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Investigating the optimal leverage ratio in the financing of new energy vehicle (NEV) projects: A risk management perspective

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Abstract:

Projects that require significant capital investment necessitate meticulous consideration of the project financing approach. Based on the background of new energy vehicle industry, this thesis proposes the assumption of empirical research on project financing method selection. To achieve this, the research conducts a comprehensive review of relevant literature, including the project financing method, factors influencing project financing structure, and decision models of financing methods. Moreover, the proposal presents a financial model that utilizes stochastic simulation optimization to identify the optimal leverage ratio from various sources. The aim is to achieve maximum net present value (NPV) while controlling the default risk. By using this approach, the model helps to balance the benefits of diversification and cost efficiency while managing the risks associated with the selected debt instruments.

1. Introductory Literature Review

The British government has put forward *Ten Point Plan* in 2020 to tackle climate change and economic recovery. The bill formulates a series of measures to support the development of new energy vehicles, such as tax relief (Lévay, Drossinos & Thiel, 2017), car purchase subsidies (Santos & Rembalski, 2021) and the construction of charging piles (Yu, 2021). Due to the capital-intensive nature and business value, electric vehicle projects have attracted the attention of a large number of investors (Serradilla et al., 2017). The research, development, and equipment costs of new energy vehicle projects are higher than those of traditional fuel vehicles. Considering the endless cash flow required by projects, Lukas et al. (2017) study the relationship between product cycles and investment decisions in the case of fluctuating cash flows. For such high-tech projects, single equity financing can lead to management difficulties (Fu & Yang, 2021). Bond financing will lead to insufficient marketization (Fu & Yang, 2021). Gong et al. (2021) pointed out that the equity-debt ratio should be optimized to promote technological innovation and market development. In the process of project financing, risk assessment will directly affect investors' decision-making (Wu et al., 2019; Gupta et al., 2023). The current research on the asset structure optimization of NEV projects mainly focused on financial performance (Kontuš et al., 2023). However, the financial indicators are only static indicators, which cannot reflect the dynamic changes and risk impact. In addition, these indicators are easily manipulated by SPVs using financial means. To make up for the shortcomings of existing models, this research will introduce risk elements and system thinking into the decision-making process of project financing.

2. Project Aim

The study aims to investigate how to improve project performance and reduce the default risk by optimizing the debt-equity ratio.

3. List of Objectives

No.	Research Objectives
1	To conduct a literature review of the related definition
2	To examine default risk management and capital structure theory used in NEV projects
3	To conduct research by using qualitative and quantitative methods
4	To analyze and discuss about the data using trade-off theory
5	To present results and future direction

Table 1: Research objectives for this proposal

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4. Project Relevance and Impact

Under the threat of climate change (Ozarisoy & Elsharkawy, 2019) and fuel poverty (Mattioli, 2017), the British government plans to ban the sale of traditional petrol and diesel cars from 2030. Electric vehicles that do not rely on traditional fuels meet the requirements of the policy. The development of new energy projects requires factory construction, equipment procurement, and technology development, which requires a large amount of financial support. Selecting the optimal combination of financing models can ensure stable cash flow and high NPV during the operation process (Han et al., 2018). To a certain extent, the risks of special purpose vehicle (SPV) can be transferred to investors. Favara et al. (2021) proposed that the research on risk identification can help financial institutions judge hazard controllability and investment value. In addition, optimizing asset structure is a bottom-up way to improve competitiveness (Qazi, 2015). In conclusion, the research results can bring certain reference value to various stakeholders related to the new energy vehicle project.

5. Research Methodology

5.1 Research Strategy

The research analyzes the mechanism between capital structure and default risk through a deductive approach. Traditional trade-off theory proposed by Kraus & Litzenberger (1973) mainly measured debt costs and benefits. However, the decision-making under this theory is entirely for the SPV's financial affairs, without considering the additional risks borne by the creditors. In addition, a high rate of return does not mean that the project is performing well because financial indicators such as ROE ignore risk factors (Sidik, 2022). Vassalou & Xing (2004) found that default risk is one of the important factors explaining stock return fluctuations. To offset this deficiency, the dynamic "default-asset model" takes the minimization of default risk into account. During this process, the combination of quantitative and qualitative methods will be used to improve the persuasiveness of research conclusions (Edmonds & Kennedy, 2017). In this project, a single mathematical analysis will deviate from the actual situation. Qualitative research should be combined to formulate research questions, propose hypotheses, and analyze data results in conjunction with practice.

5.2 Data Collection & Analysis

The independent variable of the study is the capital structure, and the dependent variable is the project performance and default probability. Based on basic financial data, capital structure is measured by the ratio of debt to equity (Christensen & Kiefer, 2021). Project performance can be represented by CROCI, which reflects the profitability and investment value (Curto, 2020). DSCR is used to measure the solvency of the cash flow (Donkor & Duffey, 2013), which can reflect the default probability. The lower DSCR of a certain project means worse debt solvency. Its corresponding debt default risk is relatively high. The calculation of the above indicators requires operating cash flow (OCF), net working capital (NWC), net profit (NP), pre-tax profit (PTP), debt service fee (DSF), debt value (D), and equity value (E). Due to the limitation of time and space, the data needed in this study are mainly secondary data obtained through a literature review and government website in UK. The specific formula and modeling process can be viewed in Appendix C. According to legal requirements, all UK-registered companies should provide an annual financial report to "GOV.UK - Companies House". Several large-scale SPVs can be found on this website. They are generally wholly owned by the parent company and established for a specific project. Hence, this thesis can use the financial report data released by SPVs as a sample. This study selected relevant data from seven large electric vehicle companies in the UK, including Arrival, Britishvolt, LEVC (London Electric Vehicle Company), Dyson, BMW (UK) Ltd, Jaguar Land Rover, and Nissan Motor Manufacturing (UK) Ltd. The SPVs information and available accounting years will be collected during the research. The next step is to identify the control variables (Donkor & Duffey, 2013; Antill & Grenadier, 2018) through multiple regression. Before building the model, key assumptions and constraints should be set according to the macro environment or EEFs & OPAs. Data analysis will be performed by SPSS and MATLAB. SPSS will be used for data cleaning, transformation, descriptive analysis, and correlation analysis. MATLAB provides various built-in functions and toolboxes, such as Optimization Toolbox and Global Optimization Toolbox. These can be used to model evaluation, nonlinear regression, and sensitivity analysis.

5.3 Research Methods

5.3.1Empirical Research

The main innovations are reflected in model optimization, including the selection of independent variables, data selection, and research design. The proposal chooses CROCI instead of traditional indicators ROE (Bunea, 2019) for the company's financial performance. Project leaders can increase ROE by increasing liabilities, but this means that SPVs bear higher financial risks. During this process, ROE does not dynamically reflect the future investment value and sustainable development. In terms of data collection, the conceptual shift approach is employed to improve data availability (King et al., 2021). Project data will be transformed into SPV company data. These data can be obtained through publicly released company financial report data. The model evaluation is based on databases in thousands and computer simulations. Monte Carlo models are used to simulate probability distribution and uncertainty. Antill & Grenadier (2018) proposed an investment decision-making model in which the capital structure and debt yield of enterprises are both random variables.

5.3.2. Sensitivity Analysis

This study uses sensitivity analysis to verify the validity of the data and results. Key variables need to be selected for multiple simulations. Sensitivity analysis can also be used to identify the most critical parameters in the model, those that have the greatest impact on the model output (Spasenic et al., 2022). For example, researchers can use sensitivity analysis to study how changes in interest rates, revenue forecasts, or

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project costs affect the optimal capital structure or project risk. By varying one parameter at a time while holding all others constant, researchers can assess the sensitivity of the model output to that particular factor.

6. Conclusion & Future direction

The data and literature on renewable energy projects drew my attention to this type of industry. British government's emphasis on carbon emissions and sustainability in GOV.UK. Firouzi & Meshkani (2021) introduce risk factors into the decision-making process of loan repayment schedules. The paper points out that both benefits and risks are factors that need to be weighed in the process of project financing. The above research is the inspiration source to introduce the perspective of loan default. The study of Spasenic et al. (2022) only provided the risk assessment process but did not study how to bring risk factors into the asset optimization process. In addition, the quantitative research methods on risk factors (Umamaheswaran & Seth, 2015; Jadidi et al., 2020) have direct reference values.

7. Appendix A - Project Gantt Chart

The choice of specific research topics is determined in Coursework B. After the exams in the second semester, tasks for dissertation can begin. In order to make the text and structure clearer, the Gantt chart is broken down into the following tables. These tables are made using tool - Excel. Assuming a weekly group meeting with the supervisor, the time setting on the horizontal axis includes the date and week number. It is convenient to report progress to the supervisor on a weekly basis.

	Date	2023/6/5	2023/6/12	2023/6/19
No.	**Week Number**	1	2	3
Task ID	Task Description			
1	**Literature Review Phase**			
1.1	**Background Study**			
1.11	New Energy Vehicle Market Overview			
1.12	Law and Policy in UK			
1.13	Technology Development Status			
1.14	Supply Chain Situation			
1.2	**Default Risk management in NEV projects**			
1.21	Literature search			
1.22	Theoretical basis research			
1.23	Current status of theme research			
1.24	Criticize existing research			
1.25	Find research gap			
1.3	**Capital structure theory**			
1.31	Four basic theoretical models			
1.32	Derivative research results			
1.33	Critical thinking			
1.34	Find room for improvement			
2	**Research methodology Phase**			
2.11	Research question			
2.12	Propose the hypothesis			
2.13	Research strategy			
2.14	Specific research method			
2.15	Design the research process			

	Date	2023/6/26	2023/7/3	2023/7/10	2023/7/17	2023/7/24

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No.	Week Number	4	5	6	7	8
3	**Data collection & analysis**					
3.1	**Data collection**					
3.11	Channels of data acquisition					
3.12	Ethical review of data					
3.13	Collect the data					
3.14	Verify the reliability of the data					
3.15	Complete missing data					
3.16	Data cleaning					
3.2	**Data analysis**					
3.21	Build the model					
3.22	Model solving					
3.22	Descriptive statistical analysis					
3.23	Regression analysis					
3.24	Model evaluation and optimization					
3.25	Sensitivity analysis					
3.26	Summary of results					

	Date	2023/7/31	2023/8/7	2023/8/14	2023/8/21	2023/8/28	2023/9/4
No.	Week Number	9	10	11	12	13	14
4	**Discussion & conclusion**						
4.11	Summary of data analysis results						
4.12	Linkage of results to research questions						
4.13	Whether the hypothesis is proved						
4.14	Limitations and uncertainties of Results						

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4.15	Future research						
5	**Ending**						
5.11	Organize the article structure						
5.12	Reduce repetition						
5.13	Modify the wording and grammar of the article						
5.14	End of dissertation (submit)						

8. Appendix B - Variable Selection

	Variables	**Indexes**	**Reference & Notes**
Dependent Variables	Project performance	CROCI	Curto, 2020
	Default risk	DSCR	Donkor & Duffey, 2013
Independent Variables	Capital structure	Debt to Equity Ratio	Agarwal, 2013; Miglo, 2016
Control Variables	Project type	NEV battery project	Different risk types
	Project scale	Large scale	Economies of scale and Risk diversification
	Economic environment	Policy and law of Britain	Nazarko & Nazarko, 2013

9. Appendix C - Model Set

According to the basic trade-off formula, the total value of the SPVs equals the debt value (D) plus the equity value (E):

$$V = D + E$$

Based on the basic formula, the relationship between leverage ratio (debt to equity ratio) and project value can be deduced if financial risks are considered:

$$VU = VL + D * (1 - T)$$

VU represents the total project value of unused debt. VL represents the total value of used debt. D is the amount of the company's debt. T is tax rate. The formula suggests that debt reduces a company's after-tax costs but also increases financial risk.

The capital structure of a project can be expressed as below:

$$Capital\ Structure = \frac{\text{Debit (D)}}{\text{Equity (E)}}$$

The financial performance of the project is calculated using the CROCI indicator:

$$CROCI = \frac{Operating\ Cash\ Flow}{\text{Invested Capital (D + E) + Net Working Capital}}$$

Project's default rate can be expressed as the following formula:

$$DSCR(Debt\ Service\ Coverage\ Ratio) = \frac{(CFADS\ +\ Depreciation\ +\ Reserve\ Accounts)}{\text{Debt Service}}$$

According to the assumptions in this proposal, the model can be drawn:

$$F\left(\frac{D}{E}\right) = k * f(CROCI) + m * f(DSCR)$$

where k and m are the relevant influence coefficients.

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