Estimation of Beta values of Indian power generation projects

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In this paper, a fuzzy logic based application tool has been developed for power plant project's systematic risk assessment and expert judgments have been used to design it. The application tool for systematic risk analysis involves a decision making approach which provides a flexible and easily understood way to analyze systematic risks of projects. The systematic risks, which are deeply influenced by the market scenarios, have been considered in the model. The relative importance (impact) of risk factors was determined from the survey results. The survey was completed with the experts that have experience in various power projects. The proposed risk analysis will give investors a more rational basis on which to make decisions. Furthermore, an effort has been made to determine Beta of a power project by estimating other factors related with the project such as Estimated Systematic Risk Factor (Determined by Fuzzy Logic), Debt Equity Ratio, 5 year Net Profit Margin, 5 year Sales Growth Rate, Interest Coverage Ratio and Annual Sales. This would help power projects to determine relevant return on equity required, analyze true NPV of project as well as set accurate Hurdle rate for any new project.

Keywords: Power, Systematic, Fuzzy, Beta, Regression, Heteroskedasticity, Robust

INTRODUCTION

Power projects are full of various risks which will cause cost and schedule overrun or project failure. Various surveys have identified high risk factors for power projects. Political and Regulatory Changes for developing countries have been categorized as highest risk by several studies including the one by World Bank on 2011. Similarly, Regulation and Compliance have been categorized as the highest business risk for 2010 by Ernst and Young. Construction of power plants in India involves uncertainties because of various external factors such as Policy/Regulatory Risk, Financial Risk and environmental issues among others. These risks arise because of frequent Policy changes in India, changing financial scenario, weakness of Indian currency with respect to US Dollar and major environmental concerns of power projects. These factors are more complicated by regular concerns of development in an area which cannot be completely done without enhancing power situation. These factors increase the construction costs and duration. This is so because in order to exclude uncertainties, more structural changes are envisaged. For example, in Himachal Pradesh concerns are raised about the safety and security of various power construction projects.
These concerns have arisen because of recent earthquakes in Himalayan region and environmental degradation of nearby areas. Hence, structural changes may be made in the current or future projects to make them Seismic Zone 4 or 5 earthquake resistant and environmentally sustainable. These changes will increase costs.

In traditional project risk analysis, risk rating values are calculated by multiplying impact and probability values. Direct analysis by taking into account these subjective factors is often ignored. Existing Risk Analysis models such as Monte Carlo Simulation and Tornado Chart are based on quantitative techniques which require accurate numerical data. It has often been observed by various surveys that such probabilistic models require detailed accurate quantitative information which is not normally available in real construction world. These factors have been highlighted by studies of Kangari and Riggs(1989).These factors are usually expressed in words or sentences in a natural language. For example, environmental risk on a power project construction site cannot be accurately obtained in quantitative terms. Nevertheless, it can be classified from very low to very high on a scale of 1 to 10. The beauty of Fuzzy Logic is that it converts qualitative information to practical quantitative information which can be used to take decisions. The objective of this paper is to apply a fresh approach of systematic project risk assessment through partial use of Fuzzy Logic in an Indian scenario which is probably substantially different from western standards. Estimation of correct systematic risk will lead to estimation of correct cost of capital and eventually correct estimation of NPV and hurdle rate.

A separate model was developed to comprehensively and qualitatively assess risks associated with a power generation project. The model used 21 risk factors. Several risk factors out of these 21 risk factors were omitted as they relate to unique risks of the project. All the risk factors considered for this study involving Fuzzy Logic systematic risk determination are somehow related with the overall market risk. Interest rates change in market and may affect individual project. There is risk of cost overrun due to inflation in the economy. Changes in foreign currency may affect the entire economy and increase costs of import of inputs for the power sector as well. In a recessionary market, it would be difficult to sell power because of low requirements and there is concern of Revenue Realization Risk. The contractors may fail in their business due to recession and disturb the power project’s finances. There is high competition risk in a well performing economy. Similarly, Tariff Change and Fall in demand and supply are related to market conditions. Thus only those risk factors which represent systematic risk have been considered for the Fuzzy Logic analysis. In addition, there is need to correctly establish beta values for a risky project. Correctly establishing beta values will lead to correctly arriving at cost of equity through application of Capital Asset Pricing Model. Correct values of cost of equity will lead firms to arrive at correct values of weighted average cost of capital. This would enable firms to correctly establish Hurdle Rates and utilize only relevant values of discount rate for NPV calculation. Finally, decision making will be improved and systematic risk incorporation into the decision making process would be less subjective.

The proposed model for determining beta is as follows:-

\[
\text{Beta} = a^{\text{Estimated Systematic Risk Factor}} + b^{\text{Debt-Equity Ratio}} + c^{5 \text{ Year Average Net Profit Margin}} + d^{5 \text{ Year Sales Growth Rate}} + e^{\text{Interest Coverage (TTM)}} + f^{\text{Annual Sales (TTM)}}
\]

The proposed model attempts to include maximum possible financial information about the project. Estimated Systematic Risk Factor is an attempt to independently identify through a different course an estimate of systematic risk. Debt Equity Ratio attempts to include information of financial leverage. Net Profit Margin is a reflection of profitability of a project. Irms that are able to expand their Net Profit margins over time are rewarded with share price growth. Sales Growth Rate is a measure of growth rate of the project in terms of expansion of revenues. Interest Coverage is another measure for ascertaining financial leverage and is also a measure of debt coverage. Annual Sales is a measure of size of the project. A project having a larger size is reasonably expected to have large Annual Sales. Management Efficiency Ratios such as Fixed Asset Turnover Ratios are not available for many power generation projects. Hence, they cannot be included.

The linear nature of the model is just a starting proposition. While analyzing the parameters, if it is decided that a non linear function should be incorporated, sufficient changes will be appropriately made. Estimated Systematic Risk Factor is expressed as a number. Debt Equity Ratio is expressed as a ratio. Net Profit Margin is expressed as a percentage. Sales Growth Rate is expressed in percentage. Interest Coverage Ratio is expressed as a ratio. Annual Sales is expressed in INR Million. Estimated Systematic Risk Factor is an effort to estimate beta according to market conditions. By definition, it is expected to be positively correlated with actual beta and correspondingly systematic risk. Debt Equity Ratio is a measure of Financial Leverage and is expected to be positively correlated with systematic risk. 5 year Average Net Profit Margin is another measure of Management Effectiveness and Profitability and is expected to be positively correlated with systematic risk.5 year Sales Growth Rate is a measure of growth and is expected to be positively correlated with systematic risk. Interest Coverage is another measure of financial leverage and because of the definition, it is expected to be negatively correlated with
systematic risk. Annual Sales is a measure of size of the project. It is expected to be negatively correlated with systematic risk. Empirical testing is envisaged for the study and hence, theoretical presumptions were ignored for the study. It is assumed that every variable has an ability to affect volatility of the returns with respect to the market. This study can better help Power Project Companies, Investors in power companies, Government and Equity Researchers in better understanding of the systematic risk of power generation companies. Analyses of only power generation projects have been undertaken in the study.

LITERATURE REVIEW

S. Kucukali (2011) developed a new approach for Risk Assessment of River Type Hydropower plants by using Fuzzy Logic approach. He has highlighted how subjective factors are significant and how they cannot be incorporated in traditional quantitative techniques of project risk assessment. He has also identified how accurate detailed information needed for quantitative analysis is not readily available in real construction world. Applicability of Fuzzy Logic to convert information is simple words and sentences into applicable quantitative information are shown in his study. Further, he checked the usability of the proposed methodology on a real case hydropower project namely Kulp IV. This project was constructed on Dicle River in East Anatolia, Turkey. This study helps us in establishing that Fuzzy Logic is an appropriate method to analyze risk inherent in power generation projects.

Adel, Abouzar, Shaban and Abbas (2013) developed a fuzzy risk map which is project assessment tool that allows for the assessment and understanding of the key risks particular to PPP Power Station projects. It is useful both to the owners and contractors. Comparison has been made of the results using different risk matrices which include crisp risk map and fuzzy risk map. Different risk zoning design has been analyzed. Comprehensive analysis shows that fuzzy risk map tool is a sound method to assess the impact of majority of risk issues faced by power stations. The key risk groups identified by the study are Political Risks, Financial and Economic Risks, Legal Risks, Market and Revenue Risks, Investment Risks, Construction Risks, Operating Risks and Relations Risks. Further Risk Groups have been classified into Micro, Mezzo and Macro levels. Just like previous study, this research also highlights the importance of Fuzzy Logic in analyzing risks associated with power generation projects. The study provided a comprehensive list of 68 risk factors which affect a PPP Power Station project. This list was analyzed with inputs from 43 power industry experts and shortlisted to include 21 risk factors for Fuzzy Logic analysis in a separate study and 8 risk factors for this present study involving systematic risk only.

Neha Roy, NC Roy, KK Pandey (2015) identified risks associated with small hydro power investments. In construction phase the most important risk factors come out as geology, relocation and climate. In operational phase, the leading factors are electricity price, operation delay and river flow. Conclusions were made that operational stage small hydro power projects are riskier than construction phase projects. Also an overall risk index can be used as early indicators of project problems. Evaluators can keep track of current risk levels with the progress of projects. Importance of creating risk index is understood by this study which can provide early indications of risks.

Shen and Wu (2005) extended the BOT concession model to emphasize that a risk concession model for BOT contract projects. Model presented an alternative for determining concession period that can protect the basic interests of both the investor and the government concerned. Various risks were found to have been present in a BOT project, which subsequently impact project cash flows. Hence, it was found imperative to describe the project NPV with a distribution of estimates by considering the impact of various risk factors. It highlights that risk factors have a significant impact on NPV of a project and subsequently the decision making process. Thus, risk factors need to be comprehensively analyzed and factored in.

Ye and Tiong (2000) developed the NPV at Risk method by combining WACC and mean variance methods for evaluation of investment decision. The method is applied in investment decision making of projects under uncertainty. Assessments were made of two hypothetical projects using different evaluation methods and it was proved that “NPV at Risk” method can provide better results for risk evaluation. A correct value of WACC in decision making is highlighted in this study. In order to find correct values of WACC, getting correct value of beta is important. Hence, it emphasizes the importance of our study.

Chee and Yeo (1995) performed risk analysis on build-operate-transfer power project and evaluated equity holders’ risk exposure with help of techniques like probability and sensitivity analysis. Risk variables included in the analysis were electricity generation, unescalated capital expenditure, tariff, fuel cost and Operations and Maintenance cost. The key findings were that the tariff had the largest impact on the project NPV because of its high sensitivity and critical variance. The fuel cost was ranked second in terms of impact on the project NPV. This study highlights the significance of tariff changes and cost overruns which are used in estimating Systematic Risk Factor by Fuzzy Logic in our case.

Brimble and Hodgson (2007) used Correlation and Regression Analysis to analyze risk variance with the
financial variables of Accounting Beta, Earnings Variability, Growth, Size, Ratio of Interest Payments, Current Ratio, Financial Leverage, Interest Coverage Ratio, Operating Leverage and Systematic Risk. They explained more than 57 percent of the risk variance from the chosen model. Relation of growth, size, interest coverage, operating leverage (profitability) with risk variance is established by this study which furthers our case for research.

Brimble (2003) utilized Correlation and Regression Analysis to establish a relationship between Systematic Risk and financial variables of Accounting Beta, Changes in profits, Growth, Size, Ratio of Interest Payments, Current Ratio, Financial Leverage, Operating Leverage and Interest Coverage Ratio. It was determined that more than 57 percent of the Systematic Risk can be explained from the chosen model. Significance of variables used in our study such as growth, size, financial leverage, interest coverage ratio and operating leverage (profitability measured by Net Profit Margin in our case) is established by this study.

Beaver, Kettler and Scholes (1970) argued that Accounting System cannot be properly made without clearly understanding the relationship between accounting data and market variables. They also concluded that market risk model cannot be accurately made without taking into consideration accounting data. This study established the link between market variables and accounting data which is a basis for starting our research.

Hamid, Prakash and Anderson (1994) showed that there is theoretical and empirical evidence of a positive relationship between growth in earnings and systematic risk. Hence, it implies that the link between growth and systematic risk need to be investigated.

Pettit and Westerfield (1972) demonstrated that liquidity ratios are positively associated with systematic risk. It highlights the importance of solvency ratios in estimating systematic risk.

Farrelly, Ferris and Reichenstein (1985) completed a study by analyzing accounting information of 25 companies during a 5 year period. The variables chosen were company’s growth, financial leverage, liquidity, firm size and earnings variability. Results showed that 79% of the changes in systematic risk can be explained by changes in these reported variables. The significance of growth, financial leverage and size were identified from this study.

Mohammad and Kermani (2013) examined in a research and established usefulness of ownership structures in estimation of performance of companies listed in Tehran Stock Exchange. Performance in stock markets is somewhat related with systematic risk as Systematic Risk can negatively impact stock prices during times of high volatility and market risk. Hence, a somewhat link is implied between ownership structure and Systematic Risk which needs to be investigated.

Naser, Ahmad and Ebrahim (2014) examined companies listed in the Tehran Stock Exchange and determined that growth opportunities and financial leverage did effect systematic risk to some extent. The importance of growth and financial leverage variables were identified from this study.

Eskew (1979) concluded that the financial variables of growth, size and earnings variability have a significant correlation with the systematic risk. The significance of growth and size variables were gauged from this study.

**RESEARCH METHODOLOGY**

The current study is an attempt to generate a risk assessment method by which we can determine and analyze comprehensive systematic risk involved in a particular project. In addition, an attempt is made to arrive at Beta values for given level of estimated Accounting Beta and few other financial variables. At the first stage, we used the established theory to identify key broad risk factors which are related to the market to some extent. The preliminary study identified 21 risk factors which were shortlisted from a broad list of 68 risk factors. These 68 risk factors were identified from a literature review as mentioned in the relevant section. The short listing was done with the help of inputs from 43 power industry experts. The relative importance of one risk factor over another was gauged again from inputs from these 43 power industry experts. Analytical Hierarchy Process is used to assign weights to these risk factors. In Analytical Hierarchy Process, increasing odd numbers are assigned to increasingly significant risk factors. Certain unique manipulations are performed on this data to arrive at Eigenvector values. These values are again manipulated in a unique way to arrive at the second set of Eigenvector values. This process in continued until the Eigenvector values don’t change up to four places of decimal. This set of final Eigenvector values provides us with the weights that should be assigned to risk factors. The 43 power industry experts and concerned managerial staff from 129 Power Generation Projects were asked to rate each individual risk factor on a scale of 1 to 5 on both probability and severity parameters for each individual power generation project. Then, inputs from the 43 power industry experts were used to arrive a unique value of Estimated Accounting Beta for unique values of weights assigned and unique ratings provided for risk factors through the use of Fuzzy Logic method. These Estimated Accounting Betas are utilized as one of the independent variables used to find the final beta values through regression. A separate study was also done to determine total risk in a power generation project. 21 Risk Factors were considered that can be
comprehensively utilized to determine total risk of a particular project. The present study doesn't include any other elements of that research. The risk factors which were unique to the project or the power industry were not used in the analysis of systematic risk. For the current study only 8 broad risk factors which are determined by the market are considered. Analytic Hierarchy Process has been used to assign relative weights to the risk factors as mentioned above. This enables us to identify the relative importance of each risk factor relative to other factors. A risk assessment model based on combined AHP-Fuzzy Reasoning is proposed. The development of the model consists of 2 steps i.e. questionnaire survey step for understanding and preparing the properly weighted risk categories and then fuzzy inference step for understanding and assessing Estimated Accounting Beta or an estimator of Systematic Risk based on risk map approach. All relevant information such as data on all Fuzzy Risk parameters and previously available estimates of Beta values were gathered for each individual power project. Also, all other accounting variables for each power project i.e. Debt Equity Ratio, 5 year Average Net Profit Margin, 5 year Sales Growth Rate, Interest Coverage and Annual Sales were collected. All these data were entered into SPSS and Multiple Regression was applied and results were analyzed.

**Questionnaire survey**

The questionnaire was designed to understand the proper risk map for power projects in India. Interviews were collected from all public and private sector projects among this industry. The first set of questionnaire designed for this study consisted of 2 parts, which included: (a) the first section explained the purpose of the research, defined some key terms, and specified critical rules to achieve the proper knowledge and insight of experts; (2) The second carried a total of 8 systematic risks associated with power projects and asked respondents to pair wise review and indicate the relative importance of each risk category with respect to the other being compared. Using pair wise comparisons the relative importance of one risk category over another can be expressed. Eigenvector solution of the pair wise matrix as generally used in Analytic Hierarchy Process is utilized to assign weights to the various risk categories. The second set of questionnaire detailed 8 systematic risk factors as explained below in data analysis section. Respondents from power projects were asked to rate these risk factors on a scale of 1 to 5 on probability and severity parameters for the concerned power project. In addition, the previously available beta value used by the project was also sought after. These beta values were also sought after from 43 power industry experts. Further values of Debt Equity Ratio, 5 year Net Profit Margin, 5 year Sales Growth Rate, Interest Coverage Ratio and Annual Sales were also sought from respondents of these power projects. Finally, all those power projects which provided complete data in all respects were included in the study. The number of power projects finally included in our study and which answered our entire questionnaire amounted to 129.

**Hypotheses**

Several hypotheses were analyzed for the studies which are as mentioned below:

a) First H0: Estimated Systematic Risk Factor has no correlation with systematic risk.

b) Second H0: Debt Equity Ratio has no correlation with systematic risk.

c) Third H0: 5 year Average Net Profit Margin has no correlation with systematic risk.

d) Fourth H0: 5 year Sales Growth Rate has no correlation with systematic risk.

e) Fifth H0: Interest Coverage has no correlation with systematic risk.

f) Sixth H0: Annual Sales has no correlation with systematic risk.

**DATA ANALYSIS**

The total list of 8 systematic risk items are listed here:-

1) Interest Rate Risk
2) Cost Overrun Risk
3) Foreign Currency Risk
4) Revenue Realization Risk
5) Financial Failure of Contractor
6) Competition Risk
7) Tariff Change
8) Fall in Demand and Supply

Using pair wise comparisons, the relative importance of one risk category over another is sought to be determined. For this reason, a detailed questionnaire was sent to CEOs, Directors, CFOs and other top level executives in the power industry. The format of the questionnaire was as shown below:-

Please indicate the following relationship between Interest Rate Risk and Cost Overrun Risk:-

A) Equally Important,
B) Interest Rate Risk is slightly more important,
C) Interest Rate Risk is more than slightly important,
D) Interest Rate Risk is fairly more important,
E) Interest Rate Risk is strongly more important,
F) Interest Rate Risk is very strongly more important,
G) Interest Rate Risk is extremely more important,
H) Interest Rate Risk is absolutely more important

Similarly other questions are asked to get insights into relative importance of risk factors over one another. An odd scale is used for marking answers. This means
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Figure 1. First Matrix of AHP

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Figure 2. First Squared Matrix of AHP

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Figure 3. First Row Sums and Total

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“slightly more important” get 3 points while “more than slightly important gets” 5 points. Survey results are noted down and responses recorded. The following points were generalized for the risk factors:
- Interest Rate Risk – 15
- Cost Overrun Risk - 13
- Foreign Currency Risk - 11
- Revenue Realization Risk - 9
- Financial Failure of Contractor - 7
- Competition Risk - 5
- Tariff Change - 3

Fall in Demand and Supply – 1

Hence, a matrix is prepared in accordance with Analytical Hierarchy Process. The idea is to calculate the Eigenvector values. In all the matrices shown below in figures the values of 15, 13, 11 etc. all represent risk factors of Interest Rate Risk, Cost Overrun Risk, Foreign Currency Risk etc. respectively.

This matrix is squared for the purpose of getting Eigenvector values.
The row values are summed up and then finally these summed row values are again summed up to calculate Row Totals. The Row Sum values are divided by the Row Total values to get our first Eigenvector as shown below:

The first squared matrix is again squared to get our second squared matrix as shown below:

The rows of the second squared matrix are again summed up as before. They are finally totaled and then the Row Sums are divided by Row Totals to get our new Eigenvector.

Our second Eigenvector is compared with our first Eigenvector to see that the values are same up to four decimal places. As we can compare values from Figure 4 and Figure 7, we can see that the values are definitely same up to four places of decimal. Hence, now we can finalize our Eigenvector correct up to four decimal places. Eigenvector values are nothing but the respective weights attached to the various risk factors. Hence, “Interest Rate Risk” gets 23.43% weight whereas “Fall in Demand and Supply” gets 1.56% weight.

Once we are done with Eigenvector values our next step is to determine a Fuzzy Logic Model by which we can assign values of probabilities of occurrence and severity of occurrence and thereby finally determine estimated value of indicator of systematic risk or “Accounting Beta”. The format of the questionnaire for determining these
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Figure 7. Second determined Eigenvector

Figure 8a. Input Setting of Variable which involves selection of Membership Function

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<tr>
<td>Revenue Realization Risk</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Financial Failure of Contractor</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Competition Risk</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Tariff Change</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Fall in Demand &amp; Supply</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>

The concerned respondents have simply got to identify probability and severity of occurrence of each type of risk for the individual power project. During the process, a Fuzzy Logic model is envisaged to be developed such that for each value of probability of occurrence, severity of occurrence and applied weights of risk factor, an indicator of accounting beta is generated.
Just before moving ahead we need to recapitulate that Fuzzy logic is a form of multi valued logic in which the truth values of variables may be any real number between 0 and 1. By contrast, in Boolean logic which is utilized by regular digital systems, the truth values of variables may only be 0 or 1. Fuzzy logic has been extended to handle the concept of partial truth to incorporate certain grey areas, where the truth value may range between completely true and completely false. Furthermore, when linguistic variables are used, these degrees may be managed by specific functions. Hence, this is an artificial improvement over the Boolean logic to suit digital systems in decision making process.

As an idea of Fuzzy Logic rule generation process, the variable of Interest Rate Risk has been worked upon in this FIS Editor box as shown below in Figure 8a.

Fuzzy Logic involves creating two inputs and one corresponding output for the input variables. Membership functions are defined for the input and output variables. In the present study, Gaussian functions were chosen as membership functions for all the input and output variables. 7 membership functions are chosen for all input and output variables as per the advice of experts. Range of values for the 2 input variables of Probability of Occurrence and Severity of Occurrence are specified from 1 to 5. Range of values for the output variable “Predicted Beta” is defined from 0.5 to 2.3 as per the advice of experts. Next process is to create rules for the Fuzzy Inference process. Following 49 rules are created for the process by utilizing insights from experts:

- If “Probability of Occurrence” is mf1 and “Severity of Occurrence” is mf1 then Output is mf1
- If “Probability of Occurrence” is mf1 and “Severity of Occurrence” is mf2 then Output is mf2
- If “Probability of Occurrence” is mf1 and “Severity of Occurrence” is mf3 then Output is mf2
- If “Probability of Occurrence” is mf1 and “Severity of Occurrence” is mf4 then Output is mf3
- If “Probability of Occurrence” is mf1 and “Severity of Occurrence” is mf5 then Output is mf3
- If “Probability of Occurrence” is mf1 and “Severity of Occurrence” is mf6 then Output is mf4
- If “Probability of Occurrence” is mf1 and “Severity of Occurrence” is mf7 then Output is mf4
- If “Probability of Occurrence” is mf2 and “Severity of Occurrence” is mf1 then Output is mf2
- If “Probability of Occurrence” is mf2 and “Severity of Occurrence” is mf2 then Output is mf2
- If “Probability of Occurrence” is mf2 and “Severity of Occurrence” is mf3 then Output is mf3

These rules are used to determine the predicted beta value based on the probability and severity of occurrence.
If “Probability of Occurrence” is mf2 and “Severity of Occurrence” is mf1 then Output is mf3
If “Probability of Occurrence” is mf2 and “Severity of Occurrence” is mf2 then Output is mf4
If “Probability of Occurrence” is mf2 and “Severity of Occurrence” is mf3 then Output is mf4
If “Probability of Occurrence” is mf2 and “Severity of Occurrence” is mf4 then Output is mf5
If “Probability of Occurrence” is mf2 and “Severity of Occurrence” is mf5 then Output is mf5
If “Probability of Occurrence” is mf2 and “Severity of Occurrence” is mf6 then Output is mf6
If “Probability of Occurrence” is mf2 and “Severity of Occurrence” is mf7 then Output is mf6
If “Probability of Occurrence” is mf3 and “Severity of Occurrence” is mf1 then Output is mf2
If “Probability of Occurrence” is mf3 and “Severity of Occurrence” is mf2 then Output is mf3
If “Probability of Occurrence” is mf3 and “Severity of Occurrence” is mf3 then Output is mf3
If “Probability of Occurrence” is mf3 and “Severity of Occurrence” is mf4 then Output is mf4
If “Probability of Occurrence” is mf3 and “Severity of Occurrence” is mf5 then Output is mf4
If “Probability of Occurrence” is mf3 and “Severity of Occurrence” is mf6 then Output is mf4
If “Probability of Occurrence” is mf3 and “Severity of Occurrence” is mf7 then Output is mf4
If “Probability of Occurrence” is mf4 and “Severity of Occurrence” is mf1 then Output is mf2
If “Probability of Occurrence” is mf4 and “Severity of Occurrence” is mf2 then Output is mf3
If “Probability of Occurrence” is mf4 and “Severity of Occurrence” is mf3 then Output is mf3
If “Probability of Occurrence” is mf4 and “Severity of Occurrence” is mf4 then Output is mf3
If “Probability of Occurrence” is mf4 and “Severity of Occurrence” is mf5 then Output is mf4
If “Probability of Occurrence” is mf4 and “Severity of Occurrence” is mf6 then Output is mf4
If “Probability of Occurrence” is mf4 and “Severity of Occurrence” is mf7 then Output is mf4
If “Probability of Occurrence” is mf5 and “Severity of Occurrence” is mf1 then Output is mf3
If “Probability of Occurrence” is mf5 and “Severity of Occurrence” is mf2 then Output is mf3
If “Probability of Occurrence” is mf5 and “Severity of Occurrence” is mf3 then Output is mf3
If “Probability of Occurrence” is mf5 and “Severity of Occurrence” is mf4 then Output is mf4
If “Probability of Occurrence” is mf5 and “Severity of Occurrence” is mf5 then Output is mf4
If “Probability of Occurrence” is mf5 and “Severity of Occurrence” is mf6 then Output is mf4
If “Probability of Occurrence” is mf5 and “Severity of Occurrence” is mf7 then Output is mf4
If “Probability of Occurrence” is mf6 and “Severity of Occurrence” is mf1 then Output is mf4
If “Probability of Occurrence” is mf6 and “Severity of Occurrence” is mf2 then Output is mf4
If “Probability of Occurrence” is mf6 and “Severity of Occurrence” is mf3 then Output is mf4
If “Probability of Occurrence” is mf6 and “Severity of Occurrence” is mf4 then Output is mf4
If “Probability of Occurrence” is mf6 and “Severity of Occurrence” is mf5 then Output is mf4
If “Probability of Occurrence” is mf6 and “Severity of Occurrence” is mf6 then Output is mf5
If “Probability of Occurrence” is mf6 and “Severity of Occurrence” is mf7 then Output is mf5
If “Probability of Occurrence” is mf7 and “Severity of Occurrence” is mf1 then Output is mf5
If “Probability of Occurrence” is mf7 and “Severity of Occurrence” is mf2 then Output is mf5
If “Probability of Occurrence” is mf7 and “Severity of Occurrence” is mf3 then Output is mf5
If “Probability of Occurrence” is mf7 and “Severity of Occurrence” is mf4 then Output is mf5
If “Probability of Occurrence” is mf7 and “Severity of Occurrence” is mf5 then Output is mf5
If “Probability of Occurrence” is mf7 and “Severity of Occurrence” is mf6 then Output is mf6
If “Probability of Occurrence” is mf7 and “Severity of Occurrence” is mf7 then Output is mf6

As is evident from the rules, a clear pattern has been followed in generating it. The parameters of membership functions used for Input Variables of Probability of Occurrence and Severity of Occurrence are the same. These membership functions are as defined below:

mf1 has Standard Deviation of 0.2831 and Mean Value of 1
mf2 has Standard Deviation of 0.2831 and Mean Value of 1.667
mf3 has Standard Deviation of 0.2831 and Mean Value of 2.333
mf4 has Standard Deviation of 0.2831 and Mean Value of 3
mf5 has Standard Deviation of 0.2831 and Mean Value of 3.667
mf6 has Standard Deviation of 0.2831 and Mean Value of 4.33
mf7 has Standard Deviation of 0.2831 and Mean Value of 5

As clearly seen the selection, mean values move ahead in steps of 0.667. It was acknowledged that increasing the membership functions to more than 7 will increase complexity without substantially enhancing information value. The membership functions of output have been defined as shown below:

mf1 has Standard Deviation of 0.1274 and Mean Value of 0.5
mf2 has Standard Deviation of 0.1274 and Mean Value of 0.8
mf3 has Standard Deviation of 0.1274 and Mean Value of 1.1
mf4 has Standard Deviation of 0.1274 and Mean Value of 1.4
mf5 has Standard Deviation of 0.1274 and Mean Value of 1.7
mf6 has Standard Deviation of 0.1274 and Mean Value of 2.0
mf7 has Standard Deviation of 0.1274 and Mean Value of 2.3

As clearly seen from the selection, mean values increase in steps of 0.3. Once, total number of membership functions and range are decided, there is little control over
standard deviation and mean values.

Utilizing the insights of experts involved with various power projects, Estimated Systematic Risk Factor or in other words, an estimated accounting beta has been calculated for various power projects. Other accounting variables as discussed above were used in the multiple regression model to arrive at comprehensive results. The screenshot of the entered data in SPSS is as shown under:-

Before analyzing the results, several assumptions have to be checked in Linear Multiple Regression. These are as mentioned below:-

1) independence of errors (residuals)
2) linear relationship between predictors and dependent variable.

3) homoscedasticity of residuals (Equal Error Variance)
4) multicollinearity.
5) no significant outliers, influential points and Normality of residuals.

1) Checking for Independence of errors:-
Running the SPSS modeler delivered the following result for Durbin Watson statistic:-

As can be seen from Durbin Watson statistic, we have got a value of 1.878 which is close to 2. Hence, we can safely assume that errors values are not correlated with each other. Also, Adjusted R Square value is 976 which means 97.6 % of the variation in dependent variable beta is explained by the variation in predictors or our independent variables. Another reason for this high value of Adjusted R Square may have been our use of several independent variables which sometimes increase R.
Square value. Hence, we have met our first assumption of independence of errors.

2) Checking for a linear relationship:

This can be checked by plotting the studentized residuals against unstandardized predicted values of beta. If a horizontal band is formed by the residuals, the relationship between the dependent and independent variable is likely to be linear. The graphs appeared as shown below:

As can be seen in Figure 13, we have a horizontal band. Hence, it can be safely assumed that the relationship between the dependent and independent variable is likely to be linear. The partial regression plots are also drawn.
between each independent variable and the dependent variable. These are as presented below:

As can be seen from Figure 14, Estimated Systematic Risk Factor is somewhat linearly related to beta.

As can be seen from Figure 15, there seems to be a linear relationship between Beta and Debt Equity Ratio.

As can be seen from Figure 16, Beta has a somewhat linear relationship with Net Profit Margin.

As can be seen from Figure 17, Beta and Sales Growth Rate has a somewhat linear relationship.

As can be seen from Figure 19, Beta bears a somewhat linear relationship with Annual Sales. Hence, our second condition is satisfied that there is a linear relationship between dependent and independent variables.

3) Checking for Heteroskedasticity:-
Further on, presence of heteroskedasticity needs to be tested. Utilizing Breusch Pagan and Koenker Test Macro available for SPSS, both these tests were done. The results are as shown below:

As we can see from the results as displayed in Figure 20, both Breusch Pagan Test and Koenker Test have indicated that heteroskedasticity is present in our data.
Hence, we cannot apply the results of Ordinary Least Squares as such. We have to either induce transformations or go for other forms of Regression such as Weighted Least Squares Regression which is robust to problems of heteroskedasticity. Inducing transformations didn’t provide much help in reducing heteroskedasticity. Before going for any other type of regression, assumptions of multicollinearity, significant outliers and normality of residuals need to be checked.

4) Checking for Multicollinearity-
Multicollinearity can be checked by analyzing VIF values of all variables included in our study. If the VIF values are more than 10 for any variable, it signifies presence of multicollinearity. As seen in Figure 21a, VIF values for one of the variables is 15.435 which is more than 10. Hence, multicollinearity is present but to a limited extent as only one variable violates it. Also, VIF value is 15.435 which is less than 30 which implies that multicollinearity is
not very intense. Multicollinearity problem can be solved by increasing data or by removing an insignificant variable. Removing an insignificant variable can solve our problem of multicollinearity. Removing ‘SalesGrowthRate’ from our variables and solving for VIF gives values as detailed in Figure 21b. As we can see that highest VIF value in Figure 21b is 11.723 which is close to 10. Hence, effects of multicollinearity can be ignored if ‘SalesGrowthRate’ is removed from the variables.

5) Checking for significant outliers and Normality of residuals:

Presence of significant outliers, influential points and normality of residuals can be checked by studying graph of standardized residual as well as by Kolmogorov Smirnov and Shapiro Wilk tests. Both the graphs and the test results as shown in Figure 22 and 23 reveal that outliers are present or that residuals are not normal. Hence, we can see that the Standardized Residual is not following a purely normal distribution and even the K-S test and Shapiro Wilk test has significance level of less than 0.05 and are rejecting normality of residuals. This also indicates presence of outliers and influential points. Outliers tend to make the residuals non normal. Hence,
we need to apply a method of regression which is robust to assumptions of both heteroskedasticity of error variances and significant outliers as well as non normality of residuals. Weighted Least Square Regression cannot be applied because it is robust only to heteroskedasticity and not so much to non normality of residuals. Ordinal Logistic Regression may lead to waste of information as continuous values of Beta will be converted to categorical values. Thus, Robust Regression is one of the best option left to us which is robust to deviations from homoscedasticity and normality. Running Robust Regression on MATLAB yielded the following results as shown in Figure 24. As we can see from the results, the first value is of the value of constant, the second value is the value of coefficient of 'EstSysRiskFactor' or Estimated Systematic Risk Factor, third value is the value...
of coefficient of ‘DebtEquityRatio’ or Debt Equity Ratio and so on. We can see that Beta has been shown to be positively correlated with Estimated Systematic Risk Factor and Debt Equity Ratio and negatively correlated with all other variables.

Hence, according to this preliminary result, value of Beta will be given by:

\[ \text{Beta} = 0.3007 + 0.4816 \times (\text{Estimated Systematic Risk Factor}) + 0.3354 \times (\text{Debt Equity Ratio}) - 0.0079 \times (\text{Net Profit Margin}) - 0.0016 \times (\text{Sales Growth Rate}) - 0.0139 \times (\text{Interest Coverage}) - 0.0019 \times (\text{Annual Sales}) \]

But, since, multicollinearity is present in the data and p values are still not tested for the results, we cannot apply this model as such. Hence, more manipulations to this model is needed for improvement. We cannot as such apply the results of this model.

As we can see from p values and correspond it to explanatory variables, Sales Growth Rate has a coefficient which has been found to be non-significant. All
other coefficients have been found to be significant. In case of Robust Regression, the p value significance is not straightforward. The corresponding t values need to be checked and if t values are found to be close to 0 i.e. as a rule of thumb within -2 to +2 the p values will be deemed insignificant. Taking a look at the results of t values in Figure 26, we are able to see that only the t value of -0.6071 corresponding to ‘SalesGrowthRate’ variable can be called as being close to 0. Hence, going by this way also leads us to believe that only the explanatory variable ‘Sales Growth Rate’ of power projects is insignificant in the equation. Rest all the variables can be said to be significant. Adjusted R Square values are displayed from the results in Figure 27. Adjusted R Square value is 0.977 which means that 97.7% of the variance in Beta can be explained by the variances in all explanatory variables. The p value for the overall fit of the model is also 4.04e-99 which is much less than 0.01 and hence, there is very less chance that the values of coefficients are all zero. DW Test as shown in Figure 28 gives a value of 1.8967 with a p value of 0.4334 which means that the residuals are not correlated with each other. Checking for multicollinearity gave the results as displayed in Figure 29 which is nothing but a reproduction of Figure 21a for convenience. VIF Factors reveal that only ‘EstSysRiskFactor’ has a VIF over 10.
which is considered slight multicollinearity. All other variables have VIFs less than 10 and their multicollinearity can be ignored. Going by the definition of Estimated Systematic Risk Factor, we know that it has a relationship with all other explanatory variables as it is an estimator of Beta. Leaving out this variable will improve multicollinearity values but significant information will be left out. Also, few experts advise against eliminating variables just for the sake of slightly improving multicollinearity. Hence, we retain this variable as such. Thus, we have checked for conditions of autocorrelation, linear dependence and multicollinearity. Conditions of
Figure 31. DW Statistic of new equation removing ‘SalesGrowthRate’

Figure 32. VIF values for stepwise regression showing values for different models. Hence, we can run a robust regression using the 4 variables as used in Model 4 of Figure 32. Running robust regression as discussed, lead to the results as shown in Figure 34.

Homoscedasticity, significant outliers and non normality of residuals have not been met but robust regression will be less susceptible to harm from these conditions as opposed to Ordinary Least Squares method.

Hence, the final model should only contain all variables which are significant. We can remove ‘SalesGrowthRate’ variable and rerun the Robust Regression using remaining variables. Doing this gives us the following data:-

We can see that Adjusted R Square value is 0.978 which means that 97.8% of the variation in Beta is explained by the remaining 4 variables. Also, there is good fit of the model as p value for rejecting the Null Hypothesis of all coefficients being zero is 1.16e-100. DW statistic is 1.9194 indicating almost no autocorrelation of errors.

Conditions of linearity have already been checked previously and there will be no change just by omitting one explanatory variable. There is no problem of error autocorrelation as provided by DW test in Figure 31. Checking for multicollinearity with these variables lead to the results as displayed in Figure 32. As we can see in Figure 32, VIF for ‘EstSysRiskFactor’ is 11.723 which is slight multicollinearity. Figure 32 and Figure 33 shows the output of stepwise regression which tells us the relative significance of different variables. As we can see from Figure 33, at least 96.3% of the variance in Beta is explained from the explanatory variables ‘EstSysRiskFactor’ and ‘DebtEquityRatio’ itself. Hence, it is not advisable to delete ‘EstSysRiskFactor’ variable. Instead, we take a quick look on Model 4 in Figure 32. In this model, the problem of multicollinearity is totally removed as all VIFs are less than 5.

As we can see from Figure 35, the residuals are not auto correlated. Hence, in the last model we have satisfied all the conditions of linearity, autocorrelation and multicollinearity. The robust regression procedure is comparatively less harmed because of the conditions of
heteroskedasticity of error variances, significant outliers and non normality of residuals. Hence, we have the following models for estimating Beta of a project depending on tolerance for slight multicollinearity. The tested models are as presented below:

- **Beta = 0.27962 + 0.46254*(Estimated Systematic Risk Factor) + 0.34968*(Debt Equity Ratio) – 0.008105*(Net Profit Margin) – 0.013862*(Interest Coverage) – 0.0018312*(Annual Sales)**  
  (4.2)

This model can be utilized if the concerned person is only interested in finding the exact value of Beta and not on the significance of individual financial variables in the model. Slight multicollinearity doesn’t affect the values of the dependent variable. This model has more number of financial variables and thus it utilizes maximum financial information to arrive at a value of Beta. The other model which was tested is as listed below:

- **Beta = 0.15393 + 0.56329*(Estimated Systematic Risk Factor) + 0.3186*(Debt Equity Ratio) – 0.0076935*(Net Profit Margin) – 0.013862*(Interest Coverage) – 0.0020346*(Annual Sales)**  
  (4.3)

This model can be used if the concerned person is more interested in studying the significance of individual financial variables used in the model. For example it can be safely assumed that increased Debt Equity Ratio...
leads to increase in the value of Beta whereas increased value of Net Profit Margin leads to a slight decrease in the value of Beta.

FINDINGS AND DISCUSSION

Assuming the robust regression results to be fairly true and respective weights to be known beforehand, we can proceed with making respective findings about various hypotheses stated earlier. The discussions regarding several hypotheses are as presented under:-

a) First H0: Estimated Systematic Risk Factor has no correlation with Systematic Risk
As we can see from the results of the robust regression, x1 in Figure 34 corresponding to ‘Estimated Systematic Risk Factor’ has a coefficient of 0.56329 and has a p value of 1.9666e-39 which is very less than 0.05. Hence, we can safely assume that Estimated Systematic Risk Factor is correlated with Beta. As Beta is an indicator of systematic risk and where $\beta \cdot \sigma^2$ i.e. Beta multiplied by variance of the market return is equal to systematic risk, we can conclude that Systematic Risk moves in the same direction as our newly defined variable ‘Estimated Systematic Risk Factor’. Our first hypothesis stands rejected and we conclude that ‘Estimated Systematic Risk Factor’ is a good estimator of Systematic Risk and is positively correlated with it.

b) Second H0: Debt Equity Ratio has no correlation with Systematic Risk
Robust Regression reveals that coefficient of ‘Debt Equity Ratio’ is 0.3186 and has a p value of 1.9666e-39 which is very less than 0.05. Hence, we can safely assume that Debt Equity Ratio is correlated with Beta and consequently Systematic Risk. Our second hypothesis stands rejected and we conclude that Debt Equity Ratio is positively correlated with Systematic Risk. This finding is consistent with theoretical understanding according to which systematic risk increases with increasing financial leverage or Debt Equity Ratio.

c) Third H0: 5 Year Average Net Profit Margin has no correlation with Systematic Risk
Robust Regression reveals that the coefficient of ‘Net Profit Margin’ is -0.0076935 and a p value of 7.5862e-10 which is significantly less than 0.05. Hence, we can assume that ‘Net Profit Margin’ is definitely correlated with Beta and consequently with Systematic Risk. As the sign of the coefficient is negative, it is an indicator that Beta moves slightly in the other direction to ‘Net Profit Margin’. Hence, our third hypothesis is rejected and we conclude that ‘Net Profit Margin’ is negatively correlated with Beta and consequently Systematic Risk. This is in contradiction to our theoretical understanding according to which Systematic Risk increases with increasing Operating Leverage or Profitability. Net Profit Margin is an indicator of Operating Leverage and Profitability. A firm which utilizes higher proportion of fixed costs commands higher Net Profit Margin and subsequently higher profitability. Possible reasons of this anomaly may be that Net profit Margin might not be reflecting true Operating Leverage of power generation projects. A power generation project may be utilizing higher proportion of fixed cost but not getting higher margin of profits.

d) Fourth H0: 5 Year Average Sales Growth Rate has no correlation with Systematic Risk
The variable ‘Sales Growth Rate’ was removed from Stepwise Linear Regression model as detailed in Figure 32 and its p value is of 0.54488 in results of Robust Regression as provided in Figure 27. Hence, we fail to reject the null hypothesis on the basis of our results. Conclusion is made that ‘5 Year Average Sales Growth Rate’ has no correlation with Systematic Risk.

e) Fifth H0: Interest Coverage has no correlation with Systematic Risk

Figure 35. Two Sided DW test of the Robust Regression Model as discussed in Figure 33
Running Robust Regression on the model which included only 5 variables gave the coefficient as -0.013862 and p value of 0.008994 which is less than 0.05 but this p value is highest among all other variables. Running stepwise regression also details that Interest Coverage is the last variable providing the least useful information to predict Beta. Inclusion of this variable also led the VIF value of ‘EstSysRiskFactor’ to shoot above 10. Hence, we conclude that Interest Coverage is negatively correlated with Beta and consequently Systematic Risk but is more or less a redundant variable. This may also be due to the fact that we have already accounted Interest Rate Risk as a major factor in Estimated Systematic Risk Factor through Fuzzy Logic analysis. Hence, information on interest rate is fully acknowledged in the first factor itself and its significance is decreased when we are considering it separately. It only provides slightly more information than that provided by ‘Estimated Systematic Risk Factor’ and ‘Debt Equity Ratio’. Theoretically also, a company employing higher debt proportion has to have a lower Interest Coverage Ratio as Interest amounts would increase as compared to EBIT values. Still, we can include this variable in our prediction model as it improves the Adjusted R Square value from 0.976 to 0.978.

f) Sixth H0: Annual Sales has no correlation with Systematic Risk
Robust Regression on the final model with 4 variables gave the coefficient of -0.0020346 and a p value of 3.5343e-07 which is less than 0.05. Hence, we conclude that Annual Sales is negatively correlated with Beta and consequently Systematic Risk.
Apart from ‘Interest Rate Risk’ as mentioned above there is no other item in Fuzzy Logic analysis which can create a major confusion in analysis of financial variables. If Annual Sales are very high, ‘Cost Overrun Risk’ is minimized to some extent. Again, this will hold true for other items also in Fuzzy Logic analysis like Revenue Realization Risk, Foreign Currency Risk and so on. In addition, if Annual Sales are very huge, project experts will incorporate necessary adjustments in Fuzzy Logic ratings such that issues are not blown out of proportion. ‘Fall in demand and supply’ is a risk factor which is similar to a negative sales growth rate. Since, Sales Growth Rate was found to be insignificant, similarly, negative sales growth rate or ‘Fall in demand and supply’ is also considered insignificant in Fuzzy Logic Risk analysis.

RECOMMENDATIONS AND FURTHER RESEARCH

Various recommendations for firms utilizing different values of accounting variables are as suggested under:-
1) Estimated Systematic Risk Factor as developed by this study is a strong indicator of Beta. It should be effectively prepared to estimate Beta and subsequently Cost of Equity from CAPM model as generally risk free rate of return and market return values are known.
2) Debt Equity Ratio is a measure of financial leverage and it is positively correlated with Beta. Increasing Debt Equity Ratio increases the value of Beta. Theoretically, the value of Levered Beta is given by the formula “Levered Beta = Unlevered Beta x (1 + ((1 – Tax Rate) x (Debt/Equity))).” Hence, firms should be prepared for a higher cost of equity if they employ more of debt. Generally, cost of debt is already known beforehand. Hence, employing more of debt will lead to a higher cost of capital.
3) Care should be taken in utilizing values of Net Profit Margin. The present study shows it to be slightly negatively correlated with Beta. This is in contradiction with theory according to which Beta should increase with Operating Leverage. It may be possible that Net profit Margin is not reflecting the correct values of Operating Leverage as it includes cost of taxes as well as interest payments. If the firm’s values of Net Profit Margin is not majorly different from similar power generation firms and they are utilizing similar values of cost of equity as revealed by analyst’s reports, then Net Profit Margin can be used to predict value of Beta along with other variables.
4) Interest Coverage is almost a redundant variable for the purpose of predicting Beta. It adds very less value to available information. Hence, it should be used along with other four discussed variables to predict and fine tune Beta information. Increasing values of Interest Coverage Ratio amounts to decreasing values of Beta. This is theoretically so because Interest Coverage Ratio is a faint measure of Financial Leverage.
5) Annual Sales slightly helps to decrease the value of Beta and consequently cost of equity. Theoretically, there is no direct relation between Beta and Size of a firm. It may be possible that Annual Sales values influence other variables which in turn lead to slight decrease in the value of Beta. As an example, higher sales will lead to higher EBIT and constant Interest expense, which will lead to higher Interest Coverage Ratio and subsequently decreased Beta.
6) Further research can be done including other variables to identify their significance. In addition, further power generation projects may be studied which may lead to better understanding of the significance of present and other added variables. Other methods can tried to estimate ‘Estimated Systematic Risk Factor’. Similarly, other approaches apart from Robust Regression can be tried. Similar studies should be made in developed countries and their results compared with ours.

LIMITATIONS OF THE STUDY

The various limitations of the study are as listed under:-
1) The number of power generation projects involved in the study is limited as their number is limited and all projects did not reveal all information.
2) Only selected variables were considered for the study.
3) Tax Rate is assumed to be same for all the projects.
4) Effect of Government Aids available to any project has been ignored.
5) Beta values have been arrived at by cost of equity level expected by Higher Level Directors, Independent Analysts and other experts.
6) Weights applied to each observation for their inclusion is assumed to be known beforehand.

CONCLUSION

Estimated Systematic Risk Factor which has been developed as a new piece of information is a good indicator of Beta. Debt Equity Ratio does its part in increasing the value of Beta. Net Profit Margin values should be used with care while monitoring values of similar projects. Increasing Annual Sales helps in slightly decreasing the value of Beta. Interest Coverage Ratio only helps in adding very little information on Beta. Increasing Interest Coverage Ratio helps in decreasing Beta but its independent effect is not known. Sales Growth Rate has no effect on Beta. Hence, when exact information on all these five variables is available, equation 4.2 should be utilized to determine the value of Beta. The other model which was tested is as listed below:-

\[
\text{Beta} = 0.27962 + 0.46254*(\text{Estimated Systematic Risk Factor}) + 0.34968*(\text{Debt Equity Ratio}) - 0.008105*(\text{Net Profit Margin}) - 0.013862*(\text{Interest Coverage}) - 0.0076935*(\text{Net P}) - 0.008105*(\text{Net P}) + 0.0076935*(\text{Net P}) - 0.0020346*(\text{Annual Sales})
\]

(8.1) [Earlier it was 4.2]

This model can be perfectly utilized if the concerned person is only interested in finding the exact value of Beta and not on the significance of individual financial variables in the model. Slight multicollinearity doesn’t affect the extended values of the dependent variable. Multicollinearity is considered more of a data problem rather than an analysis problem. This model has more number of financial variables and thus it utilizes maximum financial information to arrive at a value of Beta. Hence, when exact information on all these five independent variables is available, equation 4.2 should be utilized to determine the value of Beta. The other model which was tested is as listed below:-

\[
\text{Beta} = 0.15393 + 0.56329*(\text{Estimated Systematic Risk Factor}) + 0.31868*(\text{Debt Equity Ratio}) - 0.008105*(\text{Net Profit Margin}) - 0.0020346*(\text{Annual Sales})
\]

(8.2) [Earlier it was 4.3]

This model can be used if the concerned person is more interested in studying the significance of individual financial variables used in the model. For example it can be safely assumed that increased Debt Equity Ratio leads to increase in the value of Beta whereas increased value of Net Profit Margin leads to a slight decrease in the value of Beta. This model can be used alongside the model of equation 4.2. This will make sure maximum information is utilized in arriving at a value of Beta.

In this equation, there are no units for coefficients except that for Annual Sales as all these explanatory variables are expressed in numerical values. The unit for coefficient associated with Annual Sales is per INR Million. Estimated Systematic Risk Factor is expressed as a number. Debt Equity Ratio is expressed as a ratio. Net Profit Margin is expressed as a percentage. Interest Coverage Ratio is expressed as a ratio. Annual Sales is expressed in INR Million. The equation is good for predicting values of Beta even if it suffers with multicollinearity. This is so because it is assumed that multicollinearity will be present uniformly in all values of explanatory variables and this won’t have any bearing on predicted values of Beta.

Further research could focus on utilizing more accounting variables for the purpose of determining a value of Beta for the power projects. Comparisons can be made from similar researches in developed countries and methods to remove flaws in the process can be suggested. Similarly, other approaches such as Monte Carlo Analysis or Decision Tree Analysis can be utilized to estimate Systematic Risk of a project instead of Fuzzy Logic Analysis. Utilization of Monte Carlo or Decision Tree will involve intense quantitative values and structured probability information which will definitely add value to the research. In addition, the same research can be tried by using other tools such as ordinal logistic regression. That will provide significantly decreased information but then it will be more robust to assumptions of regression.

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