

## ASSESSING THE IMPACT OF CARBON TAXATION PLAN OF COAL COMPANIES DEFAULT RISK IN INDONESIA

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### ABSTRACT

**Background:** Increased greenhouse gas emissions from fossil fuel use can significantly increase global temperatures, contribute to climate change, and negatively impact human health. To address this issue, Indonesia signed the Paris Agreement in 2015, and proposed the implementation of a carbon tax regulation. The Indonesian government has designated Steam Power Plants (PLTU) as subject to a carbon tax starting in 2025. Other sectors, including coal mining, will also be subject to carbon tax gradually.

**Purpose:** This study is designed to explore the influence of a carbon tax on coal companies in Indonesia, with a focus on their Probability of Default.

**Design/methodology/approach:** The study sample comprises 17 companies listed on the Indonesian Stock Exchange (IDX). The study utilises a quantitative approach and employs descriptive statistical analysis for data analysis. Panel data, which are a combination of time-series data spanning a five-year period from 2018 to 2022, and cross-sectional data in the form of publicly available company secondary data, were used in this study.

**Findings/results:** The analysis reveals that the current ratio, debt-to-equity, oil price, and carbon tax have a significant impact on the probability of default. However, Gross Profit Margin, Net Profit Margin, and time interest earned were found to have no significant effect. The implementation of carbon policy was found to increase the probability of default by 42.5% in this research model.

**Conclusion:** These findings emphasise the importance of effective capital structure management through DER monitoring and liquidity optimisation through current ratio management. Company management needs to develop a comprehensive strategy that not only focuses on adjusting capital structure and liquidity, but also considers technological innovation and operational efficiency to face the carbon tax challenge.

**Originality/value (State of the art):** The novelty of this research lies in the use of the Kreditrisk+ Merton (KMV Merton) model to analyse the probability of default of coal mining companies in the context of carbon tax implementation in Indonesia.

**Keywords:** carbon tax, coal mining company, greenhouse gas, oil price, probability of default

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## INTRODUCTION

The utilization of carbon-emitting fossil fuels contributes to the rise in greenhouse gas (GHG) emissions, which can lead to global warming, climate change, and negative consequences for human life. As the concentration of carbon dioxide in the atmosphere increases, more heat waves are absorbed, resulting in a rise in Earth's surface temperature. This extreme climate change then disrupts ecosystems, such as forests, and diminishes their ability to absorb carbon dioxide. Indonesia, in particular, is a significant contributor to global emissions, with an estimated 700 million tons of carbon emissions projected for 2022, marking an 18.3% increase from the previous year and the highest increase among all countries. The primary sources of Indonesia's emissions are coal and high rates of land conversion and deforestation (databoks.katadata.co.id, 2023).

The Fuel consumption for the power generation subcategory in 2018 was 504 million BOE, which is the coal sales data for domestic sales allocation. This figure has increased since 2008, with an average annual growth of 7.08%. Fuel consumption was dominated by coal from 2008 to 2018, with a share of 53.94% to 75.92%. The government continues to depend on Steam Power Plants (PLTU) in their electricity sector policy for community use. The Fuel consumption for coal processing subcategory in 2018 was 42 thousand BOE. The volume of the coal used in processing fluctuated from 2008 to 2018. Overall, there was an average annual increase of 15% in the volume. (MEMR Data and Information Technology Centre, 2018). According to the International Energy Agency (IEA, 2021), Indonesia was the world's largest coal exporter in 2020, contributing around 28% of global coal exports. In addition, coal contributes around 4% to gross domestic product (GDP). Coal is currently the world's second largest source of primary energy after petroleum.

To address climate change and its consequences, world leaders, including Indonesia, declared the Paris Agreement on December 12, 2015, during the UN Climate Change Conference (COP21). The Paris Agreement, signed on November 4, 2016, aims to reduce global greenhouse gas emissions and limit global temperature rise to 2.0°C and seeks to limit the temperature rise to below 1.5°C. Indonesia ratified and

signed the agreement, and established its commitment through Law of the Republic of Indonesia number 16 of 2016 on the Ratification of the Paris Agreement to the United Nations Framework Convention on Climate Change.

According to the Presidential Regulation of the Republic of Indonesia, Number 98 of 2021 is a tax imposed on the use of fossil fuels, such as coal, oil, and natural gas. Hasudungan (2017) revealed that all carbon taxation scenarios diversely affect economic performance in term of the magnitude of change. In general, the results show that a carbon tax can reduce the national emission level, but it adds costs to the economy, so that GDP decreases. The probability of default is a measure of expected risk, with values between zero and one. The higher the probability of a company's default value, the higher the lender will usually charge interest rate in line with the higher probability of company default. According to Crouhy, Galai, and Mark (2000), the Probability of Default is a measure of the likelihood that a borrower will fail to meet its financial obligations within a specified period of time, generally one year.

The implementation of a carbon tax is a government strategy to reduce greenhouse gas emissions and encourage the transition to a low-carbon economy. Companies, especially those in high-emission sectors, are required to pay a tax on every ton of carbon dioxide they produce. However, the implementation of this carbon tax has the potential to affect companies' financial performance, especially for companies that are not ready to adapt. In turn, this can affect company's probability of default. An analysis within the scope of credit risk management is required to assess a company's probability of default.

Research on Factors Affecting the Carbon Tax Implementation Plan on the Probability of Default of Coal Mining Companies in Indonesia has deep significance, as Indonesia is one of the largest coal producers and exporters in the world. This research is crucial as Indonesia is in a transition phase towards the implementation of a carbon tax, while the coal mining sector remains a significant contributor to state revenue and employment. An in-depth understanding of the potential impact of this policy on the financial health of mining companies is vital to prevent unintended economic and social shocks.

The novelty of this research lies in the use of the Kreditrisk+ Merton (KMV Merton) model to analyse the probability of default of coal mining companies in the context of carbon tax implementation in Indonesia. This model offers a more comprehensive approach in assessing bankruptcy risk as it considers the company's capital structure and asset value volatility as the main factors in calculating probability of default.

Merton's KMV approach in this study provides a new perspective as it integrates the impact of carbon tax as an additional variable in the calculation of the company's asset and liability values. The model allows for a more in-depth analysis of how the carbon tax burden affects the firm's distance to default by considering changes in the firm's asset value and liability structure after the implementation of the carbon tax policy.

Research on the relationship between carbon tax and corporate default probability is becoming increasingly relevant in the current global context. With the increasing awareness of climate change and the implementation of stricter environmental policies in various countries, carbon tax has emerged as an important instrument in carbon emission mitigation efforts. However, the implementation of these taxes can have significant implications on a company's financial performance, especially for those industries that rely on fossil fuels or have a high carbon footprint. Understanding how carbon taxes affect companies' default probabilities is not only important for policymakers in designing effective and sustainable regulations, but also crucial for investors, financial institutions and companies themselves in assessing risks and developing adaptation strategies. Carbon tax is economically significant to reduce carbon emissions, where carbon emissions caused by fossil fuel products such as gasoline, aviation fuel, and gas need to be reduced fuel consumption and CO<sub>2</sub> emissions (Zhou, Shi, Li, & Yuan, 2011). The principle of carbon tax is that whoever emits must pay (Hindarto, Edwin, Samyanugraha, & Nathalia, 2019). The Emission Trading System (ETS) or cap-and-trade system is a mandatory carbon market that is formed on the basis of a policy to limit and reduce greenhouse gas emissions (Hindarto, Edwin, Samyanugraha, & Nathalia, 2019).

The objectives of this study are as follows:

1. to evaluate the impact of the implementation of a carbon tax policy on a company's balance sheet.
2. to evaluate the effect of the implementation of a

carbon tax policy on the likelihood of default of coal mining companies in Indonesia.

3. to develop a plan to mitigate the risk of default

## METHODS

The research location was carried out at the Indonesia Stock Exchange (IDX) to obtain secondary data in the form of annual financial reports and other publication reports. The research time was carried out from February to March 2024.

The research approach utilized in this study was a descriptive, inferential statistical analysis technique. As per Sugiyono (2018), descriptive statistics are used to analyze data by providing a description or summary of the collected data, and the intention is not to make broad conclusions or generalizations. On the other hand, inferential statistics are statistical methods used to analyze sample data, and the results are generalized (inferred) to the population from which the sample was drawn. In light of this understanding, the researcher employed an inferential quantitative method, which is a form of study based on systematic data collection regarding the facts and characteristics of the research object, followed by several statistical testing steps, which are interpreted in light of theories and literature related to company value and financial health.

The data used were secondary data in the form of panel data. Panel data (pooled data) are a combination of time series data over a five-year period, namely 2018-2022 with cross section data in the form of secondary company data that is publicly available in the form of financial report data and other reports and company stock data traded on the stock exchange in the 2018-2022 period. Siregar et al. (2024) post-IPO companies tend to show a more accurate representation of their operational and financial conditions.

The focus of this research is on publicly traded companies that are included in the Indonesia Stock Exchange (IDX) for the coal mining sector during the period of 2018-2022, as well as the expansion data provided by Manurung et al. (2022). During this period the author identified 17 publicly listed companies in the coal sector listed on the Indonesia Stock Exchange (IDX), namely: PT Bukit Asam, PT Adaro Energy Indonesia, PT Delta Dunia Makmur, PT Resources Alam Indonesia, PT Indo Tambangraya Megah, PT

Perdana Karya Perkasa, PT Medco Energi International, PT Golden Eagle Energy, PT Bayan Resources, PT Golden Energy Mines, PT Atlas Resources, PT Garda Tujuh Buana, PT Bumi Resources, PT Harum Energy, PT Samindo Resources, PT Petrosea, PT Toba Bara Sejahtera. These companies was selected based on the following criteria.

1. Public companies in the coal mining sector listed on the Indonesia Stock Exchange (IDX).
2. The company publishes complete financial reports for the period 2018-2022 which can be accessed from any official website of the Indonesia Stock Exchange (IDX) or the company's website.
3. The company has stock movement data for 2018-2022 that can be accessed in full.

Data analysis using the Eview12 application. In this study, the category of panel data regression, researchers can estimate fixed effects for each unit and time effects for each time period to control for between-unit variation and variation over time. An appropriate estimation method (e.g., Fixed Effects or Random Effects) is selected based on assumptions about the nature of the fixed effects and time effects, as well as the characteristics of the data used.

Referring to the framework and the results of previous research that have been presented, this study proposes several hypotheses that will be tested through a series of statistical analyses to obtain answers to research problems.

1. Hypothesis 1:  
H01a: The Current Ratio (CR) has no significant effect one company's Probability of Default (PD).
2. Hypothesis 2:  
H01b: Debt to Equity (DER) has no significant effect on the Probability of Default (PD) of the company.
3. Hypothesis 3:  
H01c: Gross Profit Margin (GPM) has no significant effect one company's Probability of Default (PD).
4. Hypothesis 4:  
H01d: Net Profit Margin (NPM) has no significant effect on the company's Probability of Default (PD).

5. Hypothesis 5:  
H01e: Times Interest Earned (TIE) has no significant effect one company's Probability of Default (PD).
6. Hypothesis 6:  
H01f: Foreign Exchange (EX) has no significant effect one company's Probability of Default (PD).
7. Hypothesis 7:  
H01g: Oil Price (OIL) has no significant effect on the thecompany's Probability of Default (PD).
8. Hypothesis 8:  
H01h: Tax Carbon has no significant effect on the Probability of Default (PD) of the company.

The dependent variable is the Probability of Default (PD) as an indicator of the company's potential bankruptcy, and the independent variable is the company's ratio, namely the Current Ratio (CR), Debt to Equity (DER), Gross Profit Margin (GPM), Net Profit Margin (NPM), Times Interest Earned (TIE), Currency Exchange Rate, and Oil Price (OIL), and carbon tax (CRB). Table 1 presents the operational definitions of the variables.

The framework is a fundamental element in a study that functions as a conceptual model of how theory relates to various factors that have been identified as research problems. In this study, the framework is to determine the effect of Current ratio (CR), Debt to equity (DER), Gross profit margin (GPM), Net profit margin (NPM), Times interest earned (TIE), Foreign exchange (EX), Oil Price (OIL), and Tax Carbon on probability of default (PD) which is presented in Figure 1.

## RESULTS

### Classical Assumption Test

#### Normality Test

If the significant value  $> 0.05$  means that the data distribution was normal; otherwise, if the significance value was less than  $\leq 0.05$ , the data distribution was not normal. In this study, the significance value based on the random effects method was 0.2; thus, the data in this study were normally distributed.

Table 1. Operational definition of research variables

Variable	Operational Definition	Parameters
<b>Dependent:</b>		
PD (Y)	Probability of Default (PD) is a financial term that describes the likelihood of default over a certain period of time.	
<b>Independent:</b>		
CR( $\beta_1$ )	A ratio that reflects the ability of current assets company to cover current liabilities or short-term debt.	current assets/current liabilities
DER( $\beta_2$ )	Debt ratio is the ratio of total debt (liabilities) and total assets owned by the company.	total debt/total equity
GPM( $\beta_3$ )	The ratio of gross revenue to sales or revenue earned by the company.	gross revenue/total revenue
NPM( $\beta_4$ )	The ratio of net income to sales or revenue earned by the company.	net revenue/total revenue
TIE( $\beta_5$ )	A ratio that shows the company's ability to settle its interest expenses using a comparison of earnings before interest and tax with interest expenses.	ebit Da/interest expense
ER( $\beta_6$ )	Exchange Rate is a measure of the conversion of money in the form of foreign currency US Dollar with rupiah units.	Kurs USDIDR
OIL( $\beta_7$ )	A variable that shows the movement of world oil prices.	oil prices
CRB( $\beta_8$ )	DUMMY variable that shows the effect of carbon policy implementation plan.	dummy variable
PND( $\beta_9$ )	DUMMY variable that shows the effect of the pandemic period.	dummy variable

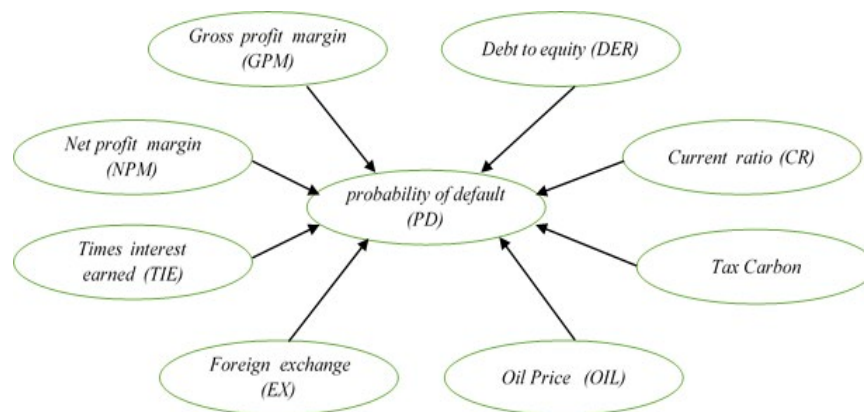


Figure 1. The framework of research

#### Multicollinearity Test.

The purpose of this test was to determine whether there was a correlation between variables. To determine whether or not there is a correlation between variables, it can be seen from the value less than 0.80. Table 2 presents the results of the multicollinearity tests. Based on Table 2, the relationship between all variables has a correlation coefficient value of less than 0.80. This indicates that this study did not have a multicollinearity problem.

#### Autocorrelation Test

Ghozali (2017) states that the autocorrelation test aims to test whether in the panel data regression model there is a correlation between confounding errors in period  $t$  and confounding errors in period  $t-1$  (previous). In the autocorrelation test, the Durbin-Watson statistic value was 1.84242, and the value was between DU and 4-DU; thus, there was no autocorrelation.

Table 2. Multikolinieritas testing

	DER	GPM	NPM	TIE	CR
DER	1	0.024	-0.103	-0.027	0.730
GPM		1	0.790	0.253	0.023
NPM			1	0.329	-0.108
TIE				1	0.011
CR					1

### Heteroscedasticity Test

Yuandari (2017), the Heteroscedasticity Test aims to test whether in the panel data regression model there is an inequality of variance and residuals from one observation to another. There are many methods that can be used to detect heteroscedasticity, but in this study, it was only performed using the White Heteroskedasticity Test on consistent standard error and covariance. The results required from The results of this test are the F-value and Obs \* R-squared. A good regression model should not exhibit heteroscedasticity. The basis for decision making in the heteroscedasticity test is as follows:

1. If the significance value is  $> \alpha = 0.05$ , the conclusion is that there is no heteroscedasticity.
2. If the significance value is  $< \alpha = 0.05$ , heteroscedasticity occurs.

In the White Heteroskedasticity Test, the consistent standard error & covariance is  $0.65 > 0.05$  so that the data in this study do not exhibit heteroscedasticity.

### Model Selection Method

The Hausman test was conducted to compare the fixed effect model and the random effect model with the aim of determining which model should be used. This test was conducted using Eviews software. The provisions for the Hausman test are as follows:

1. If the probability value of cross-section is random  $> 0.05$ , then  $H_0$  is accepted, and the regression model chosen is the Random Effect Model (REM).
2. If the probability value of cross-section is random ( $\leq 0.05$ ), then  $H_0$  is rejected, and the regression model chosen is the Fixed Effect Model (FEM).

In this study, the Hausman test had a cross-sectional random value of  $0.063 > 0.05$ . Thus the random effect model (REM) was used.

### Descriptive Statistics of Dependent and Independent Variables

Descriptive statistics are an important first step in data analysis, as a basis for further analysis and help in making informed decisions. The descriptive statistical values of the dependent and independent variables are presented in Table 3.

The lowest Probability Default was -0.0712, the highest was 1, the average was 0.9076, and the standard deviation was 20.23. This Probability Default data has a normal distribution indicated by the Jarque-Bera value, which is higher than the table value.

Based on the results of the Merton model calculation, the company's failure probability on average reached 90.76% and some reached 100%. The probability of failure of mining companies is inseparable from the price of coal, which varies considerably during the study period.

### R-Square and Hypothesis Test

To build a panel data regression formula with an existing dependent variable (PD) and independent variables with certain coefficients, researchers combined these variables in a panel data regression model. The random-effects method had an  $r$  square value of 0.425. The constituent variables in this study contributed 42.54% to the Probability of Default (PD), where as 57.46% were outside the research model.

This test determines the effect of each independent variable on the Probability of Default (PD). The variable was declared to contribute if the probability was less than 0.05. Table 4 shows the effect of each independent variable on Probability of Default (PD).

Table 3. Descriptive statistics

	Prob.	DER	GPM	NPM	TIE	CR	Kurs	Oil Price
Minimum	-0.071	-2.114	-1.94	-20.719	-1100.31	0.169	13473	45.41
Maximum	1	324.578	1	13.978	724.31	146.13	15592	80.47
Average	0.908	5.826	0.246	0.003	27.341	4.336	14214	60.687
Standard Deviation	0.202	31.557	0.294	2.394	178.953	16.646	700	13.118
SKEW	-3.412	9.255	-3.644	-3.818	-1.537	7.614	1.308	0.527
Kurt	12.49	91.072	26.915	57.531	19.898	59.084	2.554	-1.044
Jarque Bera	774.279	45896.17	3541.933	17181.24	1671.625	19137.873	39.898	98.971

Table 4 Hypothesis testing

Variable	Random Effects (Cross)			
	Coeff	Std. E	t-Stat	Prob.
CR	0.004795	0.000851	5.633619	0
DER	-0.00395	0.000553	-7.14541	0
GPM	0.202335	0.112646	1.796203	0.0765
NPM	0.030179	0.056144	0.537522	0.5925
TIE	7.06E-05	6.29E-05	1.122222	0.2653
KURS	0.530728	0.422436	1.256352	0.2129
OIL	-0.20401	0.088897	-2.29492	0.0245
CARBON	0.1423	0.048274	2.947772	0.0043

- Hypothesis 1:  
Based on Table 4 the current ratio has a probability below 0.05 with both random effects methods so that  $H_a$  is accepted and  $H_0$  is rejected. This is in line with research by Ameilia Damayanti and Rianto (2020) which states that the current ratio (CR) has a significant effect on Financial Distress (FD).
- Hypothesis 2:  
DER has a probability below 0.05 with the random effects method; therefore,  $H_a$  is accepted and  $H_0$  is rejected. This is in line with research by Damayanti and Rianto (2020) which states that DER has a significant effect on Financial Distress (FD).
- Hypothesis 3:  
GPM has a probability above 0.05 with the random effects method, so  $H_0$  is accepted and  $H_a$  is rejected. Companies with high GPM have more financial flexibility in dealing with unexpected situations or short-term income declines. This is in line with the research of Shumway, T. (2001) found that profitability is a significant predictor of bankruptcy, but using net income/total assets instead of GPM.
- Hypothesis 4:  
NPM has a probability above 0.05 both with both random effects methods so that  $H_0$  is accepted and  $H_a$  is rejected. Companies with high NPM also have greater financial flexibility to deal with market challenges and changes.
- Hypothesis 5:  
TIE has a probability above 0.05 with the random effects method, so  $H_0$  is accepted and  $H_a$  is rejected. Companies with high TIE may be better able to manage financial risks, including bankruptcy risk. Campbell et al. (2008) in their study on corporate default risk, found that a combination of accounting and market variables is more effective in predicting default than relying solely on ratios such as TIE.
- Hypothesis 6:  
EX has a probability above 0.05 both with the Fixed Effects method and the random effects method, so  $H_0$  is accepted and  $H_a$  is rejected. Companies that have international operations or conduct business transactions with foreign currencies are exposed to currency exposure risk. Fluctuations in currency exchange rates can affect a company's revenue, cost, and cash flow. Bodnar and Gentry (1993) show that the impact of exchange rate on firm value varies across industries, implying that its effect on probability of default is also inconsistent. Fernandez-Rodriguez, F. (2019) examines the impact of exchange rate volatility on corporate

credit risk and finds that the relationship is not always significant and can vary depending on firm characteristics.

7. Hypothesis 7:

Oil Price (OIL) has a probability below 0.05 with random effects method; therefore  $H_a$  is accepted and  $H_0$  is rejected. Oil price fluctuations can also affect the consumer demand for certain products and services. For example, an increase in oil prices can reduce consumer purchasing power and lead to a decrease in the demand for motor vehicles or other transport products.

8. Hypothesis 8:

Tax Carbon has a probability below 0.05 with the random effects method; therefore  $H_a$  is accepted and  $H_0$  is rejected. This means that the existence of a carbon emission tax will increase at company's Probability of Default (PD). The positive sign is also in accordance with the theory that states that the existence of a carbon emission tax will reduce profit and lead to an increase in the failure of coal mining companies.

### Managerial Implications

Debt Equity Ratio (DER) significantly positively affects the Probability of Default, meaning that an increase in the DER increases the probability of bankruptcy. To mitigate this risk, the company can negotiate with creditors to restructure debt, for example, by extending the payment tenor or changing the interest rate. This can help reduce the burden of short-term debt.

The current Ratio (CR) positively and significantly affects the Probability of Default, meaning that the higher the CR value, the higher the probability of default. To mitigate this risk, coal companies need to take proactive measures, as operational efficiency and carbon emissions reduction should be prioritized. Investments in green technology, although they may require a large initial outlay, can reduce the long-term carbon tax burden and improve the company's liquidity profile.

Carbon tax policy has a positive and significant impact on the Probability of Default. Therefore, appropriate steps must be taken to avoid the Probability of Default. To mitigate this risk, participation in an emissions

trading scheme: if available, companies can participate in a carbon emissions trading scheme. This can provide flexibility in managing carbon tax obligations and the potential to earn additional revenue from the sale of carbon credits.

## CONCLUSIONS AND RECOMMENDATIONS

### Conclusions

The application of a carbon tax will have a significant effect on the company's balance sheet, including Debt to Equity (DER) and Current Ratio (CR). The implementation of carbon tax has an impact although not significant on the company's ratio between Gross Profit Margin (GPM), Net Profit Margin (NPM), Times Interest Earned (TIE). External variables such as Oil Prices (OIL) have a significant impact. The implementation of carbon policy increases the Probability of Default (PD) by 42.5 percent in this research model. To managing DER effectively, companies need to understand the managerial implications of this ratio and take appropriate steps to ensure that the company's capital structure supports its long-term goals. By focusing on the managerial implications of the current ratio, managers can use this information to make the right decisions in managing the company's overall liquidity, operations, and finances. Companies can plan and implement effective strategies to deal with carbon tax policies, minimize their negative impacts, and take advantage of opportunities for innovation and long-term growth.

### Recommendations

We recommend that future researchers do not need to pay attention to the variables of Gross Profit Margin, Net profit margin, and time-interest earnings as internal variables do not need to be used in the model; it is better to use other variables that can logically and scientifically affect it. The oil price and exchange rate variables do not need to be used as the influence of external variables on the probability of failure. The carbon emission tax policy has a significant effect on Probability of Default (PD). Therefore, it is necessary to consider using renewable energy to minimise the Probability of Default (PD).



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