TEACHING UTILITY THEORY USING POPULAR GAME SHOW "DEAL OR NO-DEAL"

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ABSTRACT

By using "Deal or No Deal" as an example, students seem to understand the utility theory better because the situation is very familiar to them. They can imagine how to use the utility curve they have learned to build in case they are lucky enough to be on the stage of the game show. This makes learning fun. Once they learn the concept, they can apply the utility theory for sophisticated decision analysis in the classroom and in their jobs.

INTRODUCTION

We illustrate an occasion with the popular game show "Deal or No-Deal" in which the criterion of maximizing expected return in a decision making under risk seems inappropriate. This would lead to the rationale for the utility theory.

We now develop utility curves for the game show (a simplified version). Equivalent Lottery and Exponential Utility Curve Methods are presented to build our utility curves. We show the cons and pros between the two methods. We also show the similarities of the results from the two methods. An understandable in-class discussion of why the Equivalent Lottery method works deepen the theoretical backdrop for the theory. An Excel spreadsheet helps to build the utility curve in a short amount of time when using the Exponential Curve method.

By using "Deal or No Deal" as an example, students seem to understand the utility theory better because the situation is very familiar to them. They can imagine how to use the utility curve they have learned to build in case they are lucky enough to be on the stage of the game show. This makes learning fun. Once they learn the concept, they can apply the utility theory for sophisticated decision analysis in the classroom and in their jobs.

IILLUSTRATION OF A SIMPLIFIED GAME SHOW

Let us have a simplified version of "Deal or No-Deal," in which we have only six numbers on the board; $0, $1,000, $10,000, $100,000, $500,000, and $1,000,000. There are six cases numbered one through six and each case contains one of the dollar amounts displayed on the board. The player does not know which case contains which dollar amount. The player picks a brief case at his own discretion, the case is opened and the dollar amount contained in the case is eliminated off the board. The game continues until there is only one briefcase remaining. The dollar amount contained in the remaining case is the player's prize. However, throughout the game, as cases are eliminated, the "banker" offers a cash amount in exchange for stopping the game at that moment without pursuing further gain from the game. The player makes the decision whether to make the "deal" (accept the banker's offer and stop the game) or "no-deal" (continue the game and open one more case; then consider the banker's revised offer).

RATIONALE FOR UTILITY THEORY

We have seen many occasions in which the criterion of maximizing expected return is not applied for the player's decision of "deal" or "no-deal." For example, there are two remaining cases, containing \$1M and \$0 and banker's offer is, say, \$300,000. The expected return from the remaining game is \$500,000, which is more than the banker's offer of \$300,000. However, many players accept the banker's offer because they are content with the \$300,000 and are afraid of the worse situation in which the player ends up with nothing by continuing the game. This choice of the inferior expected return leads us to why we need to learn the utility theory.

BUILDING UTILITY CURVES

We often use two different methods in building the utility curves: Equivalent Lottery and/or Exponential Curve Method. It is convenient to set the utility of the smallest amount equal to zero and the utility of the largest amount equal to 1. That is U(0) = 0 and U(1M) = 1.

Equivalent Lottery Method

Let's say we are looking for U(100,000). We now compare the following two alternatives and choose a *p* which makes them indifferent. This *p* is the utility for \$100,000.

1. Receive a cash payment of \$100,000 from the banker for sure.
2. Continue the game in which he receives a payment of \$1M with probability *p* or a payment of \$0 with probability 1-*p*.

The *p* value will vary from player to player depending on the risk profile of each individual. For example, I will choose *p* to be 0.6 to make the two alternatives indifferent. Therefore, U(100,000) = 0.6 in my utility curve. Continuing with my choices, the following table is constructed for my utility curve:

x (\$ amount)	U(x)
0	0
1000	0.05
10000	0.2
100000	0.6
500000	0.95
1000000	1

Exponential Utility Curve Method

We use an exponential utility function, U(x) = 1 – exp(-x/r). This curve has a predetermined risk-averse profile because of its concave shape. It requires the assessment of only one parameter, *r* , which measures the degree of risk aversion. The larger the value of *r* , the less risk-averse (the more risk loving) the player is. One of easiest ways to determine the value of *r* is by comparing the following two alternatives and choosing the dollar amount of *r* such that the two alternatives become indifferent:

1. A 50-50 gamble in which the results will be a gain of *r* dollars or a loss of *r*/2 dollars.
2. A zero payoff.

Again let us proceed with my choice of the value of *r* which happen to be around \$50,000. Given *r* =50000 and so the utility curve of U(x) = 1 – exp(-x/50000), my utility table is constructed below:

x	U(x) = 1-exp(-x/50000)
0	0

1000	0.019801327
10000	0.181269247
100000	0.864664717
500000	0.9999546
1000000	0.999999998

Comparison of the Two Methods

To our satisfaction, the Utility values constructed by Equivalent Lottery and Exponential Curve seem quite similar. That is, we may use either method without too much discrepancy. Students find that it takes a long time to build all utility values (often very large numbers) one by one using the Equivalent Lottery method. Therefore, they find the Equivalent Lottery method to be impractical. On the other hand, they find that the Exponential Curve Method can be quite easily constructed with the help of an Excel spreadsheet in particular.

DEAL OR NO-DEAL DECISIONS USING THE UTILITY CURVE – AN EXAMPLE

Let us assume that we choose to use the table calculated by the Exponential Curve Method for the following example. The table built above by exponential utility curve method has been extended for all monetary values ranging from $0 to $1M using an Excel, without presenting the numbers here.

At the beginning of the game, the expected utility of the game is 0.51 which has the cash equivalent value of around $35,000. For example, let's assume that there are three remaining numbers: $10,000, $100,000, and 500,000. The expected utility for the game at the moment is: (U(10000)+U(100000)+U(500000))/3 = 0.6827 which has cash equivalent value of slightly less than $60,000. That is, if the banker's offer is $60,000 or higher, then take the deal.

REFERENCES

[1] Eppen, Gould, Schmidt, Moor & Weatherford, *Introductory Management Science.* Prentice Hall, 1998.