**STUDY MATERIAL 1 Module -11 ECONOMICS HONOURS SEMESTER –I CC 1-1 2019-20**

What economists call game theory psychologists call the theory of social situations, which is an accurate description of what game theory is about. Although game theory is relevant to parlor games such as poker or bridge, most research in game theory focuses on how groups of people interact. There are two main branches of game theory: cooperative and noncooperative game theory. Noncooperative game theory deals largely with how intelligent individuals interact with one another in an effort to achieve their own goals. That is the branch of game theory I will discuss here.

In addition to game theory, economic theory has three other main branches: [decision theory](http://www.dklevine.com/general/whatis.htm#Decision%20theory), [general equilibrium theory](http://www.dklevine.com/general/whatis.htm#General%20equilibrium%20theory) and [mechanism design theory](http://www.dklevine.com/general/whatis.htm#Mechanism%20design%20theory). All are closely connected to game theory.

*Decision theory* can be viewed as a theory of one person games, or a game of a single player against nature. The focus is on preferences and the formation of beliefs. The most widely used form of decision theory argues that preferences among risky alternatives can be described by the maximization of the expected value of a numerical utility function, where utility may depend on a number of things, but in situations of interest to economists often depends on money income. Probability theory is heavily used in order to represent the uncertainty of outcomes, and Bayes Law is frequently used to model the way in which new information is used to revise beliefs. Decision theory is often used in the form of decision analysis, which shows how best to acquire information before making a decision.

*General equilibrium theory* can be viewed as a specialized branch of game theory that deals with trade and production, and typically with a relatively large number of individual consumers and producers. It is widely used in the macroeconomic analysis of broad based economic policies such as monetary or tax policy, in finance to analyze stock markets, to study interest and exchange rates and other prices. In recent years, political economy has emerged as a combination of general equilibrium theory and game theory in which the private sector of the economy is modeled by general equilibrium theory, while voting behavior and the incentive of governments is analyzed using game theory. Issues studied include tax policy, trade policy, and the role of international trade agreements such as the European Union.

*Mechanism design theory* differs from game theory in that game theory takes the rules of the game as given, while mechanism design theory asks about the consequences of different types of rules. Naturally this relies heavily on game theory. Questions addressed by mechanism design theory include the design of compensation and wage agreements that effectively spread risk while maintaining incentives, and the design of auctions to maximize revenue, or achieve other goals.

**An** **Instructive Example**

One way to describe a game is by listing the players (or individuals) participating in the game, and for each player, listing the alternative choices (called actions or strategies) available to that player. In the case of a two-player game, the actions of the first player form the rows, and the actions of the second player the columns, of a matrix. The entries in the matrix are two numbers representing the utility or payoff to the first and second player respectively. A very famous game is the Prisoner's Dilemma game. In this game the two players are partners in a crime who have been captured by the police. Each suspect is placed in a separate cell, and offered the opportunity to confess to the crime. The game can be represented by the following matrix of payoffs

|  |  |  |
| --- | --- | --- |
|  | not confess | confess |
| not confess | 5,5 | -4,10 |
| confess | 10,-4 | 1,1 |

Note that higher numbers are better (more utility). If neither suspect confesses, they go free, and split the proceeds of their crime which we represent by 5 units of utility for each suspect. However, if one prisoner confesses and the other does not, the prisoner who confesses testifies against the other in exchange for going free and gets the entire 10 units of utility, while the prisoner who did not confess goes to prison and which results in the low utility of -4. If both prisoners confess, then both are given a reduced term, but both are convicted, which we represent by giving each 1 unit of utility: better than having the other prisoner confess, but not so good as going free.

This game has fascinated game theorists for a variety of reasons. First, it is a simple representation of a variety of important situations. For example, instead of confess/not confess we could label the strategies "contribute to the common good" or "behave selfishly." This captures a variety of situations economists describe as public goods problems. An example is the construction of a bridge. It is best for everyone if the bridge is built, but best for each individual if someone else builds the bridge. This is sometimes refered to in economics as an externality. Similarly this game could describe the alternative of two firms competing in the same market, and instead of confess/not confess we could label the strategies "set a high price" and "set a low price." Naturally it is best for both firms if they both set high prices, but best for each individual firm to set a low price while the opposition sets a high price.

A second feature of this game, is that it is self-evident how an intelligent individual should behave. No matter what a suspect believes his partner is going to do, it is always best to confess. If the partner in the other cell is not confessing, it is possible to get 10 instead of 5. If the partner in the other cell is confessing, it is possible to get 1 instead of -4. Yet the pursuit of individually sensible behavior results in each player getting only 1 unit of utility, much less than the 5 units each that they would get if neither confessed. This conflict between the pursuit of individual goals and the common good is at the heart of many game theoretic problems.

A third feature of this game is that it changes in a very significant way if the game is repeated, or if the players will interact with each other again in the future. Suppose for example that after this game is over, and the suspects either are freed or are released from jail they will commit another crime and the game will be played again. In this case in the first period the suspects may reason that they should not confess because if they do not their partner will not confess in the second game. Strictly speaking, this conclusion is not valid, since in the second game both suspects will confess no matter what happened in the first game. However, repetition opens up the possibility of being rewarded or punished in the future for current behavior, and game theorists have provided a number of theories to explain the obvious intuition that if the game is repeated often enough, the suspects ought to cooperate.

**If** **We Were All Better People The World Would Be A Better Place**

Some of the power and meaning of game theory can be illustrated by assessing the statement "If we were all better people the world would be a better place." This may seem to you to be self-evidentally true. Or you may recognize that as a matter of logic this involves the fallacy of composition: just because a statement applies to each individual person it need not apply to the group. Game theory can give precise meaning to the statement of both what it means to be better people and what it means for the world to be a better place, and so makes it possible to prove or disprove the statement. In fact the statement is false, and this can be shown by a variation of the Prisoner's Dilemma.

Let us start with a variation on the Prisoner's Dilemma game we may call the Pride Game.

|  |  |  |  |
| --- | --- | --- | --- |
|  | proud | not confess | confess |
| proud | 4.0, 4.0 | 5.4, 3.6 | 1.2, 0.0 |
| not confess | 3.6, 5.4 | 5.0, 5.0 | -4.0, 10.0 |
| confess | 0.0, 1.2 | 10.0, -4.0 | 1.0, 1.0 |

The Pride Game is like the Prisoner's Dilemma game with the addition of the new strategy of being proud. A proud individual is one who will not confess except in retaliation against a rat-like opponent who confesses. In other words, if I stand proud and you confess, I get 1.2, because we have both confessed and I can stand proud before your humiliation, but you get 0, because you stand humiliated before my pride. On the other hand, if we are both proud, then neither of us will confess, however, our pride comes at a cost, as we both try to humiliate the other, so we each get 4, rather than the higher value of 5 we would get if we simply chose not to confess. It would be worse, of course, for me to lose face before your pride by choosing not to confess. In this case, I would get 3.6 instead of 4, and you, proud in the face of my humiliation would get 5.4.

The Pride Game is very different than the Prisoner's Dilemma game. Suppose that we are both proud. In the face of your pride, if I simply chose not to confess I would lose face, and my utility would decline from 4 to 3.6. To confess would be even worse as you would retaliate by confessing, and I would be humiliated as well, winding up with 0. In other words, if we are both proud, and we each believe the other is proud, then we are each making the correct choice. Morever, as we are both correct, anything either of us learns will simply confirm our already correct beliefs. This type of situation - where players play the best they can given their beliefs, and they have learned all there is to learn about their opponents' play is called by game theorists a *Nash Equilibrium*.

Notice that the original equilibrium of the Prisoner's Dilemma confess-confess is not an equilibrium of the Pride game: if I think you are going to confess, I would prefer to stand proud and humiliate you rather than simply confessing myself.

Now suppose that we become "better people." To give this precise meaning take this to mean that we care more about each other, that is, we are more altruistic, more generous. Specifically, let us imagine that because I am more generous and care more about you, I place a value both on the utility I receive in the "selfish" game described above and on the utility received by you. Not being completely altruistic, I place twice as much weight on my own utility as I do on yours. So, for example, if in the original game I get 3 units of utility, and you get 6 units of utility, then in the new game in which I am an altruist, I get a weighted average of my utility and your utility. I get 2/3 of the 3 units of utility that belonged to me in the original "selfish" game, and 1/3 of the 6 units of utility that belonged to you in the "selfish" game. Overall I get 4 units of utility instead of 3. Because I have become a better more generous person, I am happy that you are getting 6 units of utility, and so this raises my own utility from the selfish level of 3 to the higher level of 4. The new game with altruistic players is described by taking a weighted average of each player's utility with that of his opponent, placing 2/3 weight on his own utility and 1/3 weight on his opponent's. This gives the payoff matrix of the Altruistic Pride Game

|  |  |  |  |
| --- | --- | --- | --- |
|  | proud | not confess | confess |
| proud | 4.00, 4.00 | 4.8, 4.20\* | 0.80, 0.40 |
| not confess | 4.20\*, 4.80 | 5.00, 5.00 | 0.67, 5.33\* |
| confess | 0.40, 0.80 | 5.33\*, 0.67 | 1.00\*, 1.00\* |

What happens? If you are proud, I should choose not to confess: if I were to be proud I get a utility of 4, while if I choose not to confess I get 4.2, and of course if I do confess I get only 0.4. Looking at the original game, it would be better for society at large if when you are proud I were to choose not to confess. This avoids the confrontation of two proud people, although of course, at my expense. However, as an altruist, I recognize that the cost to me is small (I lose only 0.4 units of utility) while the benefit to you is great (you gain 1.4 units of utility), and so I prefer to "not confess." This is shown in the payoff matrix by placing an asterisk next to the payoff 4.2 in the proud column.

What should I do if you choose not to confess? If I am proud, I get 4.8, if I choose not to confess I get 5, but if I confess, I get 5.33. So I should confess. Again, this is marked with an asterisk. Finally, if you confess, then I no longer wish to stand proud, recognizing that gaining 0.2 by humiliating you comes at a cost of 1 to you. If I choose not to confess I get only 0.67. So it is best for me to confess as well.

What do we conclude? It is no longer an equilibrium for us both to be proud. Each of us in the face of the other's pride would wish to switch to not confessing. Of course it is also not an equilibrium for us both to choose not to confess: each of us would wish to switch to confessing. The only equilibrium is the box marked with two asterisks where we are both playing the best we can given the other player's play: it is where we both choose to confess. So far from making us better off, when we both become more altruist and more caring about one another, instead of both getting a relatively high utility of 4, the equilibrium is disrupted, and we wind up in a situation in which we both get a utility of only 1. Notice how we can give a precise meaning to the "world being a better place." If we both receive a utility of 1 rather than both receiving a utility of 4, the world is clearly a worse place.

The key to game theory and to understanding why better people may make the world a worse place is to understand the delicate balance of equilibrium. It is true that if we simply become more caring and nothing else happens the world will at least be no worse. However: if we become more caring we will wish to change how we behave. As this example shows, when we both try to do this at the same time, the end result may make us all worse off.

To put this in the context of day-to-day life: if we were all more altruistic we would choose to forgive and forget more criminal behavior. The behavior of criminals has a complication. More altruistic criminals would choose to commit fewer crimes. However, as crime is not punished so severely, they would be inclined to commit more crimes. If in the balance more crimes are committed, the world could certainly be a worse place. The example shows how this might work.

For those of you who are interested in or already know more advanced game theory, the Pride Game has only the one Nash equilibrium shown - it is solvable by iterated strict dominance. The Atruistic Pride Game, however, has several mixed strategy equilibria. You can compute them using the fine open source software program [Gambit](http://gambit.sourceforge.net/) written by Richard McKelvey, Andrew McLennan and Theodore Turocy. One equilibrium involves randomizing between proud and confess, so is worse than the proud-proud equilibrium of the Pride game. The other is strictly mixed in that it randomizes between all three strategies. The payoffs to that equilibrium gives each player 2.31 - so while it is better than both players confessing for certain, it is still less good than the unique equilibrium of the Pride Game.

tors and despots (e.g., Adolf Hitler, Joseph Stalin), havebeen described as narcissistic. In addition narcissism hasbeen examined as a potential factor in political terrorism.In criminology narcissistic personality traits are thoughtto predict criminal behavior, including murder, rape,assault, spousal abuse, and white-collar crime. Narcissismis also a key feature of a psychopathic personality, which isperhaps the most important personality profile for pre-dicting serious criminal behavior.Several significant issues remain unresolved in the sci-entific study of narcissism. First, there remains debate overthe definition of narcissism. While there is strong agree-ment on key features of narcissism like grandiosity andlow empathy, there is disagreement about the linkbetween narcissism and feelings of depression or unhappi-ness. Some theorists argue that narcissism contains a com-ponent of depression or low self-esteem; others argue thatnarcissism is related to positive emotions. Still othersargue that narcissism is linked to negative emotions andself-perceptions but that these feelings are experiencedonly at an unconscious level. Second, while there are sev-eral theories about the development of narcissism in indi-viduals, there is no firm conclusion about its etiology.Some researchers argue that narcissism results from per-missive parenting, while others argue that narcissism is areaction to cold, controlling parents. Finally, the role ofculture in maintaining narcissism is not well understood.Some researchers and theorists have identified a rising tideof narcissism, but the cause of this remains unclear.SEE ALSOFreud, Sigmund; Individualism; Leadership;Neuroticism; Obsession; Personality; Political Science;PsychologyBIBLIOGRAPHYAmerican Psychiatric Association. 1994. Diagnostic andStatistical Manual of Mental Disorders. 4th rev. ed.Washington, DC: Author.Freud, Sigmund. [1914] 1957. On Narcissism: An Introduction.In The Standard Edition of the Complete Psychological Works ofSigmund Freud, ed. and trans. James Strachey, vol. 14,67–104. London: Hogarth.Lasch, Christopher. 1978. The Culture of Narcissism: AmericanLife in an Age of Diminishing Expectations. New York:Norton.Morf, Carolyn C., and Frederick Rhodewalt. 2001. Unravelingthe Paradoxes of Narcissism: A Dynamic Self-regulatoryProcessing Model. Psychological Inquiry 12 (4): 177–196.W. Keith CampbellJoshua D. Miller

NASH EQUILIBRIUM

Nash equilibrium is a fundamental concept in the theory of games and the most widely used method of predictingthe outcome of a strategic interaction in the social sci-ences. A game (in strategic or normal form) consists of the following three elements: a set of players, a set of actions(or pure-strategies) available to each player, and a payoff(or utility) function for each player. The payoff functionsrepresent each player’s preferences over action profiles,where an action profile is simply a list of actions, one foreach player. A pure-strategy Nash equilibriumis an actionprofile with the property that no single player can obtaina higher payoff by deviating unilaterally from this profile.This concept can best be understood by looking atsome examples. Consider first a game involving two play-ers, each of whom has two available actions, which we callAand B. If the players choose different actions, they eachget a payoff of 0. If they both choose A, they each get 2,and if they both choose B, they each get 1. This “coordi-nation” game may be represented as follows, where player1 chooses a row, player 2 chooses a column, and the result-ing payoffs are listed in parentheses, with the first compo-nent corresponding to player 1’s payoff:The action profile (B,B)is an equilibrium, since aunilateral deviation to Aby any one player would result ina lower payoff for the deviating player. Similarly, theaction profile (A,A) is also an equilibrium.As another example, consider the game “matchingpennies,” which again involves two players, each with twoactions. Each player can choose either heads (H) or tailsNash EquilibriumFigure 1(1,1)(0,0)BA(0,0)(2,2)A B Figure 2(1,1)(1,1)TH(1,1)(1,1)H T 540INTERNATIONAL ENCYCLOPEDIA OF THE SOCIAL SCIENCES, 2ND EDITIONiess\_B3\_H-O 4/12/07 4:13 PM Page 540

(T); player 1 wins a dollar from player 2 if their choicesare the same, and loses a dollar to player 2 if they are not.This game has no pure-strategy Nash equilibria.In some cases, instead of simply choosing an action,players may be able to choose probability distributionsover the set of actions available to them. Such randomiza-tions over the set of actions are referred to as mixed strate-gies. Any profile of mixed strategies induces a probabilitydistribution over action profiles in the game. Under cer-tain assumptions, a player’s preferences over all such lot-teries can be represented by a function (called a vonNeumann-Morgenstern utility function) that assigns a realnumber to each action profile. One lottery is preferred toanother if and only if it results in a higher expected valueof this utility function, or expected utility. A mixed strat-egy Nash-equilibrium is then a mixed strategy profile withthe property that no single player can obtain a highervalue of expected utility by deviating unilaterally from thisprofile.The American mathematician John Nash (1950)showed that every game in which the set of actions avail-able to each player is finite has at least one mixed-strategyequilibrium. In the matching pennies game, there is amixed-strategy equilibrium in which each player choosesheads with probability 1/2. Similarly, in the coordinationgame of the above example, there is a third equilibrium inwhich each player chooses action Awith probability 1/3and Bwith probability 2/3. Such multiplicity of equilib-ria arises in many economically important games, and hasprompted a large literature on equilibrium refinementswith the purpose of identifying criteria on the basis ofwhich a single equilibrium might be selected.Nash equilibria can sometimes correspond to out-comes that are inefficient, in the sense that there existalternative outcomes that are both feasible and preferredby all players. This is the case, for instance, with the equi-librium (B,B) in the coordination game above. An evenmore striking example arises in the prisoner’s dilemmagame, in which each player can either “cooperate” or“defect,” and payoffs are as follows:The unique Nash equilibriumis mutual defection, anoutcome that is worse for both players than mutual coop-eration. Now consider the game that involves a repetitionof the prisoner’s dilemma for nperiods, where nis com-monly known to the two players. A pure strategy in thisrepeated game is a plan that prescribes which action is tobe taken at each stage, contingent on every possible his-tory of the game to that point. Clearly the set of purestrategies is very large. Nevertheless, all Nash equilibria ofthis finitely repeated game involve defection at everystage. When the number of stages nis large, equilibriumpayoffs lie far below the payoffs that could have beenattained under mutual cooperation.It has sometimes been argued that the Nash predic-tion in the finitely repeated prisoner’s dilemma (and inmany other environments) is counterintuitive and at oddswith experimental evidence. However, experimental testsof the equilibrium hypothesis are typically conductedwith monetary payoffs, which need not reflect the prefer-ences of subjects over action profiles. In other words, indi-vidual preferences over the distribution of monetarypayoffs may not be exclusively self-interested.Furthermore, the equilibrium prediction relies on thehypothesis that these preferences are commonly known toall subjects, which is also unlikely to hold in practice.To address this latter concern, the concept of Nashequilibrium has been generalized to allow for situations inwhich players are faced with incomplete information. Ifeach player is drawn from some set of types, such that theprobability distribution governing the likelihood of eachtype is itself commonly known to all players, then we havea Bayesian game. A pure strategy in this game is a functionthat associates with each type a particular action. A Bayes-Nash equilibriumis then a strategy profile such that noplayer can obtain greater expected utility by deviating to adifferent strategy, given his or her beliefs about the distri-bution of types from which other players are drawn.Allowing for incomplete information can have dra-matic effects on the predictions of the Nash equilibriumconcept. Consider, for example, the finitely repeated pris-oner’s dilemma, and suppose that each player believes thatthere is some possibility, perhaps very small, that his or heropponent will cooperate in all periods provided that nodefection has yet been observed, and defect otherwise. Ifthe number of stages nis sufficiently large, it can beshown that mutual defection in all stages is inconsistentwith equilibrium behavior, and that, in a well-definedsense, the players will cooperate in most periods. Hence,in applying the concept of Nash equilibrium to practicalsituations, it is important to pay close attention to theinformation that individuals have about the preferences,beliefs, and rationality of those with whom they are strate-gically interacting.Nash EquilibriumFigure 3(1,1)(3,0)DC(0,3)(2,2)C D INTERNATIONAL ENCYCLOPEDIA OF THE SOCIAL SCIENCES, 2ND EDITION541iess\_B3\_H-O 4/12/07 4:13 PM Page 541

SEE ALSOGame Theory; Multiple Equilibria;Noncooperative Games; Prisoner’s Dilemma(Economics)BIBLIOGRAPHYCournot, A. A. 1838. Recherches sur les principes mathématiquesde la théorie des richesses.Paris: L. Hachette.Fudenberg, Drew, and Jean Tirole. 1991. Game Theory.Cambridge, MA: MIT Press.Harsanyi, John C. 1967–1968. Games with IncompleteInformation Played by Bayesian Players. Management Science14 (3): 159–182, 320–334, 486–502.Harsanyi, John C., and Reinhard Selten. 1998. A General Theoryof Equilibrium Selection in Games. Cambridge, MA: MITPress.Kreps, David, Paul Milgrom, John Roberts, and Robert Wilson.1982. Rational Cooperation in the Finitely RepeatedPrisoner’s Dilemma. Journal of Economic Theory27: 245–252.Nash, John F. 1950. Equilibrium Points in N-Person Games.Proceedings of the National Academy of Sciences36 (1): 48–49.Osborne, Martin J., and Ariel Rubinstein. 1994. A Course inGame Theory. Cambridge, MA: MIT Press.von Neumann, John, and Oskar Morgenstern. 1944. Theory ofGames and Economic Behavior. Princeton, NJ: PrincetonUniversity Press.Rajiv Sethi

NASSER, GAMAL ABDEL

1918–1970Gamal Abdel Nasser, who served as president of Egyptfrom 1956 to 1970, was born on January 15, 1918, in thesmall village of Bani Mor in the Egyptian province ofAssiut, where he lived for eight years. He came from ahumble and poor background to become one of the mostprominent and influential leaders in the Middle East andthe third world. His father worked as a mail carrier in theEgyptian Ministry of Communication, a position thatrequired him to move with his family from Bani Mor toAlexandria and finally Cairo, where Nasser lived for tenyears. In his memoirs, Nasser spoke proudly of his hum-ble origin. His poor background might have been behindhis socialist tendencies and his commitment to improvethe living conditions of Egyptian peasants and workers.During his high school years, Nasser participated instudent demonstrations against the British occupyingforces. After receiving his high school diploma in 1937,Nasser entered the Egyptian Royal Military Academy,which started admitting sons of lower-income families in1936. A year later, he joined the Egyptian army, where hemet several of his future colleagues, including Anwar el-Sadat (1918–1981) and Zakaria Mohyi El Deen, both ofwhom served as his vice presidents, and Abdul HakeemAmer, who became a minister of defense. In 1942 Nasserwas transferred to Sudan, where he and other officersfounded the Free Officers, a secret revolutionary organiza-tion. The Free Officers was a secular nationalist move-ment that was opposed to the British occupation of Egypt,the “corrupt” royal family, and the domination of Egypt’seconomy and parliament by a small landowning class. In1948 Nasser was a member of the Egyptian army thatalong with other Arab armies was sent to Palestine tothwart the establishment of Israel. The humiliating defeatof the Arab armies in the 1948 war raised his awareness ofthe Palestinian problem and the inefficacy of the existingArab governments.On July 23, 1952, Nasser and his Free Officers seizedpower and deposed the king. A year later, theRevolutionary Command Council of the Free Officerspromulgated a new constitution, abolished the monarchy,and declared Egypt a republic. Though GeneralMohammad Naguib (1901–1984) served as the head ofthe government from 1952 to 1954, Nasser held the realpower through his control of the RevolutionaryCommand Council. In November 1954 Nasser placedNaguib under house arrest, accusing him of knowingabout an attempt by a member of the MuslimBrotherhood to assassinate Nasser.In 1956 Nasser was elected president of Egypt, a posi-tion he held until his death in 1970. As president, Nassercreated an authoritarian police state, banning politicalparties and suppressing political opposition, including thelocal communists and members of the MuslimBrotherhood. He ruled the country through the ArabSocialist Union, a government-controlled party.Between 1956 and 1966, Nasser introduced severalsocialist measures, including the nationalization of variousindustries, private companies, and banks, and heexpanded the public sector significantly. He also intro-duced agrarian reform, including the confiscation of2,000 square miles of cultivable land from wealthylandowners, which he distributed to Egypt’s poor peas-ants. The aim of these socialist measures was to improvethe living conditions of the country’s peasants and work-ers. Nasser contended in his book The Philosophy of theRevolution(1955) that Arab socialism was a prerequisitefor Arab unity and freedom and for surmounting thesocial and economic legacy of colonialism.In addition to his domestic socialist reforms, Nasseradopted an anti-Western and anticolonial foreign policy.Initially however, he tried to secure arms from Britain andthe United States, and it was only after the two countriesdeclined his request that he acquired such weapons fromthe Soviet Union and Eastern Europe. Along with PrimeNasser, Gamal Abdel542INTERNATIONAL ENCYCLOPEDIA OF THE SOCIAL SCIENCES, 2ND EDITIONiess\_B3\_H-O 4/12/07 4:13 PM Page 542