Eskişehir Anadolu Üniversitesi
İktisadi ve İdari Bilimler Fak. Dergisi
C: VIII, S: 1 - 2, 1990

TRADITIONAL AND ALTERNATIVE MODELS OF INDIVIDUAL BEHAVIOR UNDER UNCERTAINTY**

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1. INTRODUCTION :

Although the basic model of consumer theory describes a wide variety of situations, many problems of consumer choice cannot be analyzed without some important modification of the model. In this paper we will examine traditional and alternative models that have been developed to explain the effect of uncertainty on individual's behavior.

Since risk and uncertainty require reexamination of individual preferences, we will shortly review basic concepts as a first step in the paper. To do so, we begin with the concepts of probability and expected value in Section 2. This section also involves the proposition that individuals act to maximize expected utility known as the expected utility hypothesis. What follows this as Section 3 is naturally the Von Neumann - Morgenstern utility approach which essentially asserts that consumers will behave so as to maximize their expected utility. Before going further, one should differentiate

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(**) We would like to thank Prof. Andrew P. SUM of Northeastern University, Boston, Mass, for his helpful comments and suggestions on an earlier draft of this paper. We bear sole responsibility for any errors remain.

a risk averse and risk seeker individual since the response to uncertainty depends not only on how people think about it but also on the set of possible responses. Section 4, therefore, basically deals with this issue.

However, there are many situations in which individual responses to uncertainty do not seem to be modeled well by the expected utility approach. Some situations may be better considered by concepts from the theory of games against persons. We will illustrate this by considering Slumlord's Dilemma and Prisoner's Dilemma. On the other hand behavior in some other situations may be better modeled by considering the concept of bounded rationality. These models are discussed in Section 5 named as alternative models of individual behavior under uncertainty.

2. EXPECTED VALUE AND EXPECTED UTILITY HYPOTHESIS :

It is predominantly assumed that each person knows and understands the alternatives with certainty as he or she makes an economic decision. Many economic decisions, however, are made under conditions of uncertainty about what the individual will receive as a consequence of his or her choice. Purchasing goods and services involves the risk of dissatisfaction; even the passive act of owning things involves risks of theft, fire, or liability of someone else's injury. The individual whose wealth position depends heavily on two alternative events does not know which event will occur and cannot affect the sequence of these events, but can assess the relative likelihood or probability of each, which means that a particular state will occur. If an evenly weighted coin is flipped, the probability that it will come up heads is 1/2 and the probability that it will come up tails is 1/2, as well. Likewise, the probability of a four being up on an evenly weighted die is 1/6. If you are betting that a four will come up on the die, then only two situations are relevant to you : four or not four. In other words you have 1/6 chance of getting four and 5/6 chance of not four. In some situations, such as the die tossing example above, the probability assignment is straightforward. In other situations such probability assignments are somewhat ambiguous. Despite the fact that assessing the probability of such events involve difficulties, it is quite acceptable that decision makers are able to assign, at least subjective, probabilities to the numerous outcomes in any risky situation by using unification of past acquaintance, objective indication and subjective perception. Thus, we can refer to the probability of an event in an unambiguous sense. If we multiply the payoff (or loss) of each outcome by its probability of occurrence and sum these weighted payoffs, we get the expected value. Therefore, if there are **n** possible situations, and each situation has a payoff X_i and the probability of π_i, then the expected value **E(V)** is

$$E(V) = \sum_{i=1}^{n} \pi_i, X_i$$

The probability of any given outcome is a number between o and 1 and; if all possible outcomes are adequately considered, it will be always true that

$$\sum_{i=1}^{n} \pi_i = 1$$

that is, it is inevitably certain that some outcome will occur. If we flip the coin, it must come up either heads or tails. Games whose expected value is to be zero or which cost their expected values for the right to play are known as the **fair games**. It is common for individuals to refuse playing fair games and to avoid paying a great deal to play risky, but fair games. The underlying

fact that individuals consider more than just expected value was illustrated by an example introduced by **Nicholas Bernoulli** in 1728 and now known as the **St. Petersburg Paradox** (1). In monetary units it may be phrased as

> Suppose someone offers to toss a fair coin repeatedly until it comes up heads and to pay you $2 if this happens on the first toss, $4 if it takes two tosses to land a head, $8 if it takes three tosses, $16 if it takes four tosses, etc.

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(1) M.J. MACHINA, «**Choice under Uncertanity: Problems Solved and Unsolved**» in J.D. HEY (Ed.) CURRENT ISSUES IN MICROECONOMICS, St. Martin's Press, New York, 1989, pp. 13.

Thus the game has the following expected payoffs:

Number of tosses	Probability	Payoff	Expected Value
1	1/2	2	1
2	1/4	4	1
3	1/8	8	1
4	1/16	16	1
.	.	.	.
.	.	.	.
.	.	.	.
i	**$1/2^i$**	**2^i**	**1**
.	.	.	.
.	.	.	.
.	.	.	.

Since this game offers a one-in-two change of winning $2, a one-in-four chance of winning $4, etc. and theoretically can persevere forever, its expected value is infinite. That is,

$$\sum_{i=1}^{\infty} \pi_i X_i = 1 + 1 + 1 + 1 + \ldots + 1 \ldots = \infty$$

However, when people are asked how much they are willing to pay to play this game, the response is that no player would pay very much. In fact, a very few people will hold out more than $10 to play. This is the paradox: Why should people offer so little to play the game with such an high expected value?

The resolution of this paradox was offered by Daniel Bernoulli. He suggested that people appraise not expected dollars, but rather the expected utility. Provided that the diminishing marginal utility of money distinguishes individual utility functions, then the expected utility of a loss $100 will be greater than that of a gain. In the St. Petersburg Paradox, the expected utility which is called «moral value» by Bernoulli would diminish and could therefore have a finite sum (2). Consequently, it could be defined as follows: «The expected utility of a risk bearing situation is the sum of the resulting utility level in each possible state of the world weighted by the probability

(2 W. NICHOLSON, **Microeconomic Theory, Principles and Extensions,** 4th Ed., The Dreyden Press, New York, 1989, pp. 241.

that it will occur. If Wo denotes the initiative wealth, E_0 denotes the entry price and U(W) represents the utility function, the expected utility E(U) may be expressed as

$$E(U) = \Sigma \ \pi_i \ U(W_0 - E_0 + X_i)$$

According to the above expression it is easy to say that the expected utility hypothesis indicates that people choose among alternatives so as to maximize utility (3).

However, Bernoulli's suggestion does not provide a reasonable explanation about why most people will offer low amounts of money to play the game. The answer of the paradox depends certainly on the fact that there isn't any gambler who has enough resources in order to make such a larger payoffs. Put it another way, since «there is no upper bound on the utility function, payoffs in the game can be suitably redefined so as to generate the paradox (4)».

At this point we will move one step further by saying that choices among uncertain prospects cannot be explained by expected value alone. It is because individuals have preferences with regard to the amount of risk they are willing to take. It is generally supposed by the economists that risk is an undesirable commodity. This means that the typical individual is **risk averse,** he will gamble only if he perceives the market odds to be favorable (5). These people prefer the certainty of not playing which has the same net expected value as playing to the risky situation. In the case of gambling the assumption of risk aversion does not seem as applicable universally, though. Many people seem to be **risk seekers** willing to wager considerable sums of money even at unfavorable odds.

3. THE VON NEUMANN - MORGENSTERN THEOREM:

To examine the economic behavior of individuals under conditions of uncertainty, John von Neumann and Oskar Morgenstern developed mathematical models in their book, **The Theory of Games**

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(3) L.S. FRIEDMAN, **Microeconomic Policy Analysis,** McGraw-Hill Book Company, New York, 1984, pp. 198.

(4) NICHOLSON, pp. 242.

(5) A.C. DESERPA, **Microeconomic Theory, Issues and Applications,** 2nd Ed., Allyn and Bacon Inc., Boston, 1988, pp. 141.

and Economic Behavior. The authors tried to find the mathematically complete principals which define **rational behavior** for the participants in a social economy and to derive from them the general characteristics of that behavior (6). They eventually concluded that maximizing expected utility seemed to be a reasonable goal to pursue in uncertain situations.

To understand the behavior implied by the theorem let us construct an example showing how an expected utility maximizer evaluates risky choices. Suppose that the individual can join in a lottery with only two possible outcomes: winning $50,000 ($X_2$) or nothing ($X_1$). We can arbitrarily assign a utility value of 1 to the best lottery (that is $50,000 with certainty) and 0 to the worst lottery (that is $0 with certainty).

$$U(X_1) = 0$$
$$U(X_2) = 1$$

We can also illustrate the utility level and payoff of each of the two lotteries by using the diagram below.

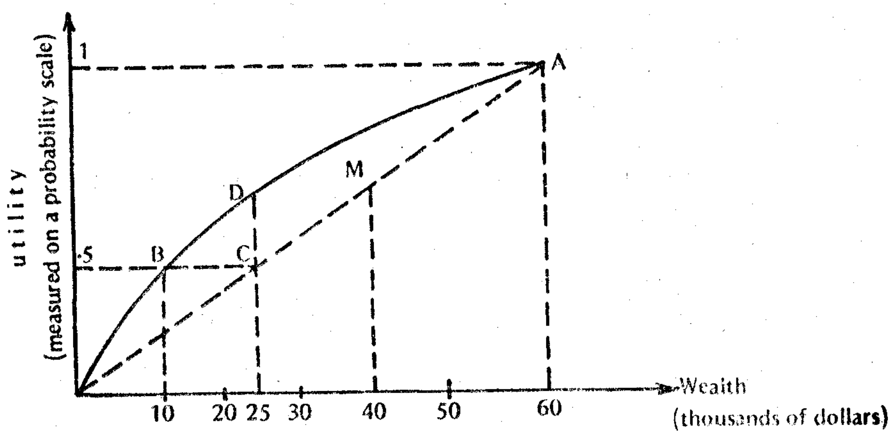

FIGURE 1 : The Von Neumann - Morgensteen Utility Index for risky situations

(6) J. vonNEUMAN and O. MORGENSTERN, **The Theory of Games and Economic Behavior,** Princeton University Press, Princeton N.J., 1972, pp. 31.

In figure 1 point A shows the best lottery and the origin shows the worst lottery (no gain situation). Using these two lotteries as reference points to the von Neumann-Morgenstern theorem we can construct a utility index specific to the individual. This index can be used to assign utility numbers to the other possible outcomes between the best and the worst.

Now let us broaden our example by considering that there are other prizes between $0 and $50,000 like $10,000, $20,000, $30,000, and $40,000. The new order of the prizes will be as follows

PRIZES :	0	10000	20000	30000	40000	50000
SITUATIONS :	(X_1)	(X_2)	(X_3)	(X_4)	(X_5)	(X_6)

Assume any amount of money between X_1 ($0) and X_6 ($50,000), say X_i. If we ask the individual, there will be a probability, say, π_i that he or she would be indifferent between X_1 with certainty and a lottery offering prizes of X_6 (the best one) with probability π_i and X_1 (the worst one) with the probability $(1-\pi_i)$. The individual will always be indifferent between a lottery and a sure thing if in the lottery the probability of winning the best prize is high enough. That is, probability π_i shows the desirability of the prize X_i. The Von Neumann-Morgenstern theorem explains the utility of X_i as the expected utility of gamble that can be considered equally desirable by the individual. Algebraically it can be shown as follows

$$U(X_i) = \pi_i * U(X_n) + (1-\pi_i) * U(X_1) \qquad (1)$$

Putting the values of $U(X_n)$ and $U(X_1)$ in this equation we can get the same result which we just expressed

$$U(X_i) = \pi_i * 1 + (1-\pi_i) * 0$$
$$U(X_i) = \pi_i \qquad (2)$$

Now we can return to our previous diagram to see the Von Neumann Morgenstern utility index. Suppose X_1 is $10,000 and the individual identify the probability as .5. According to the above equation (2) we define the .5 probability as the utility value of $10,000 with certainty. This is shown as point B in the diagram. If we do the same thing for all prizes between $0 and $50,000, we can obtain an indirect utility function showing the relationship between individual's utility level and wealth (the solid curved line). The utility level, which is the height of the curve, equals the probability of winning necessary to make the individual indifferent to the lottery and the level of certain wealth. This construct is named as **the von Neumann-Morgenstern Utility Index** (7).

The important point which we have to mention is that this index is not a cardinal utility scale. Although it is unique up to a linear transformation and in the sense it is cardinal, it does not measure preference intensity. For instance, one cannot deduce that a risky situation with E(U) = .4 is twice as preferable as one in which E(U) = .2. The only function of the index is rank-order alternative risky situations.

The dashed straight line in the figure presents the expected value of the lottery as a function of probability of winning. As an example the expected value of the lottery with .5 chance of winning is

$$E(U) = .5*(\$50{,}000) + .5*(\$0)$$
$$E(U) = \$25{,}000$$

As we can see from the figure 1, this is shown as point C. Using Equation 1 derived before we can also show that the height at point C equals the expected utility of the lottery

$$E(U_1) = \pi_i * U(X_n) + (1-\pi_i) * U(X_1)$$
$$E(U) = .5 * 1 + .5 * (0)$$
$$E(U) = .5$$

Since the utility index allows us to calculate and compare the expected utilities of risky situations, we can now use it to rank-order these situations. As we mentioned before, according to the Von Neumann-Morgenstern theorem a rational individual will choose the lottery (a risky situation) which provides the highest level of expected (Von Neumann-Morgenstern) utility. To show this, consider that there are two lotteries. One lottery offers X_2 with probability q and X_3 with probability $(1-q)$ whereas the other offers X_4 with probability s and X_5 with probability $(1-s)$. In this situation the individual will choose lottery 1 **if and only if** the expected utility of lottery 1 excels the expected utility of lottery 2. Since the followings are the expected utilities of the lotteries

$$\text{Expected Utility } (1) = q * U(X_2) + (1-q) * U(X_3) \quad \ldots\ldots\ldots \quad (3)$$
$$\text{Expected Utility } (2) = s * U(X_4) + (1-s) * U(X_5),$$

(7) FRIEDMAN, pp. 199.

not guess accurately what will happen tomorrow, but we can assume that it is possible to categorize all of the possible things which might happen into a number of well-defined states (i.e., it snows tomorrow, it does not snow tomorrow).

In the modern economic characterization of risk it is the first step to represent individuals' preferences by the shape of their von Neumann-Morgenstern utility function. In figure 2 below, the random variable $\tilde{X}$ ise assumed to take on the values X' and X" with respective probabilities 2/3 and 1/3. According to this figure bearing a random wealth $\tilde{X}$ is riskier than receiving a certain payment of $\tilde{X}$ = E[X] (i.e., the expected value of random variable $\tilde{X}$). Hence it is true that an individual would be risk averse, i.e., always prefer a payment of E[X] and obtaining utility U(E[X]) to bearing risk $\tilde{X}$ and obtaining expected utility E(U[$\tilde{X}$]) **if and only if** his or her utility function were concave.

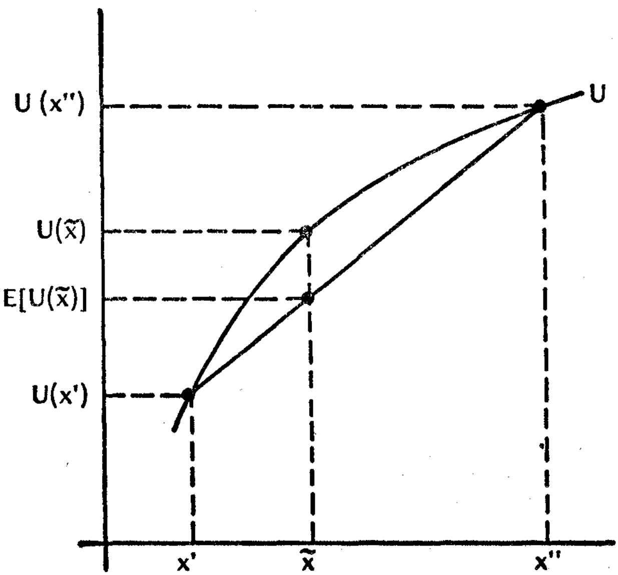

Figure 2 : Von Neumann-Morgenstern Utility Function of a Risk Averse Ind.

Many people, however, are risk seekers. Such people would have a **convex** utility function, which means that individuals exhibit expected value and certain value equivalent of a risky situation. This difference is named as **the pure cost of risk.** To illustrate this, we can use the following numerical example.

Suppose an individual is a risk averse person with wealth of $50,000. There is an even chance that the individual will develop a disability which will reduce his or her wealth to $30,000 if the insurance is actuarially fair. This means the individual pays as much in premiums as he or she expects to get back in times of loss. Here the individual expects to get back $20,000 half of the time and $0 half of the time. So the premium will be

$$E(L) = .5 * 20000 = \$10000$$

where E(L) represents the expected value of loss.

If the individual's utility function U(W = **ln** (W), then we can calculate the maximum amount he or she would prepare to spend to purchase the insurance:

With insurance, the individual will pay a premium of $10,000, so his or her wealth will be $40,000. Here

$$U(40000) = \ln (40000) = 10.5966$$

Without insurance, the individual's expected utility is

$$E(U) = .5 * U(50000) + .5 * U(30000)$$
$$E(U) = .5 * (10.8198 + 10.3090)$$
$$E(U) = 10.5644$$

The maximum amount insurance he or she will pay is the insurance that will leave the individual no better off than if he or she were not insured. Denoting the maximum insurance premium by M this means that U(50000 − M) = 10.5644 and so

$$\ln (50000 - M) = 10.5644$$

taking the antilog we can solve to get

$$M = \$11270.$$

5. ALTERNATİVE MODELS OF INDIVIDUAL BEHAVIOR UNDER UNCERTAINTY

A. THE SLUMLORD'S DILEMMA

As we mentioned earlier, in many situations the probabilities are not known. One class of these situations may be regarded to as

strategic games against other persons, like chess playing or even nuclear weapons strategies. Slumlord's dilemma is an interesting example of these types of games. This game was first proposed by Otto Davis and Andrew Whinston and is about the phenomenon of urban renewal involved externalities which a preventative solution can be obtained throughout a constrained game approach (9). Consider that there are two slum owners, Slumlady Sally and Slumlord Larry, who have nearby houses. The following is known by each owner: If both invest in improving their houses, they will have the nicest low rent apartments in the region and will earn high returns on their investments (i.e., extra profit of $6,000). On the other hand, if Slumlord Larry invests but Slumlady Sally does not, then Larry will loose his shirt but Sally will make a big profit. In this case it is clear that the payoff to each owner depends upon the decision of the other owner.

Because externality plays an important role here, the latter may happen. Namely, slumlord Larry invests but slumlady Sally does not. The result is that Larry will realize only a slight increase in the demand for his apartment because of negative externality since his apartments are right next door to a slum. The increased rent is more than offset by the renovation costs and Larry finds his net profit decreased by $5,000 whereas Sally now finds her apartments in greater demand without making any investment because of an external benefit. Since her apartments are now in a nice neighborhood her profit goes up by $7,000. To see the problem clearly we can illustrate the alternative behaviors of owners in matrix form.

		Slumlady Sally	
		INVEST	DO NOT INVEST
SLUMLORD	INVEST	$1000, $6000	–$5000, $7000
LARRY	DO NOT INVEST	$7000, –$5000	$0, $0

(9) O.A. DAVIS and A. WHINSTON, **«Externalities, Welfare and the Theory of Games»,** THE JOURNAL OF POLITICAL ECONOMY, Vol. 70, June 1962, No. 3, pp. 260.

If we think the possible reasons they might have in deciding whether to invest or not to invest we may find the followings. Slumlord Larry thinks as: If Sally invests, then I am better off not to invest ($7,000>$6,000). If Sally does not invest, then I am again better off not to invest ($0>−$5,000). Since I am better off in both of two cases if I do not invest, then I will not invest. Obviously Sally will have the same reasoning and decide not to invest. As we can follow from the matrix that this kind of decision will cause them to loose the golden opportunity of earning $6,000 together and they will end up with having no benefit at all. Why this occurs?

The main reason of this situation is that each player is uncertain about whether the other will really invest even if each agrees to do so. In other words, each owner has an incentive to be misleading and the other knows it. Let us make our example more realistic by assuming that there are 10 or 20 houses. In this case the inability to trust one another can lead to the uneconomic perpetuation of slums.

The next question is how to solve this problem. The solution is not different from the other problems caused by externalities, internalizing the effects in some way. If there are only two owners then we persuade one of them to sell the tenement to the other. But realistically it is difficult to do so if there are too many owners. **Urban renewal** might be the solution in these cases. Namely, the government buy up all the property by using its power. Then it can redevelop the property as a whole either itself or by selling it to a developer.

At this point to show the differences between games against persons and those against nature, let us look our first example from a different point of view by using the state preference approach which we mentioned earlier. Assume that Larry has to play the game against two different states instead of a person. In case of state A Larry will get $6,000 if he invests $3,000 if he does not whereas in case of state B he will loose $2,000 if he invests and get nothing if he does not. Consider how Larry might reason if state A or state B is to be deliberately chosen by another person for whom the payoffs are identical with those to Larry and again assume that the two people are not allowed to communicate. In this situation Larry will realize that the other person has a dominant strategy. That is, since state A is superior to state B, no matter which strategy Larry will choose, the other person will choose A. Hence Larry will decide to invest.

Once the state preference approach is involved to the analysis, an individual forms subjective opinions about the probabilities of the states. In this case information is valuable since it alters **a priori** probabilities and allows individuals to make better decisions. It also permits the individual to revise his or her choices so as to achieve a higher expected utility at given probability estimates. Now suppose that state A is a favorable legislation of the city council which will affect Larry's investment decision positively. If Larry could find out with certainty whether this legislation will be issued in near future, what would be the price of this information? The answer is that the utility value of perfect information is the difference between the expected utility of the current with lack of information and the expected utility of being able to choose the best strategy in what ever state occurs. It is clear that to follow the expected utility maximizing strategy which we tried to explain in this section, Larry must have subjective apprehensions of the probability of each state.

B. PRISONER'S DILEMMA :

Another type of strategic game against other person is known as **Prisoner's Dilemma.** Two people, arrested with stolen property in their possession, are being interviewed separately by the police. They both know that if they keep quiet there is not evidence for them to be convicted and they will only get one-year gaol sentence for being in possession of stolen property. If both confess to the theft they will both get nine years in prison. However, if one confesses and the other does not, the confessor goes free while the other gets ten years in prison (the extra year is for not assisting the police) (10). Writing the payoffs in the matrix form we get.

		PERSON A	
		CONFESS(1)	DO NOT CONFESS(2)
PERSON	CONFESS(1)	−9, −9	0, −10
B	DO NOT CONFESS(2)	−10. 0	−1, −1

(10) L.C. THOMAS, **Games, Theory and Applications,** Ellis Horwood Limited, Chicester, U.K., 1986, pp. 17.

According to the above matrix the maximin-maximin pair of the strategies and the only equilibrium pair are the same (A1-B1) where both prisoners confess. However this is not a satisfactory solution to the game since it leads to payoffs (−9, −9), which is worse for both players than (−1, −1). This game includes two of the major dilemmas in conflict situations. The first dilemma is what the player's objective as an individual or as a part of a group should be. This conflict is between **individual rationality** which would lead one to confess or **group rationality** which would propose keeping quiet. Which one is used related with the psychological side of the game and depends on the individual involved and his or her previous experience with other people.

The second dilemma is whether to think of Prisoner's Dilemma as one-off game or as one that will be played repeatedly. If it is a one-off game it seems best to confess sincethere is no reason to build up your opponent's trust in you. But if we play the game a fixed number of times and the number of times is not known by the players there will be equilibrium pairs that result in the «keep quiet» strategy being played all the time.

The last example about this kind of strategic game arises from medical insurance because of the same logic. Briefly, what we observe is that, the insurance changes the economic incentives that individual faces and thus causes to be different. In medical policies, the cost of medical care is not completely determined by the illness suffered by the individual but depends on the choice of a doctor and his willingness to use medical services. It is frequently witnessed that widespread medical insurance increases the demand for expensive medical care. It may be convenient for the physicians or pleasing to their patients to prescribe more expensive medication, private nurses, more frequent treatments and other marginal variations of care (11).

C. BOUNDED RATIONALITY :

As we have shown, if a simple die tossing game that takes in effortlessly understandable risks is regarded, it is quite reasonable to expect that common behavior of an individual is consistent with

(11) K.J. ARROW, **«Uncertainty and the Welfare Economics of Medical Care»**, THE AMERICAN ECONOMIC REVIEW, Vol. 53, No. 5, December 1963, pp. 962.

the expected utility maximization approach. What if situations in situations in which the decision making process becomes more complex are confronted? In these situations, as we know, factual behavior of the individual takes on a different shape. The most important point to understand this is to recognize that decision making is itself a costly process and that individuals will allocate only a limited amount of their own resources, including time, to the activity of deciding. Thus, it is supposed to be said that human rationality may be limited or bounded during the decision making process. Bounded rationality is an essential argument in the behavioral approach to economics. It is intensively concerned with the ways by which the decision reached are affected. The term **bounded rationality** is therefore used to specify rational choice that takes into account the cognitive limitations of the decision maker - limitations of both knowledge and computational capacity (12).

Theories of bounded rationality has been generated by loosing up some of the assumptions of the theory of subjective utility underlying neo-classical economics. As it was shown before, neo-classical subjective utility theory claims that choices are realized

(1) among a given set of alternatives;

(2) with known subjective probability distributions of consequences for each; and

(3) in such a way in order to maximize expected value of a given utility function.

In models of bounded rationality, a process for generating alternatives is studied under modern cognitive psychology. These studies (13) show that under most circumstances to talk about finding «all the alternatives» is not reasonable. This process is a long and expensive one. Instead of presupposing known probability distributions of consequences, estimating procedures and strategies to treat

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(12) H.A. SIMON, **Models of Bounded Rationality, Vol. I,** M.I.T. Press, Cambridge, Mass., 1982, pp. 27-28.

(13) See, for instance R.M. HOGARTH, **Judgement and Choice: The Psychology of Decision,** Willey and Sons, Co., New York 1980; P. MILGRAM and J. ROBERTS, **«Informational Asymmetries, Strategic and Industrial Organisation»**, THE AMERICAN ECONOMIC REVIEW, Vol. 77, No. 2, March 1987, pp. 184-193.

uncertainty should be looked for. Also, postulating a satisficing strategy is more sensible than maximizing a utility function.

To see this point, think about the differences in decision making during the process of playing the games of tic-tac-toe(*) and chess (14). Playing tic-tac-toe a couple of times is enough to turn out to be an expert player by trial and error. The optimal choice of moves is not accomplished by mentally considering all the alternatives and their possible consequences (9 possible openings * 8 possible responses * 7 possible next moves, etc.) and seeing which current move is the best. Although people do not have the mental capacity there is no need to make such calculations to become an expert learning a small set of routine offensive and defensive tricks is enough. The same limited calculating ability which prevents systematic consideration of all alternatives in tic-tac-toe applies to the game of chess. No one has the ability of considering all possible outcomes of alternative moves to find out the best one. Therefore, the same problem-solving procedure is followed. However. there is a basic difference between the two games: Although almost everyone finds out optimal strategies for tic-tac-toe, no individual has ever found an optimal (unbeatable) strategy for chess. In this sense, chess players develop routines that satisfice.

Since the empirical evidence on individual consumer choice shows that actual behavior in most cases is not consistent with expected utility maximization (15), bounded rationality theories claim, the bounds are themselves the cause of uncertainty to the extent that rationality is bounded. It can be said that bounded rationality approach is more ambitious, in undertaking to get the actual process of decision as well as the core of the final decision itself. It is also possible to say that a veridical theory of this kind can only be built up on the basis of empirical knowledge of the abilities and limitations of human mind, in other words, on the basis of psychological research (16).

(*) Tic-tac-toe is a game which is played between two people by writing the marks O and X in turn on a pattern of nine squares with the purpose of writing three such marks in a row.

(14) This example has been adopted from FRIEDMAN, pp. 222-224.

(15) See D.W. GRETHER and C.R. PLOTT, **«Economic Theory of Choice and the Preference Reversal Phenomenon»,** THE AMERICAN ECONOMIC REVIEW, Vol. 69, No. 4, September 1979, pp. 623-638.

(16) SIMON, pp. 5.

6. SUMMARY AND CONCLUSION :

The assumption that individuals are well informed plays a major role in the theory of individual behavior. However many economic decisions are made under conditions of uncertainty because of the unpredictable behaviors of the people with whom we transact as well as natural events. Analysis of risk and uncertainty begins with the concept of expected value, a statistical parameter for evaluating the wealth consequences of uncertain prospect. Since the presence of uncertainty is generally considered costly, many economic problems (for instance, insurance and investments) may be analyzed under the assumption that individuals are risk averse, meaning that they dislike it and are willing to pay in order to avoid or reduce it.

Individuals will attempt to make the decisions that maximize their expected utilities when they confronted with risky choice situations. To explain the relationship between fair games and the expected utility hypothesis we used St. Petersburg Paradox arguing that individuals do not care directly about the dollar prizes of a game, rather they respond to the utility of these dollars provide. Although N. BERNOULLI did not really solve the paradox, he made an important remark by looking at the expected utility rather than the expected dollar values.

The hypothesis that individuals make choices in uncertain situations based on expected utility is the subject of the Von Neumann-Morgenstern theorem. In their theorem they developed a utility index which plays the role of utility function. By using it they eventually showed that individuals make choices among risky options so as to maximize expected utility. Even though there are debates on the exact relationship between Von Neumann-Morgenstern utility and the more traditional concept, it is generally assumed that the basic Von Neumann-Morgenstern axioms hold. Therefore it is possible to talk about individuals maximizing expected utility.

Under the light of expected utility maximization hypothesis, it is possible to examine whether particular choice situations can be modeled successfully. Some situations like Slumlord's and Prisoner's Dilemma may be observed as uncertain rather than risky. Slumlord's Dilemma, for example, shows that choice making may result from strategic reasoning rather than estimating probabilities of the various possible states. It is generally argued that the government encourage the production of goods and services that entail external economies and discourage the production of those that entail external diseconomies.

Prisoner's Dilemma also is seen as an illustration of the divergence between individual and collective rationality. Decisions that are rational from the point of view of each individual may be defective from the points of view of both. It is possible to characterize many social situations by a similar bifurcation between decisions prescribed by individual and collective rationality. Price wars are conspicuous example to this.

The expected utility maximization, however, cannot be applied to all cases. A more general alternative to this is the models of bounded rationality. According to the bounded rationality models there are limits to human information-processing abilities such that the calculations required to maximize expected utility may be beyond them in some situations. For instance, no one has yet discovered an optimal chess strategy although we know that at least one exists. The bounded rationality models emphasize that with enough trials and errors, learning and imagination people can solve complex problems even if they do not find the optimal strategy. On the other hand, in other situations where there is complexity or the lack of trials people's choice may be very poor or irrational.

REFERENCES

ARROW, K.J., **«Uncertainty and the Welfare Economics of Medical Care», THE AMERICAN ECONOMIC REVIEW,** Vol. 53, No. 5, December 1963.

DAVIS, O. - A. WHINSTON, **«Externalities, Welfare and the Theory of Games», THE JOURNAL OF POLITICAL ECONOMY,** Vol. 70, No. 3, June 1962.

DESERPA, A.C., **Microeconomic Theory, Issues and Applications,** 2nd Ed., Allyn and Bacon Inc., Boston, 1988.

FRIEDMAN, L.S., **Microeconomic Policy Analysis,** McGraw-Hill Book Company, New York, 1984.

GRETHER, D.W. - C.R. PLOTT, **«Economic Theory of Choice and the Preference Reversal Phenomenon», THE AMERICAN ECONOMIC REVIEW,** Vol. 69, No. 4, September 1979.

HEY, J.D. (Ed.), **Current Issues in Microeconomics,** St. Martin's Press, New York, 1989.

HOGARTH, R.M., **Judgement and Choice: The Psychology of Decision,** Willey and Sons, Co., New York, 1980.

MACHINA, M.J., **«Choice Under Uncertainty: Problems Solved and Unsolved»,** in J.D. HEY (Ed.), **CURRENT ISSUES IN MICRO-ECONOMICS.**

MILGRAM, P. - J. ROBERTS, **«Informational Asymmetries, Strategic and Industrial Organisation», THE AMERICAN ECONOMIC REVIEW,** Vol. 77, No. 2, March 1987.

NICHOLSON, W., **Microeconomic Theory, Principles and Extensions,** 4th Ed., The Dreyden Press, New York, 1989.

SIMON, H.A., **Models of Bounded Rationality,** Vol. I, M.I.T. Press, Cambridge, Mass., 1982.

THOMAS, L.C., **Games Theory and Applications,** Ellis Horwood, Limited, Chicester, U.K., 1986.

VONNEUMANN, J. - O. MORGENSTERN, **The Theory of Games and Economic Behavior,** Princeton University Press, Princeton N.J., 1972.