Quantification of Financial Risk of Bankruptcy using Altman's Z-Score model: An Empirical Analysis of Select Hydropower Companies in India

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Abstract

This research endeavors at measuring the financial risk of bankruptcy of select hydropower companies using Altman's Z-Score model. The aim of this study is to quantify the financial risk of bankruptcy in the sample hydropower companies as well as identify the zone in which they fall in terms of the Z-Score model. For the purpose, two hydropower companies have been investigated for the decade from 2010-11 to 2020-21. Secondary data sourced from annual reports/financial statements and other reports of the corresponding sample companies was used to work out the five financial ratios required in the model, and then the discriminant function of the model was applied on these ratios to arrive at the Z-Score of the sample companies. Results indicate the financial risk of bankruptcy of both the sample companies for all the financial years forming reference period for the study coming out to be <1.81. Moreover, empirical evidence from the present study has led to the classification of both the sample companies as in the "Distress" zone.

Keywords: *Hydropower, Financial Risk, Bankruptcy, Z-Score.*

Introduction

Electricity is a basic facility for all facets of life, recognized as a basic human need. It is a crucial infrastructure on which the socio-economic development of the country depends **[1]**. Electricity constitutes one of the vital infrastructural inputs in the socio-economic development of a country **[2]**. Economic growth of a country and the living standard of its citizens depends, among other things, upon the availability of adequate, reliable and affordable power **[3]**.

In the context of India, electric power is a critical infrastructure for the growth of Indian economy **[4]**. India holds the fifth largest and one of the most diverse power systems in the world including hydropower generation systems. Hydropower is one of the main energy resources in India with projects above 2MW contributing 15% of the total installed capacity **[5]**.

Infrastructure project development incurs financial risks including the risk of cost overruns, inflation, exchange rate risks etc **[6]**. A member of the infrastructure projects family, hydropower projects are capital intensive and have long gestation periods which result in their exposure to various uncertainties and risks including financial risks **[7]**. Poor risk management of hydropower projects leads to time and cost overruns; ultimately resulting in the failure of these projects.

The development of hydropower projects inter-alai involves financial risks and one major financial risk is the risk of bankruptcy **[8]**. Also known as default or insolvency risk, the bankruptcy risk measures the risk that a firm will be unable to meet its debt obligations **[9]**. Bankruptcy risk exists at all stages of a firm's life cycle **[10]**.

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The normative capital structure is measured in terms of a normative ratio of debt and equity; project developers are liable to service the debt in line with the corresponding terms and conditions in course of the development of the project and hence, the risk that a firm will be unable to meet its debt obligations arises. From lenders' perspective, hydropower projects requiring huge investments besides having long gestation periods need long-tenure loans, resulting in considerable business and credit/bankruptcy risks; risk avoidance by the owner further reinforces this perception of riskiness leading to the financers' tendency to avoid the project **[11]**. Normally lenders while appraising a lending proposal consider the cumulative impact of risks influencing the project timeline **[12]**.

The consequences of bankruptcy risk impact both on the firm's whole activity of business and all other contracted firms it is associated with **[13]**. Hence, prediction of the risk of bankruptcy assumes more importance in case of hydropower project development; the sector being highly capital intensive and complex in nature **[11]**.

Objective(s) of the Study

The present research endeavors at measuring the financial risk of bankruptcy of select hydropower companies in India. The aim of this study is to quantify the financial risk of bankruptcy in the sample hydropower companies as well as identify the intensity of financial risk of bankruptcy in the same hydropower companies with the purpose to classify them.

Review of Literature

Infrastructure project development incurs financial risks including the risk of cost overruns, inflation, exchange rate risks etc. **[6]**. The development of hydropower projects inter-alai involves financial risks **[8]**. From lenders' perspective, hydropower projects have long gestation periods and are capital intensive, and thus need long-tenure loans, resulting in considerable business and credit/bankruptcy risks; risk avoidance by the owner further reinforces this perception of riskiness leading to the financers' tendency to avoid the project **[11]**.

A study on water supply projects executed under public-private-partnership mode in Iran to identify and categorize its risk factors for measuring the overall risk level found that financial risk was the highest in ranking followed by experimental, technological and legal risk respectively **[14]**. With an emphasis on the comparative cost of financing of public and private financing in traditional procurement and public-private-partnership mode of procurement in the context of infrastructure projects, an investigation into the cost associated with transferring risk from public to private sector by the implementation of projects in public-private-partnership mode concluded that the risk transfer through public-private-partnership arrangement leads to inefficient risk premium which goes above the direct cost of financing **[15]**.

To ensure sustainable availability of finances considering various funding models, one study presented a systematic framework for appraisal and assessment of the risk of infrastructure projects executed in public-private-partnership mode in Libya. The results of the study indicated that the proposed framework was a successful analytical tool to assess the effectiveness of public-private-partnership project over the life cycle in terms of its viability to achieve the targeted internal rate of return and the predicted results for IRR were accurate to the extent of 83%, close to those executed with regard to the risk management process **[16]**. Another study focused on large-scale infrastructure project risk assessment in the field of road and motorway construction in order to facilitate decision-making on project financing, only to emphasise the need to pay attention to the economic efficiency indicators which form the basis for acceptance or rejection of a project for financing **[17]**. The role of the financial sector in

renewable energy development in non-OECD countries was investigated in a research study and it was confirmed that the influence of financial sector development on the use of renewable energy; financial intermediation particularly in the form of commercial banking having a significant positive impact on the amount of renewable energy produced - impact being larger in case of non-hydropower renewable energy **[18]**.

Key risk factors associated with infrastructure projects in Siberia funded under project financing method was studied and it found significant deviations from plans during project execution and lack of use of project risk management techniques included some major risk factors. The results of the study indicated flaws in project-technical documentation with the highest risk emergence (83%) followed by legal risks in the project host country (74%), and political risk being the least emergent (58%) **[19]**. Another study identified twenty-two critical risk factors in power and transport sector projects, giving an insight as to how risks and their significance vary across sectors. Above all, this study inter-alia found the delay in financial closure as the most critical risk in the power sector **[20]**.

Review of the extant literature on risk management of hydropower projects within the purview of sustainable development was conducted in one study, highlighting the need for incorporation of risk analysis in the cost estimation process as well as the provision of sufficient financial margin on the ex-ante base cost to cover uncertainties, besides recommending sensitivity analysis as a primary method for evaluation of the significant risk factors in hydropower projects **[7]**. In another study on hydropower risks the focus of which was to determine the relative importance of four risks –sector-specific risks, project financing risks, political risks and legal risks associated with hydropower projects, concluded that hydrological risks assumed the highest indicating high threats to project sustainability **[8]**.

Researching on the financers' perspective of risk in hydropower projects with the aim to maximizing the probability of obtaining sustainable finance for a project, a study found that social and environmental risks as the greatest risks that can cause reputational damage to the stakeholders, leading the financers to best avoid them **[21]**. Similarly, an investigation on the subject matter of risk endeavoured to explore relationship between the perceptions of risk influence and financing of hydropower projects. Based on the data collected focus groups participants comprising of lawyers, insurers, lenders, equity investors, development banks and lenders' engineers, the researchers found that the two most important financial risks are foreign exchange risk and electricity market risk, and climate finance for hydropower projects might reduce the financial risk of a project by diversifying the range of sources of its financing **[11]**.

Bankruptcy risk exists at all stages of a firm's life cycle concluded a study **[10]**. Prediction of the risk of bankruptcy assumes more importance in case of hydropower project development; the sector being highly capital intensive and complex in nature **[21]**. The consequences of bankruptcy risk impact both on the firm's whole activity of business and all other contracted firms it is associated with found another research study **[13]**.

Bankruptcy prediction models are important from investors as well as lenders and even the firms themselves **[22].** The first financial metric to quantify the probability of a firm entering bankruptcy was developed by Edward Altman **[23]**. Known as the Altman's Z-Score, the technique consolidates several financial ratios into a single indicator of the financial health of a firm. With the help of Z-Score model, Altman himself was able predict a firms' bankruptcy up to 2-3 years in advance **[24].** A study conducted to analyse the performance of Z-Score model on various firms from 31 European and 3 non-European countries found that Z-Score model works reasonably well for most countries with the prediction accuracy of 0.75 approximately **[25]**. Another study found out high predictive power for Z-Score model **[26].**

Research Methodology

In light of the objectives of the study in conjunction with the review of the extant literature, Altman's Z-Score model has been applied to measure the financial risk of bankruptcy of two sample companies viz. NHPC and JKPDC. This technique consolidates several financial ratios into a single indicator of the financial health of a firm. Altman's Z-Score is considered is be a reliable method for predication of the risk of bankruptcy.

The underlying principle of Altman's Z-Score model is to establish a criterion of categorizing companies into either financial stable or financially distressed group with minimal estimation errors, by employing a set of accounting ratios appropriately weighted and condensed into a statistical index known as the Score, which is arrived at through the formulation of a function called as the discriminant function **[27]**. The discriminant function synchronizes independent variables comprising various balance sheet indicators with each indicator assigned a specific coefficient as weight.

The general discriminant function is represented as follows:

$Sj = v\mathbf{1}x\mathbf{1}j + v\mathbf{2}x\mathbf{2}j + \ldots + v\mathbf{n}x\mathbf{n}j$

Where:

Sj = score of the jth company

vi = coefficient of the variable *xi*

xij = descriptive variable of the *i*th characteristic for the *j*th company, each of the measured parameters must be considered several times over a period of time **[27].**

The final discriminant function for Altman's Z-Score is outlined below **[25]; [28]:**

$Z = \{(1.2* x_1)+(1.4* x_2)+(3.3* x_3)+(0.6* x_4)+1.0*x_5)\}$

Where,

$\boldsymbol{x_1}$=Working Capital / Total Assets

$\boldsymbol{x_2}$=Retained Earnings/Total Assets

$\boldsymbol{x_3}$=EBIT/Total Assets

$\boldsymbol{x_4}$=Market Value of Equity / Total Liabilities

$\boldsymbol{x_5}$=Sales/Total Assets

Variable x_1 comprising the "ratio of working capital and total assets" is an effective indicator of a firm's ability to manage short-term financial obligations given a firm encountering operational losses, the proportion of current assets to total assets tends to decrease **[28].** x_2 representing the "ratio of retained earnings to total assets" reflects a firm's financial health over a long period; as to what extent the firm has utilized its retained earnings to consolidate its asset base **[28].** Higher the value of this ratio signifies reduced dependence of the firm on external debt. The ratio of "EBIT (earnings before interest and taxes) to total assets" - x_3, maps a firm's profitability to its asset base, capturing its ability to generate operating income with the underlying asset base **[28]**. The ratio of "market value of equity to book value of total liabilities" is labelled x_4, illustrates the extent to which a firm's assets may undergo a decrease in value - calculated by the market value of equity and debt – before its liabilities surpass its assets to turn insolvent, hence providing insight into potential financial distress. Finally, x_5 the ratio of "sales to book value of total assets" measures a firm's capacity to general sales with the available assets **[29].**

For the purpose of this study, sample companies have been investigated for the decade from 2010-11 to 2020-21. Secondary in nature, the time series data sourced from annual reports/financial statements and other reports was used to arrive at the ratios (***x1, x2, x3, x4 and x5***) required for computation of Altman's Z-Score.

Data Analysis and Results

Following compilation of ratios forming the basic parameters for applying the Altman's Z-Score model, results of the analysis are presented in table 1.1 and 1.2.

Table 1.1: Altman's Z-Score for NHPC Time Series

Variable	Financial Years										
	2010-11	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**
x_1	0.068	0.097	0.107	0.091	0.072	0.081	0.007	-0.013	-0.004	0.025	0.023
x_2	0.091	0.113	0.131	0.138	0.031	0.057	0.049	0.065	0.082	0.092	0.118
x_3	0.068	0.073	0.066	0.061	0.072	0.077	0.087	0.083	0.078	0.068	0.078
x_4	0.097	0.098	0.091	0.734	0.798	0.757	1.076	1.110	0.841	0.619	0.540
x_5	0.089	0.107	0.097	0.138	0.123	0.135	0.139	0.130	0.137	0.135	0.146
Z-Score	**0.581**	**0.683**	**0.681**	**1.082**	**0.970**	**1.021**	**1.149**	**1.146**	**1.007**	**0.890**	**0.918**

Source: *Authors' Exploration on the Basis of Time Series Data.*

The results depicted in the Table 1.1 indicate that the Z-Score for all the reference financial years is < 1.81 which indicates that the firm falls in the distress zone. Thus, the NHPC is likely to experience financial challenges in the near future for the projects under study **[28]; [30]; [31].**

Similarly, Altman's Z-Score for JKPDC time series was calculated, results of which are presented in the Table 1.2.

Table: 1.2- Altman's Z-Score for JKPDC Time Series

Variable	Financial Years										
	2010-11	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**
x_1	0.144	0.021	0.054	0.035	0.021	0.226	0.015	-0.039	0.022	0.070	0.127
x_2	0.022	0.046	0.019	0.016	0.020	0.001	0.009	0.020	0.026	0.062	0.052
x_3	0.035	0.050	0.052	0.042	0.041	0.039	0.046	0.051	0.049	0.087	0.078
x_4	0.480	1.351	0.554	0.434	0.506	0.024	0.219	0.523	0.710	1.347	1.271
x_5	0.142	0.127	0.117	0.097	0.093	0.093	0.105	0.111	0.115	0.157	0.132
Z-Score	0.747	1.191	0.710	0.561	0.585	0.508	0.418	0.574	0.766	1.424	1.376

Source: *Authors' Exploration on the Basis of Time Series Data.*

In case of JKPDC time series also, the results depicted in the Table 1.2 indicate that the Z-Score for all the reference financial years is < 1.81 which signifies that the firm falls in the distress zone and thus, is likely to experience financial challenges in the near future **[28]; [30]; [31].**

Discussion

The Altman' Z-Score is considered as one of the best models to predict the bankruptcy risk of the firms. As per Altman the score of above 2.6 is considered **"Safe"**, score between 1.1 and 2.6 is considered **"Grey"** and while as score below 1.1 is considered **"Distress"**. However, in 2019 a lecture delivered by Altman himself titled "50 years of the A Z-Score" has conveyed that a score between 0-1.80 is the figure at which investors need to worry about the financial well-being of the company. It has been seen that the median Altman's Z-Score of the companies during 2007 crisis was 1.81. The credit rating of these companies was equivalent to 'B' and this indicated that fifty percent of the firms were having lower ratings, were highly distressed and had a high possibility of becoming bankrupt. Thus, the companies whose Altman's Z-Score is nearer to threshold ratio of 1.81 are facing high probability of solvency risk. So, the results of the present study indicate that both the sample firms have Altman's Z-Score of less than 1.1 - far less than threshold ratio of 1.81, and as such, there are clear signs of distress faced by the sample companies.

Conclusion

The present study has been able to measure the financial risk of bankruptcy of both the sample companies for all the financial years of reference coming out < *1.81*. Moreover, empirical evidence from the present study has led to the classification of both the sample companies as in "*Distress*" zone.

Owing to the evidence of distress in both the sample companies in the present study, it is implied that the hydropower projects exhibit a high degree of financial risk of bankruptcy. As a consequence, the risk of bankruptcy has an impact on the borrowing cost from the investor's point of view, which in turn would impact the cost of generation, thus stretching the pricing competitiveness of the energy generated from the hydropower projects. From lenders perspective, the financial risk of bankruptcy would entail higher pricing by virtue of added risk premium and collateral to secure the risk.

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