The Stage Game; Finitely Repeated Games; Nash Equilibrium in Finitely Repeated Games; The "Folk Theorem" for Finitely Repeated Games; Multiple Equilibria in the Stage Game and "Good" Behaviour Among Players in Finitely Repeated Games; Infinitely Repeated Games; Trigger Strategies in Infinitely Repeated Games; Nash Equilibrium in Trigger Strategies; The "Folk Theorem" for Infinitely Repeated Games; Trigger Strategies and "Good" Behaviour Among Players in Infinitely Repeated Games

Case Study: OPEC in the 70's

<u>*Unit 9*</u> *(if there is time and the class spirit is high)*

Static Games of Incomplete Information

Up to now we have been discussing games in which any imperfection of information was related to not knowing the exact "history" of previous actions players have taken. In all cases, however, all players knew the exact

characteristics of their opponents, their “types”. Put differently, all players knew exactly what game they were playing. Now we turn to cases where one or more players do not know the exact characteristics of their opponents. Not knowing the characteristic of your opponent is equivalent to not knowing exactly the game you are involved. It is a different think, for instance, to face a low-cost rival than a high-cost one: the consequences of the same actions taken by you and your rival will result to different payoffs in each case. Therefore what is best for you may differ in each case. We discuss how to model such games and how to find the equilibrium in the case of their static variant, the Bayesian-Nash equilibrium.

Keywords: “Types” of players; Transformation of Games of Incomplete Information to Games of Imperfect Information; “Type”-conditional Strategies; Bayesian-Nash Equilibrium