An Application of Game Theory in Strategic Decision of Marriage Occurrence

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Abstract

Game theory illustrates independent and interdependent decision-making practice of human behaviour. It studies the formal conflict and cooperation between two players. The concept of Game theory is applied whenever the actions of agents are interdependent. These agents may be individuals, groups, firm etc. It also provides a language to formulate structure, analyze, and understand strategic scenarios. This paper examines the decision making process of marriage occurrence in India by using Expected Utility Theory (EUT). There are two important players, one is parent of bridegroom's and another is parent of bride's. The occurrence of marriage determined with the satisfaction of both the parties in terms of utility. The study is based on observation of my own marriage occurrence and applied game theory for, analysing the strategic decision of both families.

Key Word*:* Game theory, Expected Utility, Marriage Occurrence and Strategic Decision

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"Man is a gaming animal. He must always be trying to get the better in something or better"

(Charles Lamb, 1775-1884 'Essays of Elia')

1. Introduction

Since long back most of the economists used economic theory for explaining the behaviour of peoples outside the monetary market sector, and non economists have been examine the cultural discrimination, fertility, politics, crime, education, statistical decision making, adversary situations, labour-force participation, the uses of 'leisure' time, and other behaviour are much better inherent. Definitely, economic theory helps by providing a unified framework for all behaviour involving scarce resources, nonmarket as well as market, nonmonetary as well as monetary, small group as well as competitive. But the behaviour of parents related to marriage occurrence has been almost completely ignored by economists. Probably the Becker's theory of marriage (1973 and 1974) was first application of economic theory in marriage analysis. The idea of the Becker's theory of marriage is easy and applied two basic approaches for the economic analysis of marriage; cost-benefit analysis and market analysis. The assumption of rational choice is widely used in economics, both in the theoretical and empirical application. Accordingly, individuals are viewed as rational agents who marry each other if they are better off married than single. The two type's doctrine is working in the society. One is that, marriage is practically always voluntary, either by the persons marrying or their parents, the theory of preferences can be gamely applied, or persons marrying/their parents can be assumed to expect to raise their utility level after marriage rather than to remain single. As well as many men and women compete as they seek mates, a market in marriages can be presumed to exist. Each person tries to find the best mate, subject to the restrictions imposed by social and family conditions.

Generally marriage related decisions are taken by our parents after the acceptance of their children for marriage, the boys can take decision related to choice of girls and girls have also permission to choose her life partner in India. But in some families the decision related to marriage is taken by parents and children have no role in choices of life partner. Decisions related to choice of relations between two families are supported by relatives/middleman. During the choosing of bride these things matter; height, age, colour and education of the girl along with family background, caste, relation possibility, living standard, social status, daubery etc. On the other hand in the selection of bridegrooms, girls parents looks these things; job, colour, age, health, education, and caste of the boy with living standard, social status, family income, number of brothers, economic condition, demand etc. The relative/

middleman helps in exchanging their massages form one party to another party but finally decision are taken by the both families in the favour of their children.

2. Review of Literature

Before penetrating the behaviour of parent related to marriage decision, the need feels to point out some studies which are relating to game theories applications. *Kahneman and Tversky (1979)* noticed that decision making is difficult because the outcomes from a particular action are seldom fully predictable. Consequently, decision makers must always take uncertainty into consideration when they make choices. *Sutton & Barton (1998)* In addition, such action outcome relationships can change frequently, requiring adaptive decision making strategies that depend on the observed outcomes of previous choices. *Gillies (1959)* found that the major outcome of a transferable utility cooperative game is the set of feasible results that cannot be improved upon by any coalition of players. *Kannai, (1992)* again supported the above view that the core of a game may be empty, generalizations and modifications have been considered from the beginning. *Megiddo (1974)* studies aggregate monotonicity of players and finds that when the worth of the grand coalition increases while the worth's of all other coalitions remain the same, then everyone's payoff should weakly increase.

The study of social decision making starts with game theory by Neumann, & Morgenstern. The original formulation of game theory seeks to find the strategies that a group of decision makers will converge on, as they try to maximize their own payoffs. Nash equilibrium refers to a set of such strategies from which no individual players can increase their payoffs by changing their strategies unilaterally *(Nash, 1950)*. In case of two-player competitive game known as matching pennies, for example, each player Can choose between two alternative options, such as the head and tail of a coin. One of the players wins if both players choose the same option and loses otherwise. For the matching-pennies game with a symmetrical payoff matrix, the Nash equilibrium is to choose both options with the same probabilities. Any other strategy can be exploited by the opponent and therefore reduces the expected payoff. In both humans and nonhuman primates, however, the predictions based on the Nash equilibrium are often systematically violated for such competitive games *(Neumann, & Morgenstern, 1944) and (Erev & Roth, 1998).*

Games can be played repeatedly, between the same set of players, which makes possible for some players to coach others to deviate from the equilibrium predictions for one-

shot games. In adding up, humans often cooperate in prisoner's dilemma games, whether the game is one-shot or repeated *(Sally, 1995).* Consequently, for humans, decision making in social contexts may not been tiredly driven by self-interest, but at least partially by preferences regarding the well-being of other individuals. Indeed, cooperation and altruistic behaviours abound in human. In theory, multiple mechanisms including relative's selection, direct and indirect reciprocity and group selection can increase the fitness of co-operators and thus uphold cooperation *(Fehr, 2003 and Nowak, 2006).*

To the extent that game theories of marriage are an alternative to Becker's neoclassical theory of marriage. Game theory has been applied to the study of marriage at least since *Shapley (1962).* According to a version of this theory found in *McElroy (1990)* each household member have a utility function and at a threat point the person maximise utility level with outside the household. Such individual threat points are influenced by prices, incomes, sex ratios, and laws, the same factors which Becker and Grossbard-Shechtman considered when analyzing marriage markets. Outcomes, such as one spouse's consumption or labour supply, vary with all the factors which influence these threat points. Consequently, the individual supplies of labour or demands for goods found in *Mc Elroy (1990)* are very similar to the supplies of labour and demands for goods found in Grossbard Shechtman *(1984, 1993).*

Game-theoretic models do not incorporate marriage market conditions as directly as the marriage market models do. Therefore, it is not straight forward to say that how game-theoretic models of decision making tie into the existing literature on labour supply. In contrast, marriage market models - at least the G-version - tie very easily into traditional models of labour supply. In sum, many but not all the advantages of Becker's theory of marriage that were mentioned in a comparison between that theory of marriage and pooled household models are shared by game-theory models of marriage *(Shechtman, 1993).*

3. Game Theory and Decisions of Players

Game theory is a formal methodology and a set of techniques to study the interaction between rational players in strategic decisions. Here 'rational' means the standard article in economics: maximizing our well being with defined objectives; 'strategic' means that players care not only about their own actions, but also care about the actions taken by other players. It is important to know about term, 'decision theory', which can be seen at least a bit of last term, it is the study of how an individual makes decisions in non-strategic settings; hence game

theory is sometimes also referred to as multi-person decision theory. The common terms comes from the field, its presumed applications to games i.e. poker, chess, etc.[2] However, on the applications of these games are usually interested in have little directly to do with such games. In particular, in the case of "zero-sum" games in the sense that one player's loss is another player's gain; they are games of pure conflict *(Kartik, 2009).*

According to *Eric Maskin (2008)* Game-theoretic solution concepts divide into two types, one is non-cooperative and another is cooperative. Non-comparative is, that when the basic unit of analysis is the individual player and cooperative is, when the focus is on coalitions of players. John Von Neumann and Oskar Morgenstern themselves viewed the cooperative part of game theory as more important, and their seminal treatise, *Von Neumann and Morgenstern (1944),* devoted fully three quarters of its space to cooperative matters. This paper is also considered on the cooperatives nature of players in strategic decisions related to marriage occurrence, because Nash equilibrium has been emerge as a successful solution of cooperative behaviour of players and it is logically coherent. Specifically, it is the only concept that is consistent both with (a) expected payoff-maximization by players (rational behaviour) and (b) correct forecasts by players about what others will do (rational expectations). Moreover, it has proved to make good predictions of behaviour both in experimental and field settings, at least when players have acquired sufficient experience playing the game in question.

A fundamental concern of economics is optimality, how players/agents maximize in accordance with the normative predictions our theoretical models. Decision making in a social group has two distinctive features. First, humans habitually alter their behaviour in response to changes in their economic and social environment. As a result, the outcomes of decisions that depend on the behaviour of multiple decision makers are difficult to predict and require highly adaptive decision-making strategies. Second, decision makers may have preferences regarding consequences to other individuals and therefore choose their actions to improve or reduce the well-being of others.

The essential necessitate of decision making that underlie the processes of learning and valuation, both are important for decision making in social contexts. However,

[2] Statistically, game theory actually has limited prescriptive advice to offer on how to play either chess or Poker. For example, we know that chess is "solvable" in a sense to be made precise later, but nobody actually knows what the solution is! This stems from the fact that chess is simply too complicated to solve.

interactions among multiple decision makers in a social group show some additional features. First, behaviours of humans and animals can change frequently, as they seek to maximize their self-interest according to the information available from their environment. This makes a difficult task to predict the outcomes of a decision maker's actions and to choose optimal actions accordingly. As a result, more sophisticated learning algorithms might be required for social decision making. Second, social interactions open the possibilities of competition and cooperation. Humans and animals indeed act not only to maximize their own self-interest, but sometimes also to increase or decrease the well-being of others around them. These aspects of social decision making are reflected in the activity of wits areas involved in learning and valuation *(Fudenberg & Levine, 1998 and Camerer 2003).*

The two-player competitive game known as matching pennies is shown in Fig. 1(a), each player can choose between two alternative options, such as the head or tail of a coin. One of the players wins if both players choose the same option and loses otherwise. For the matching-pennies game with a symmetrical payoff matrix, the Nash equilibrium is to choose both options with the same probabilities. Any other strategy can be exploited by the opponent and therefore reduces the expected payoff. In case of humans, the predictions based on the Nash equilibrium are often systematically violated for such competitive games. How game theory can be used to investigate cooperation and altruism is illustrated by a well known game, the prisoner's dilemma.

Some times in economics peoples wants to able describe a situation that involves strategic instruction. Strategic instruction means, cases where your peppiness depends not only your choices but also on the choices of other peoples in the society, markets, industries and individual groups.

		Non matcher	
		Head	Tail
Matcher	Head	*1,* **-**1	*-1,* 1
	Tail	*-1,* 1	*1,* **-**1

Fig. 1(a) Payoff Matrix for the Game

In a typical example of strategic instruction usually involves decisions among all family members, friends and others. When go for another example for strategic instruction in different context weather two players can confess or not in particular crime. Strategic instruction of two players can see below in case of crime. Figure 1 (b) shows the pay off matrix of both the criminals and try to find out right responses each of them. Some hypothetical question arises in minds what are both players' strategies when one confess,

what should be other best responses? If player-I confess, what should player-II do? Player-II confessed with pay off 5

If player don't confess what should player-II do? Player-II so also confessed with payoff 15. Means in both cases player-II confess, this situation called dominant strategies of player-II. Same hypothetical situation arises in case of Player-I' dominant strategies.

		Player-II (Confess?)	
		No	Yes
Player-I (Confess?)	No	*10,* 10	*0,* 15
	Yes	*15,* 0	*5,* 5

Fig. 1(b) Prisoner's Dilemma Game

The best responses of player-I shows in Blew and second in green colour. Here saturation arises when both players confessed in both the cases and comparing their dominant strategies pay off. Where both the circle overlaps each other is called Nash equilibrium. Nash equilibrium is a saturation where each player's action is the best responses for the others player's action.

The important point to note that there is no guarantee that players will always play an equilibrium strategy, since it's certainly possible to guesses incorrectly regarding what others players is going to do, but equilibrium strategies are those where no player has universal incentive to deviate from the strategy. In this case, the equilibrium is likely to be reached since the players best responses does not change based on what they think and other are going to do.

4. Derivation of Expected Utilities Function

In economics, the subjective desire of a particular choice is determined by its expected utility function. The Expected Utility Theory (EUT) was first proposed by *Daniel Bernoulli (1738)* and he tried to solve puzzled over a problem that how much a rational individual is prepared to pay to enter a gamble, hence it is also called as Bayesian Decision Theory. *John Von Neumann and Oskar Morgenstern (1944)* considered the same problem and developed the notion of EUT. This is also called von Neumann-Morgenstern EUT. The main aspects of EUT are the preferences and the axioms, which determine decisions under risk and uncertainty. Most of these axioms rest on an assumption that individuals are rational and they have well-defined preference. Even though the classical decision theories had separate concepts of risk and uncertainty. Decision-making under risk means that outcome probabilities are known, whereas in decision making under uncertainty these probabilities are unknown. However, most decisions are made in the middle field between known and

unknown probabilities. Therefore, we do not separate decisions under risk and uncertainty. EUT can be derived from three separate axioms as ordering, continuity, and independence.

Preferences over prospects can be represented by function $U(\boldsymbol{x}^*)$, which gives a real-valued index to each prospect. $U(\boldsymbol{x}^*)$ Function operates between prospects so that $U(\boldsymbol{x}) \geq U(\boldsymbol{r}) \leftrightarrow \boldsymbol{x} \geq \boldsymbol{r}$. An individual will choose prospect $\boldsymbol{x}$ over prospect $\boldsymbol{r}$ if and only if a value of the index $\boldsymbol{x}$ is no less than a value of the index $\boldsymbol{r}$. It is also assume that an individual maximizes the function index. Moreover, the expected utility theory to choices between prospects is based on the following three canons.

Expectation: If all three axioms ordering, continuity and independence are hold, preferences to prospect $\boldsymbol{x}$ can be represented by the following utility function;

$$U(\boldsymbol{x}) = \sum_i p_i .u(x_i) = p_1 .u(x_1) + \ldots\ldots + p_n .u(x_n) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where; $U(\boldsymbol{x}^*)$ is a utility function. We assume that the utility function is continuous, monotonous and at least twice differentiable. Thus, $U(\boldsymbol{x})$ is the expected utility of prospect $\boldsymbol{x}$.

Asset Integration: If $\boldsymbol{w}$ is initial sure wealth before speculate occurrence of the marriage, then an individual will choose gamble $\boldsymbol{x}$ if and only if

$$U(\boldsymbol{x}) = U(\boldsymbol{w} + \boldsymbol{x}) > u(\boldsymbol{w}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

In other words, a prospect is acceptable if the utility resulting from the prospect including the initial wealth exceeds the utility of initial wealth alone. Thus, EUT considers risky decisions from a perspective of final decision related to marriage occurrence (asset include demand by bride party/ dowry) rather than just gains or losses. Social prestige and middleman also effected the both parties' decisions. Both parties think in terms of Utilities as on proxy for happiness of own and their children's under the consideration of social norms. Both parties played a game in such a way that both can maximise their own utilities as well as their children.

5. An Application of Game Theory in Marriage Decision

The game theory can be applied in case of choice of relations, but the occurrence of marriage is held by a chance when both parts cooperate each other with the acceptance of both newly couples. Both side's parents want to maximise own and their children's utility and the utilities of both parties varies from parent to parent but all bride parent prefer to educated, jobholder, smart, healthy and good character boy on the other hand parent of Bride groom also prefers, educated, beautiful, good character girl, but above all grooms parents also

demanded dowry directly or indirectly, which is equally important with all the above requirement.

Figure 1(c) shows the pay off matrix of both side's parent in terms of their respective utilities, when both the player cooperate each other the utility of both the parties are optimum but in the case of non cooperation/ compete, marriage Also occurred with minimum utilities and both the parties are not satisfied to each other, in this case there is more opportunity to divorce and family quarrels. In case of my own marriage both side's parents are very happy because the marriage occurs under the cooperation of both side and all family members happy with the nature of new coming member. As a result in the case of cooperation (my marriage) the Nash equilibrium occurred and both parties receive optimum utility but the cooperation is rarely seen between the both families. In case of Indian marriage's the middle man play crucial role in cooperation of both side parents but he played role as messenger to one party to other ,some time the false information of middle man also reduce the marriage occurrence opportunity between the two couples.

		Parent (Bride Groom)	
		Cooperate	Compete
Parent (Bride)	Cooperate	$U_{B\ opt},\ U_{BG\ opt}$	$U_{B=0},\ U_{BG\ max}$
	Compete	$U_{B\ max},\ U_{BG=0}$	$U_{B\ min}, U_{BG\ min}$

Fig. 1(c) Payoff Matrix of Both Players Utilities

7. Conclusion

In India usually marriage related decision is affected by the various factors but in the case of my marriage, education, height, colour, cast and the nature are significant factor that influenced the decisions of both families. The cooperative strategic decisions are seen between both parties because the middle man was my maternal elder brother and both the families well know to each other due to relation of my elder brother. Therefore both parties obtain optimum utility from marriage. After the marriage the cooperation and thoughts matches both families, we are also happy with our parent's decisions and Nash equilibrium condition seen in the cooperation of both families.

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