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ECONOMIC RISK EXPOSURE OF SELECTED PROJECTS AND RISK ATTITUDE OF INVESTORS; EVIDENCE FROM LIBERIA

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ABSTRACT

Thepresent research is about quantifying the economic risk exposure of the projects and willingness of investors to take a chance on an investment of uncertain outcome based on risk attitude. This paper explains typical investment situations of decision makers who do not know with certainty the outcome of their investment and illustrates with probability distribution a way of measuring risk exposure and introduces the use of utility functions to determine a decision maker's risk attitude. It is concluded from the study that to determine the true value of investments for risk takers, economic analysis must account for increasing marginal satisfaction of higher payoffs with corresponding increases in marginal utility. A firm or institution can use utility theory in a normative or prescriptive role to establish risk policy for investments that support the firm's or institution's risk attitude. Overall the paper provides a useful study on economic risk exposure of projects and risk attitudes of investors in Monrovia, the capital of Liberia.

Keywords: Investment, Economic, Risk exposure, Risk attitude

INTRODUCTION

This study describes how to measure risk exposure and risk attitude in typical investment situations for investors who do not know with certainty the outcome of their investment. Liberia has been the victim of war for more than 10 year which caused huge devastation of public and private infrastructure. The economic activities and re-building of Liberia started in year 2003 when United Nation's troops were deployed in the country. Many construction and infrastructural development projects were initiated. Local investors were encouraged to take part in this whole process. This presented a typical investment situation for the investors and they were highly doubtful about the probable outcome of their investment. This environment provided an excellent opportunity to

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undertake this study. This paper illustrates the quantification of risk exposure of the projects with probability distribution function and risk attitude of investors with utility function, utilizing the data collected for selected ongoing construction projects and individual investors in Monrovia, the capital of Liberia.

REVIEW OF LITERATURE

Corporate finance is an area of finance dealing with financial decisions and the tools used to make these decisions. The primary goal of corporate finance is to maximizecorporate valuewhile managing the firm's financial risks. Technically speaking, risk means that there are number of different possible outcomes associated with a particular action and we do not know beforehand which one will occur (Binswanger, 1980). Financial risk management is concerned with creating economic value in a firm by using financial instruments to manage exposure to risk (Baumol, 1977). It comprises identifying sources of risk, measuring it, and plans to address them. It is useful tool to handle uncertainties related to investment decision such as investments in long lived projects which are characterized by uncertainties and exact values of variable factors are usually unknown; making reliable economic evaluations difficult. Failure to account for uncertain input variables means that investors are confronted with risk exposure which is the probability of a project's having an economic outcome less favorable than what is economically acceptable (Hammond and Raiffa, 2002). Investors faced with an investment choice under uncertain conditions also confront a second aspect of risk which is their attitude towards it, called risk attitude. Risk attitude can be measured by the willingness of a decision maker to take a chance on an investment of uncertain outcome (Neuman, 1944). The implication of different risk attitudes is that a given investment of known risk might be economically acceptable to an investor who is a risk taker but unacceptable to another investor who is risk averse.

RESEARCH METHODOLOGY

Data was collected from the firms and investors in Monrovia. Nine ongoing construction projects, 27 firms and 133 individual investors of different economic status were visited and thorough survey was carried out including distribution of risk profiling questionnaire. Following steps were followed for the study: (i) Field survey and collection of data from the individual investors and for ongoing construction projects in Monrovia; (ii), Analysis of the data of selected projects to measure risk exposure with probability distribution function; (iii), Analysis of the data to deduce risk attitude of investors with utility functions curves and (iv), Conclusions.

Study area

Liberia is situated in West Africa, bordering the North Atlantic Ocean to the country's southwest. It has Guinea in the north, Sierra Leone in the east Cote D' Ivory in the West and North Atlantic Ocean in the south. It lies between latitudes 4° and 9°N, and longitudes 7° and 12°W. Study was carried out for construction projects and individual investors in Monrovia, the populated capital city of Liberia. A satellite view of Monrovia is shown in Figure 1.

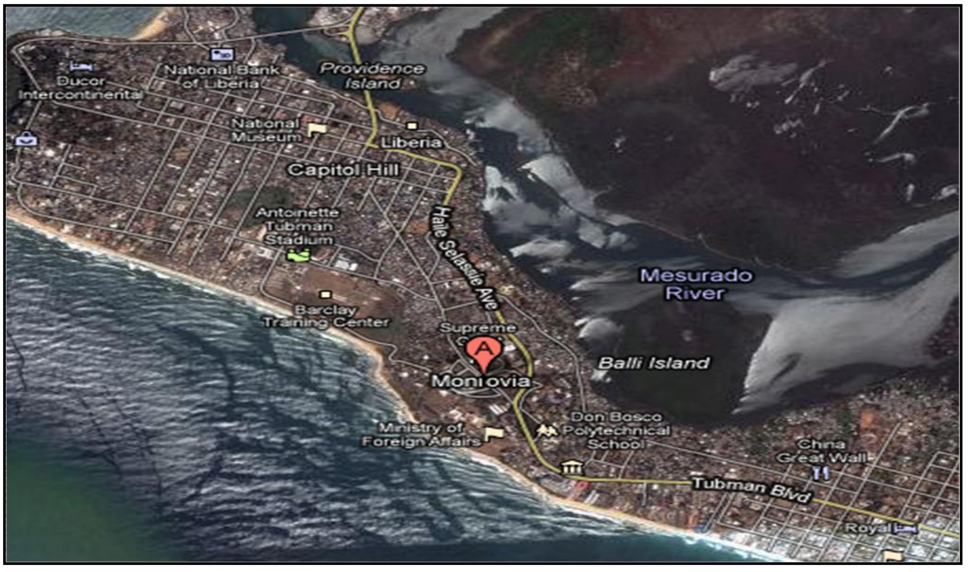

Figure 1: Satellite view of study area, Monrovia, Liberia (Google, 2009)

The Liberian Civil War (1989-98) destroyed much of Liberia's economy, especially the infrastructure in and around Monrovia. Many businessmen fled the country, taking capital and expertise with them. Richly endowed with water, mineral resources, forests, and a climate favorable to agriculture, Liberia had been struggling even for basic products, while local manufacturing, had been small in scope. The restoration of the infrastructure and the raising of incomes in this ravaged economy required the implementation of sound economic policies of the government, including the encouragement of foreign and local investment. Many steps were initiated to rehabilitate the infrastructure and basic facilities in Liberia, especially around Monrovia. Presently, construction activities are in progress to redevelop the capital mainly through local construction firms. Local investors (though small scale) have been encouraged to invest money in the development process. Besides, the local labor is employed for all the developmental projects. With these efforts in place, economy is getting pace in Liberia. Few selected ongoing construction projects and local investors are the focus of this study.

Quantification of risk exposure by probability distribution function

The uncertainty in the investment situations leads to risk exposures. One way to illustrate risk exposure is by finding the probability distribution of the measure of economic worth. The probability profile quantifies risk exposure by showing probabilities of achieving different values of economic worth (Eckel and Grossman, 2007). Measuring the probability of the project's economic worth being less than an economically acceptable value reveals the risk of accepting an uneconomic project. Figure-2 shows discrete probability distribution profiles against benefit to cost ratio (BCR) of various investment options for four selected construction projects at Monrovia.

These four projects are construction of a grand plaza, multi storey houses, community roads and a modern private hospital.

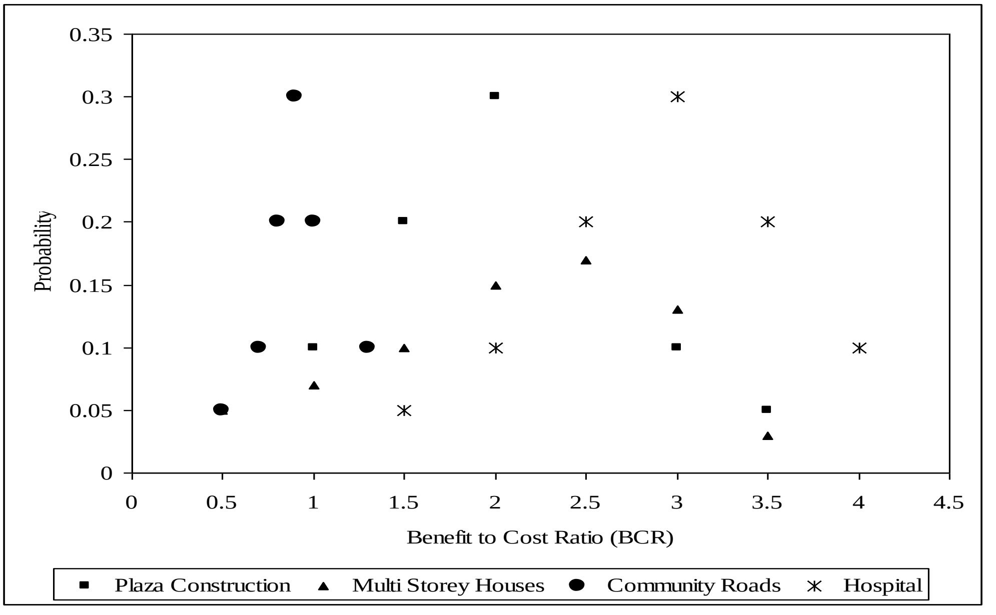

Figure 2: Discrete probability distribution of the bcr for selected projects in monrovia, liberia

Probability of various BCR values for different investment options was calculated based on the collected data for the four projects. Consequently, an x-y plot was constructed having on the vertical axis the probability of the investment's achieving the corresponding BCR on the horizontal axis. The mean (expected value) of the BCR for the plaza and multi storey hoses construction projects was found out to be 2, for community roads it was 0.96 and for hospital it was 2.75. This suggested that, except for community roads project, the most likely measure of worth for the investment in rest of the three projects was exceeding the 1 BCR which is normally regarded as the minimum necessary for project acceptance. However, this may be misleading. The mean BCR may be less than or more than 1, but project may behave in a different way. For the accurate picture of the risk exposure, we need to consider the mean and variance of probability of a particular BCR for the projects under consideration. Therefore, as a first step standard deviation and mean for the probability distribution was found to determine the likelihood that the actual BCR was within acceptable bounds around the mean. The smaller the spread of the distributions, as measured by the standard deviation, the tighter the distribution was around the mean value and the smaller was the risk exposure associated with the project.

It is known that in a normal distribution, the probability that the actual value will be within one, two and three standard deviations of the mean is 68.26, 95.46 and 99, 73%, respectively. Assuming that the discrete probability distribution in Figure-2 approximated a normal distribution, the probability of the CBR's being within any one of the standard deviation ranges was estimated for all four projects. For clarity purposes the details for construction of plaza project will be discussed here. The standard deviation for the construction of plaza project from Figure-2 was found to be 0.72. Thus, there was a 68.26% probability that the BCR will lie in the range of 1.28 to 2.72 (i.e. 2.0 ± 0.72). The formula which was devised for calculation of the standard deviation (now commonly known as Gul's equation) was as under:

$$SD = [\sum_{S=1}^{N} (BCR - M)^2 . E_S]^{1/2} \quad (1)$$

Where
SD = Standard deviation.
S = Possible state.
N = Number of possible state.
BCR = Benefit cost ratio in the sth state.
M = Mean or expected value of the distribution.
Es = Probability of the sth state.

However, the probability distribution in Figure-2 did not reveal directly the probability of choosing a project having a BCR greater than or less than some target value. But, when it was transformed to the cumulative distribution function as shown in Figure-3 for construction of plaza project, it facilitated not to choose the project with BCR smaller than 1.The function relating BCRs to cumulative probabilities was upward sloping, indicating positive trend between the two parameters. For construction of plaza project, the probability (or risk of exposure) of the BCR's being less than 1.0 was 5% as shown in Figure-3 or, said another way, the probability of the project's earning positive net benefit or at least breaking even was 95%. The probability that the BCR is less than the expected value of 2.0 was 35%. Therefore, it was concluded that the construction of plaza project had less risk exposure. Similar calculations were done for rest of the three projects, summary of which is shown in Table 1.

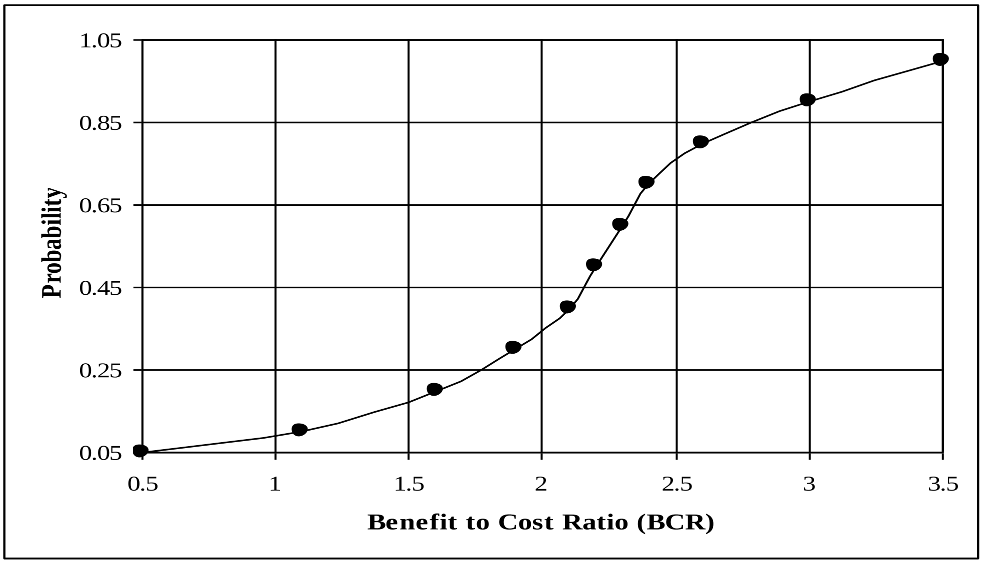

Figure 3: Cumulative probability distribution function of the bcr for the project of plaza construction in monrovia, liberia

Table 1: Probabilities of various BCR values and risk exposure for the four selected projects

Construction Project	Probability				Risk Exposure
	BCR < 1	BCR > 1	BCR < 2	BCR > 2	
Plaza	5	95	35	65	Low
Multi Storey Houses	5	95	35	65	Low
Community Roads	5	95	100	0	Low
Private Hospitals	0	100	5	95	No Risk

Probability and cumulative distribution functions provided information about risk exposure lacking in deterministic approaches that assumes certainty and provides single value measure of project worth. But the functions did not reveal risk attitude of the investors. Different investors may respond differently to any given profile of risk exposure. Thus, to make efficient choices when investment outcomes are uncertain, investors need to consider their unique risk attitudes.

PROJECT PREFERENCE WITH PROBABILITY DISTRIBUTION

The preference of a particular project over the other by investors of Monrovia was determined by quantifying risk exposure with probability distribution function for selected projects. Two approaches of the investors to handle risk exposure were identified during the field survey which is discussed here. First, they were found to take risk on the basis of their subjective or intuitive perception without measuring it. From economics point of view, this approach being informal in nature, allowed for the consideration of risk exposure but lacked any standard procedure for measuring risk when making a choice. This approach was adopted by investors with high level of income and enhanced financial capacity. Small percentage (7 – 10 %) of investors was found in Monrovia using this approach for the investment decisions.The second approach for considering risk exposure was formal in which investors resorted to proper measurement of risk and then using that measurement, economic worth of a project was evaluated. This approach was adequate for a single as well as for several projects competing for a limited budget. Although, the preferred choice was not obvious from an examination of probability density functions for individual projects, it became obvious when functions for alternative projects were superimposed, as shown in Figure-4 and 5 for two alternative construction projects at the Monrovia Port. Here the probability profiles were good indication of project choice because project A clearly had stochastic dominance over project B. As can be seen, for every BCR value in Figure-4 and 5, project A exceeded that BCR than project B. In other words, for every BCR value, project B provided a lower or equal BCR compared to project A. Thus, project alternative whose function was farthest to the right was the preferred alternative for the investors. It should be noted that if Life Cycle Cost (LCC) of alternatives were measured on the horizontal axis instead of the BCRs, the alternative farthest to the left would have been preferred because objective function would have been to minimize LCC rather than to maximize the BCR.

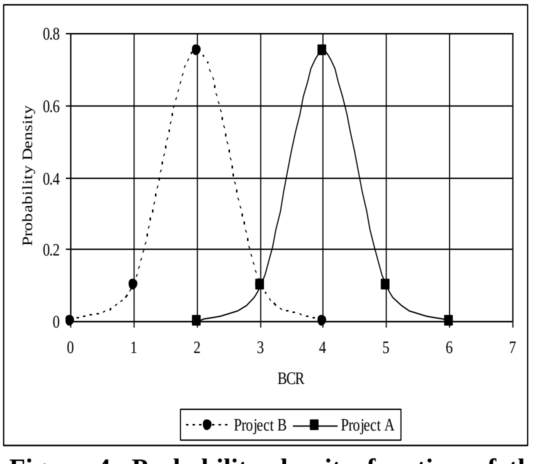

Figure 4: Probability density function of the BCR for projects A and B

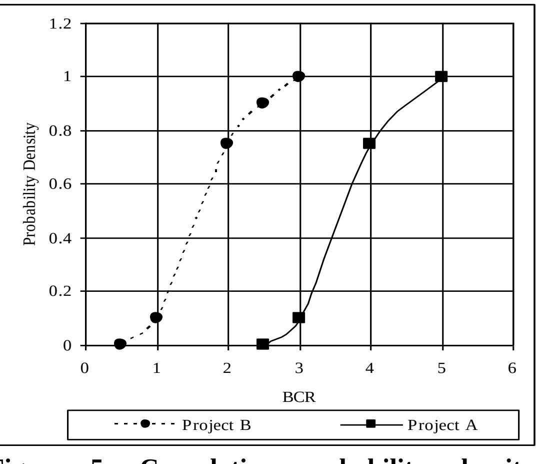

Figure 5: Cumulative probability density functions of the BCR for project A and B

The formal technique, however, had limitations for the projects with no clear indication of stochastic dominance illustrated by the intermingled probability distributions shown in Figure-6 and 7 for two construction projects at Monrovia Airport. Although project D had the large mean, it also had the larger variance or risk exposure which means that the project with greater expected return had greater variance or risk exposure. There was no clear indication of stochastic dominance, so the project preference was difficult in this case. This situation was evaluated using utility functions for the two projects, as described in ensuing paragraphs.

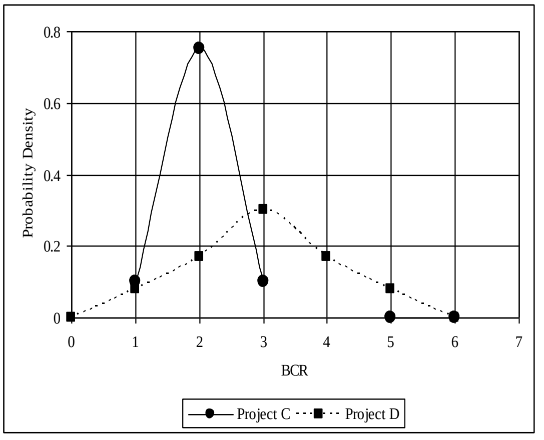

Figure 6: Intermingled probability density functions of the BCR

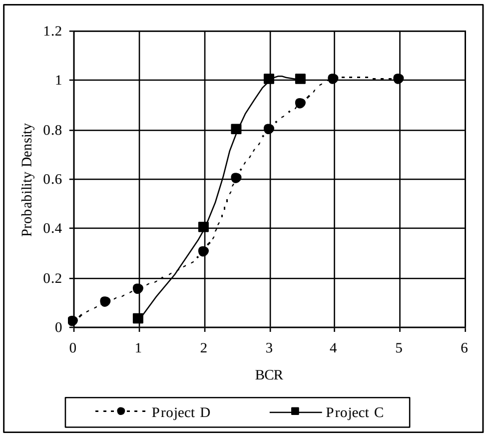

Figure 7: Cumulative probability density functions of the BCR for project C and D

QUANTIFICATION OF RISK ATTITUDE BY UTILITY FUNCTION CURVES

We know that an individual's ability to take risk relates to financial circumstances and investment goals. Generally speaking, the higher the level of wealth and income relative to any liabilities, the more is the ability to take financial risk and the greater is the risk capacity (Binswanger, 1980). In order to know about the investors' risk attitude in Liberian's economic environment, a risk profiling questionnaire was developed. Obviously, risk attitude is a complex area and, as a result, risk profiling is not an exact science, but it does show the pattern in which investors will behave when confronted with particular risk situation. Moreover, a well-designed risk profiling tool can contribute significantly to financial planning process (Keeney and Raiffa, 1993). During the process of field survey of 133 individual investors, the designed questionnaire was distributed to the investors and filled sheets were collected. Survey revealed tendency as shown in Table-2.

Table 2: Risk attitude profiling for investors in monrovia, liberia

Investor's Category	Percentage (%)
Risk Taker	15
Risk Averse	65
Risk Neutral	9.8
Combination	10.2

Table 2 shows that most of the investors in Monrovia were risk averse. They were reluctant to accept a bargain with an uncertain payoff rather than another bargain with more certain, but possibly with lower, expected payoff. For example, 65 % of the investors chose to put his or her money into a bank account with a low but guaranteed interest rate, rather than into a stock with high returns, but also had a chance of becoming worthless. This indicated that they were mostly cautious. Risk neutrals were those who were indifferent between the best and expected. Risk takers were willing to take risk. These were lesser in percentage and were the investors with greater financial capacity. Considerable number of investors showed mixed attitude; for some aspects they were willing to accept risk and for some aspects they were unwilling. Their percentage was almost equal to the investors who were risk neutrals.The quantification of risk attitude for investors and selected projects was based on utility theory which provides a methodological framework for the evaluation of alternative choices made by individuals, firms and organizations. Utility refers to the satisfaction that each choice provides to the decision maker (Booij and Kuilen, 2006). Thus, utility theory works on utility maximization principle, according to which the best choice is the one that provides the highest utility (satisfaction) to the decision maker (Friedman and Savage, 1952). It helps in determining the economically preferred investment choice when measures of risk exposure alone fail to indicate the preferred project.

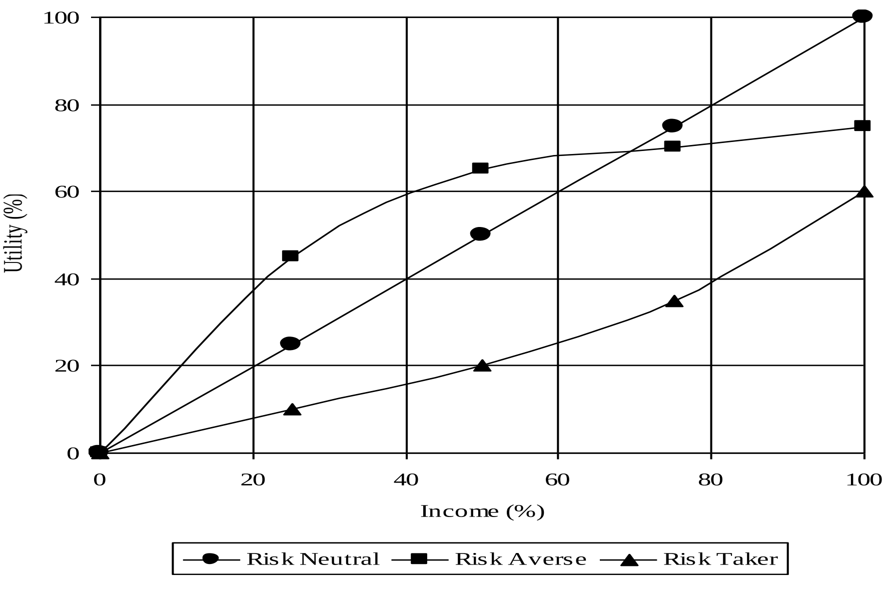

Figure 8: Three types of risk attitudes shown by investors of Monrovia

Figure 8 shows three shapes of utility functions which were achieved for investors in Monrovia as a result of this study. Each shape represents one of three different risk attitudes; risk neutral (RN), risk averse (RA), and risk taking (RT). Utility values, displayed on the vertical axis, are arbitrary units used to measure the degree of utility or satisfaction associated with a given amount of money shown on the horizontal axis. The utility function reflected a particular relationship between satisfaction, a subjective value, and monetary amounts. It was found that the utility function was unique to one individual, firm or institution. Each investor was having a different utility function for different level of investments. During this evaluation, it was assumed that an investor was indifferent among investments with the same expected utility and would prefer investment X to investment Y only if the expected utility was greater for X than for Y.

The Figure 8 interprets that for the straight-line utility function (RN), each additional, fixed increment of income yielded a constant increase in utility; i.e. the marginal utility of income was constant. The investor was considered risk neutral because the gain or loss of a large amount of money would yield the same increase or decrease, respectively, in utility as would the gain or loss of a small amount of money. The risk neutral (RN) investors had taken their investment decision on the basis of Expected Monetary Value (EMV). For example the worth of EMV for the lottery, with 50% probability of earning $25000 and 50% of earning nothing, described earlier was calculated as:EMV = 0.5 ($25,000) + 0.5 ($0.00) = $12500. Therefore, risk neutral investors were found indifferent to the lottery or a sure cash payment of $12500. They were categorized as risk neutral since they were willing to accept a fair venture. The utility function for a risk neutral decision maker was a straight line, because there was a constant tradeoff between satisfaction in utility and income. When doing this analysis, an implicit assumption was that investors considered EMV for investing the money. Thus, there was no explicit consideration of risk attitude because maximizing the expected value was assumed to be equivalent to maximizing expected utility.For risk averse (RA) investors, the utility function curve was a belly up curve.

For them, increasingly large amounts were required to achieve constant increments of utility; the marginal utility of income was diminishing. This means that an investor would prefer a sure payment that is less than the expected value of risky venture. In the lottery described earlier, the risk averse investors preferred a sure cash payment of less than $12500 instead of participating in the lottery, because of aversion to risk of the lottery’s outcome. This implied that investors regarded marginal payoffs to be worth less (to be of less utility) as total payoffs increased. Thus, to determine the true value of investments for risk averse investors, economic analysis must account for decreasing satisfaction of higher payoffs with corresponding decrease in marginal utility (Eckel and Grossman, 2007). This study has shown that most of the investors were risk averse. For the risk takers (RT), the utility function was a belly down curve. For them, successively smaller income was required to achieve constant increments in utility; the marginal utility of income was increasing. This implies that the investors would actually pay and premium for a lottery ticket, a value greater than the expected value of the lottery. In the lottery example, the investors preferred the lottery ticket to a sure amount greater than $12500. The reason was that the investors regarded project payoffs to be worth more (to have more utility) as the total payoffs increased. Thus, to determine the true value of investments for risk takers, economic analysis must account for increasing marginal satisfaction of higher payoffs with corresponding increases in marginal utility (Binswanger, 1980).

The present study revealed investors with more than one risk attitude, depending on the monetary stakes. For example, many low income investors were willing to buy insurance at a premium greater than the expected value of a loss without insurance (the sign of a risk aversion) and at the same time to play the lottery at worse than fair odds (the sign of a risk taking). This suggested a utility function with risk averting and risk taking segments, as shown in Figure 9.

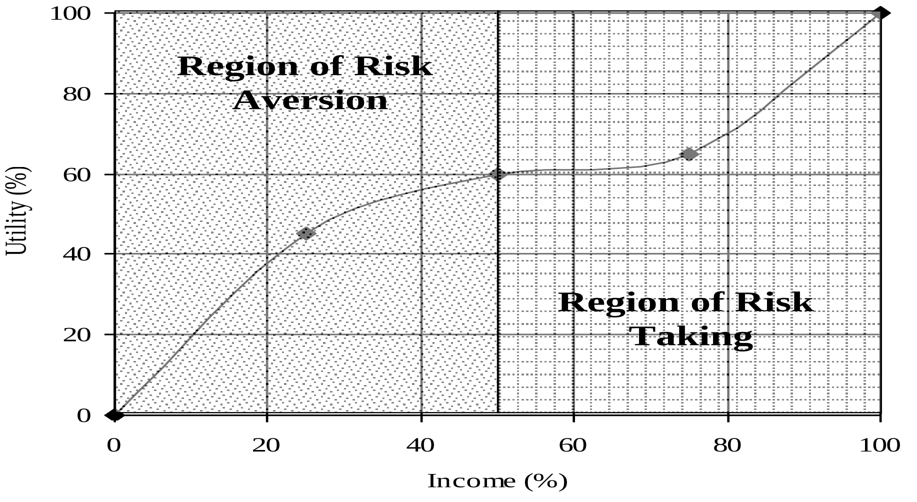

Figure 9: Utility function showing both risk averse and risk taking attitude by investors in Monrovia

The utility function technique helps to choose among completing projects that do not exhibit stochastic dominance, like projects C and D in figures 6 and 7 for which the utility function curves are shown in figure 10. The two curves show that Project C was neutral from the risk point of view as income and utility for all the investment options for this project were almost directly proportional. Project D was showing mix risk profile. For considerable portion, investment options exhibited risk aversion strategy and there after the risk taking approach as shown by utility function curve of the project in Figure-10. This indicated that the investors were initially risk averse and later on risk takers as they become sure of the sure profits with time.Under the uncertain conditions project C was preferred over project D, to avoid any chance of risk aversion by the investors, as they may not choose go into the risk taking mode at all and remain in the risk aversion mode for entire life of the project, making it abortive ultimately.

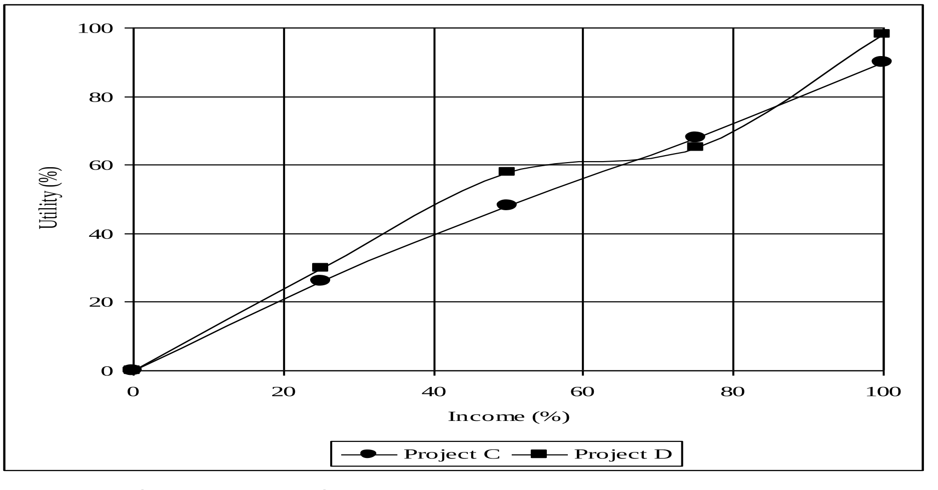

Figure 10: Utility function curves for project C and D at Monrovia Airport

MERITS AND DEMERITS OF USING UTILITY FUNCTIONS FOR QUANTIFYING THE RISK ATTITUDE

Utility functions will not always predict the way investors will actually choose among alternative investments since individual investor cannot be expected to act rationally and consistently in every investment situation with respect to their revealed utility money functions. It is even more unlikely that a group of executives representing a firm will always agree upon and act consistently according to a corporate utility function. Investors do not; in fact calculate utilities before making every choice. This may be due to their unwillingness to give up use of personal judgment in project evaluation. Second, the investors may be unwilling to cooperate in defining the risk policy because they do not want to be bound by such policy. Another reason is that they may have difficulty with risk taking because they are risk averters in their personal frame of reference.A utility analysis is useful, nevertheless, provided if investors compare expected utilities and knows the odds for the economic choices being evaluated. Under these conditions, a firm can use utility theory to establish risk policy that will direct management towards investments which support the firm's risk attitude. Specially, the use of utility theory in project evaluation does have merits. It has a sound theoretical basis which helps to do investments that are consistent with the firm's risk attitude and select better project over the long run. Use of utility function can overcome many of limiting factors in developing and implementing a risk policy.

CONCLUDING REMARKS

Most of the investors in Monrovia are risk averters. They don't like to take risk, if the income is not visible. In some of the cases, they were found confused about the realistic situation showing mixed behavior about risk taking and aversion at the same time.Probability and cumulative distribution functions provides information about risk exposure lacking in deterministic approaches, however, it does not say anything about risk attitude. Utility function curve can overcome the limitation of project preference inherent in probability distribution function for the projects with no or less stochastic dominance. Since, the shape of the utility function is dependent on tradeoffs between uncertain money payoffs of known probability and sure money payoffs, it also helpful to know risk attitude directly in terms of how an investor reacts to chance venture. If no other options are available for investment, the risk neutral options should be selected for investment. Risk aversion should be the last option as excessive risk aversion will virtually retard the investment process. Risk attitude is unique quality of each individual investor and so is the utility function curve. Utility theory is useful in project evaluation and establishing firm's risk policy which will help the investors to do investment consistent with the firm's risk attitude.

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