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The Effect of Long-Term Debt, Environmental Cost, and Firm Growth on EBITDA of Mining Companies

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Abstract–This study examines the effects of long-term debt, environmental cost, and firm growth on earnings before interest, taxes, depreciation, and amortization (EBITDA) as a proxy for operating performance in Indonesian mining firms. Using secondary data from published financial statements, the population comprises all mining companies listed on the Indonesia Stock Exchange (IDX) over 2021–2024, covering 65 firms per year and yielding a balanced panel of 260 firm-year observations. Panel regression is applied, and the Chow test supports the fixed-effects model ($p < 0.001$). The results indicate that long-term debt is negatively and statistically significantly associated with EBITDA, suggesting that higher leverage may weaken operating performance through greater financial burdens. Environmental cost shows a positive and statistically significant relationship with EBITDA, implying that environmental expenditures may function as long-term investments that enhance operational efficiency and support corporate sustainability. Firm growth is statistically insignificant, indicating that expansion does not necessarily translate into immediate operating gains in this capital-intensive sector. The model is jointly significant (F-test) and demonstrates strong explanatory power ($R^2 = 0.871942$). These findings highlight the importance of balancing financing decisions, environmental spending, and growth strategies to strengthen operating performance and long-term sustainability

Keywords: Long Term Debt; Environmental Cost; Firm Growth; EBITDA

1. INTRODUCTION

The mining sector plays a strategic role in the Indonesian economy as one of the main contributors to exports, employment creation, and foreign exchange earnings, particularly for coal, mineral, and metal commodities. In facing global economic challenges and changes in natural resource demand, mining companies must maintain their operational profitability (Ferreras & Castro, 2023). One of the operational performance indicators commonly used is Earnings Before Interest, Taxes, Depreciation, and Amortization (EBITDA), as it reflects a company's ability to generate profit from core operations before non-operational expenses. EBITDA is important as a benchmark of operational health that is not affected by capital structure and certain accounting decisions. Nevertheless, EBITDA levels may be influenced by various internal company factors, including financing structure, environmental responsibility expenditures, and firm growth (Alcalde, 2023).

The mining sector occupies a highly strategic position within Indonesia's economic structure, both in terms of contribution to Gross Domestic Product (GDP), national exports, and regional development. Mining commodities such as coal, nickel, copper, gold, and bauxite serve as the backbone of Indonesia's exports and play a crucial role in maintaining the trade balance. In addition, the mining sector significantly contributes to state revenue through taxes, royalties, and various levies, while also promoting regional economic growth through job creation and supporting infrastructure development.

In financial performance analysis, selecting appropriate indicators is particularly important for industries with specific characteristics such as mining. EBITDA is widely used by investors, financial analysts, and creditors because it is considered capable of reflecting pure operational performance. EBITDA eliminates the effects of financing decisions (interest expenses), fiscal policies (taxes), and non-cash accounting methods (depreciation and amortization), thereby providing a more objective picture of a company's ability to generate profit from core activities (Nhleko & Schutte, 2024).

For mining companies, the use of EBITDA becomes increasingly relevant given the high value of fixed assets and substantial depreciation expenses. Net profit often fails to reflect actual operational conditions because it is distorted by these non-operational expenses. Therefore, EBITDA is frequently used as a basis for mining project feasibility assessments, debt covenant calculations, and evaluations of a company's ability to generate operational cash flows (Moolkham, 2024).

In Indonesia, mining companies also face increasingly stringent environmental regulations. The government requires companies to provide reclamation and post-mining guarantee funds and to implement sustainable environmental management programs. These obligations generate substantial and ongoing environmental costs throughout the mine's lifecycle. Although environmental costs may suppress cash flows in the short term, effective environmental management can enhance corporate reputation, reduce the risk of social conflict, and strengthen relationships with government authorities and local communities in the long run (Nkansah, 2025).

In the capital market context, EBITDA plays a crucial role as a performance indicator frequently used by investors and creditors to assess the operational health of mining companies. Investors do not only focus on net profit but also emphasize a company's ability to generate sustainable operational cash flows. This is due to the characteristics

of the mining industry, which include long business cycles, high revenue volatility, and significant capital expenditure requirements. EBITDA is considered to better reflect a company's internal capacity to support future operations and investments (Ferreras & Castro, 2023).

For creditors, EBITDA serves as one of the primary bases for evaluating creditworthiness and a company's ability to meet its debt obligations. Many long-term debt agreements in the mining sector use EBITDA-based ratios, such as debt-to-EBITDA or EBITDA-based interest coverage ratios, as financial covenants. Therefore, changes in EBITDA have direct implications for a company's financial flexibility and its relationship with lenders. When EBITDA weakens, companies face the risk of covenant violations, which may trigger debt renegotiations or increased financing costs (Ir & Tarumingkeng, 2025).

In this context, understanding the factors that influence EBITDA becomes essential not only for internal management but also for external investors and creditors. This study contributes by identifying how long-term debt, environmental cost, and firm growth affect EBITDA, thereby serving as a reference in investment and financing decision-making processes in the mining sector (Myriam et al., 2025).

Firm growth is an important indicator in assessing long-term prospects and competitiveness. In the mining industry, growth may occur through mine expansion, increased production capacity, or commodity diversification. Theoretically, growth enables firms to achieve economies of scale, improve production efficiency, and expand market share (Wibowo, 2021).

However, growth in the mining industry often requires substantial initial investment and involves long payback periods. In the early stages, growth may increase operational costs and suppress EBITDA. Therefore, the impact of firm growth on EBITDA is not always immediate and may vary depending on the company's lifecycle stage (Pitaloka et al., 2022).

Most prior studies associate firm growth with profitability ratios such as ROA and ROE, while studies using EBITDA as an operational performance indicator remain relatively limited. This indicates a research gap that needs to be addressed to provide a more comprehensive understanding of growth dynamics and operational performance in mining companies (Maria-Gorretti, 2020).

The regulatory context in Indonesia also represents a significant factor influencing the operational performance of mining companies. The Indonesian government has implemented various policies related to natural resource management, reclamation obligations, and environmental reporting. These policies aim to enhance the sustainability of the mining sector but simultaneously increase companies' operational costs.

In addition, downstreaming policies and bans on raw material exports encourage mining companies to invest in processing and refining facilities. Such investments require long-term financing and increase the complexity of corporate cost structures. Therefore, analyzing the effects of long-term debt, environmental cost, and firm growth on EBITDA becomes increasingly relevant within the context of these national policies.

Nevertheless, EBITDA is not a standalone indicator. EBITDA levels are still influenced by various corporate policies and strategic decisions, including financing structure, environmental cost allocation, and growth strategies. Consequently, it is essential to empirically examine the factors affecting EBITDA, particularly in the context of Indonesian mining companies.

Mining companies that are able to harmoniously integrate financial and environmental policies tend to exhibit more stable operational performance. Well-planned environmental investments can reduce the risk of operational disruptions arising from environmental and social issues, thereby supporting long-term EBITDA sustainability. Conversely, companies that neglect environmental aspects may face unexpected future costs, such as fines, legal claims, or temporary operational shutdowns, ultimately negatively affecting EBITDA.

This study considers it important to examine the effect of environmental cost on EBITDA within the framework of corporate financial policy. Thus, the results are expected to provide a more comprehensive overview of the trade-offs and synergies between financing policies and environmental management in the mining industry.

The mining industry requires very large long-term investments, including exploration, mine development, and construction of production facilities and supporting infrastructure. These funding needs encourage companies to rely on long-term debt as a primary financing source. Long-term debt allows companies to obtain substantial funds at a relatively lower cost of capital compared to equity, but it also increases financial risk.

However, reliance on the mining sector also creates structural challenges, particularly related to global commodity price volatility. Sharp price fluctuations can directly impact revenue and profitability. This condition requires companies to maintain strong financial resilience and operational efficiency to survive various economic cycles. Therefore, managing operational performance becomes a critical aspect of sustaining mining business continuity in Indonesia.

Environmental cost expenditures may be viewed as companies' efforts to obtain legitimacy. With strong legitimacy, companies tend to enjoy greater operational stability, thereby supporting sustainable EBITDA generation. Therefore, the influence of environmental cost on EBITDA cannot be simplified merely as a cost relationship but should be seen as part of a corporate sustainability strategy.

Firm growth also plays an important role in shaping operational performance. In mining companies, firm growth is often manifested through increased fixed assets, mine area expansion, and product diversification. Such growth requires substantial investment and long payback periods, so its impact on EBITDA is not always immediately

observable. In some cases, companies that aggressively expand experience short-term EBITDA declines due to increased operational costs and depreciation expenses.

Financing structure through long-term debt is a primary option for funding capacity expansion and fixed asset investments (Ir & Tarumingkeng, 2025). However, long-term debt also entails interest burdens and higher financial risk, which may reduce operational profitability if cash flows are insufficient to cover financing costs. Empirical studies on Indonesian mining companies evaluating financial factors, including leverage, indicate that leverage affects profitability, although results are not always consistent across firm sizes and time periods (Aurelia et al., 2022). This highlights the importance of further examining the relationship between long-term debt and EBITDA in this sector, particularly using approaches that consider environmental costs and firm growth dynamics.

On the other hand, mining companies face significant environmental costs, including expenditures for land reclamation, waste management, environmental impact mitigation, regulatory compliance, and sustainability reporting. Sustainability-related studies in the mining industry indicate that environmental management and reporting efforts may moderate the relationship between performance and firm value, and such costs often affect short-term profitability (Juliana & Sembiring, 2025). Metta et al. (2025) show that environmental components within the Environmental, Social, and Governance (ESG) framework can influence investor valuation and profitability in the mining sector, although the complexity often results in indirect relationships or dependence on other variables such as performance and firm value. Therefore, it is necessary to examine both the impact of environmental costs on EBITDA and how mining companies manage these expenditures in the context of operational profitability.

In addition to financing structure and environmental cost, firm growth represents another important determinant of medium- and long-term profitability. Companies experiencing asset growth, increased production capacity, or market expansion typically benefit from greater economies of scale, improved operational efficiency, and expanded market share, which theoretically enhance EBITDA performance. Although growth studies are mostly discussed using classical profitability ratios such as ROA or ROE, empirical evidence suggests that firm growth is positively associated with long-term financial performance in mining companies due to improved production efficiency and revenue diversification (Wibowo, 2021).

Based on the literature review and empirical context, several key research gaps can be identified. First, there remains limited research using EBITDA as an operational performance indicator in the Indonesian mining industry. Second, studies examining the simultaneous effects of long-term debt, environmental cost, and firm growth are scarce. Third, panel data regression approaches using the Fixed Effect Model that capture firm heterogeneity have not been widely applied.

Therefore, this study not only fills a gap in the literature but also provides empirically relevant contributions to managerial decision-making and policy formulation in the mining sector. In traditional paradigms, environmental costs are often viewed as burdens that reduce profitability. However, sustainability literature increasingly recognizes environmental costs as strategic investments with long-term benefits. Effective environmental management can improve operational efficiency, reduce sanction and social conflict risks, and strengthen corporate reputation among stakeholders.

The natural-resource-based view suggests that a firm's ability to manage natural resources sustainably can become a source of competitive advantage. In the mining context, companies that successfully integrate environmental practices into their operational strategies tend to exhibit more stable and sustainable performance. Consequently, the relationship between environmental cost and EBITDA becomes an important subject for empirical investigation.

According to trade-off theory, companies seek optimal capital structures by balancing the tax benefits of debt against bankruptcy costs arising from increased financial risk. In the mining context, these risks are compounded by heavy reliance on volatile global commodity prices. When commodity prices decline, operational cash flows may be pressured, while interest and principal debt obligations remain fixed.

Several empirical studies indicate that high leverage tends to negatively affect the operational performance of mining companies. However, findings are not always consistent, depending on firm size, economic conditions, and performance indicators used. Therefore, examining the impact of long-term debt on EBITDA is essential to provide more specific and contextual empirical evidence.

Long-term debt, environmental cost, and firm growth were selected because they represent three key dimensions of mining company management: financial management, sustainability commitment, and growth strategy. These dimensions are interrelated and collectively shape operational performance as reflected in EBITDA (Nhleko & Schutte, 2024).

From a corporate finance perspective, financing structure is a strategic decision that directly affects risk and performance. Trade-off and pecking order theories explain that firms choose financing combinations that minimize capital costs and financial risk. In the mining industry, financing decisions are particularly critical due to revenue uncertainty and long-term investment requirements. Therefore, long-term debt should not only be viewed as a funding source but also as a factor that may constrain operational flexibility if not managed prudently.

Meanwhile, environmental cost in this study represents corporate commitment to environmental sustainability. In modern accounting literature, environmental costs are no longer viewed merely as mandatory expenditures but as components of long-term business strategy. Stakeholder theory suggests that companies meeting stakeholder expectations, including those of communities and regulators, tend to achieve more stable and sustainable performance.

In mining, neglecting environmental aspects can lead to social, legal, and reputational risks that ultimately harm operational performance.

Firm growth was selected as the third variable because it reflects corporate direction and long-term strategy. Firm growth is often considered an indicator of managerial success in resource utilization and opportunity capture. However, in mining, growth does not always equate to short-term operational performance improvement. Mining projects require long periods to reach optimal production, resulting in delayed impacts on EBITDA. Therefore, empirical testing of firm growth is necessary to better understand growth-performance dynamics (Ir & Tarumingkeng, 2025).

Beyond theoretical contributions, this study also offers strong methodological relevance. Panel data usage allows the integration of time and firm dimensions, capturing mining companies' operational performance dynamics more accurately. Indonesia's mining industry comprises firms with diverse characteristics in scale, commodity type, and operational location. Such heterogeneity is difficult to capture using cross-sectional or time-series data alone (Wibowo, 2021).

Firm growth in the mining industry has greater complexity compared to other sectors. Growth depends not only on managerial strategies but also on natural resource availability, licensing, and surrounding environmental and social conditions. Therefore, mining firm growth is often nonlinear and influenced by external factors beyond corporate control.

In the short term, firm growth may increase operational costs and capital expenditures, potentially suppressing EBITDA. However, in the long term, successful growth may enhance production capacity, operational efficiency, and revenue diversification, ultimately improving operational performance. Therefore, the relationship between firm growth and EBITDA must be empirically analyzed to determine whether growth in Indonesian mining companies is value-creating or value-destroying from an operational perspective.

By incorporating firm growth as an independent variable, this study provides a more balanced perspective on the impact of growth on operational performance. The findings are expected to assist corporate management in designing growth strategies that prioritize not only expansion but also operational sustainability.

This methodological approach strengthens the study's position within empirical literature by accounting for industry complexity. Consequently, the results are expected to provide a holistic picture of operational performance determinants in Indonesian mining companies.

The urgency of this research continues to increase alongside changes in the mining business environment and regulatory landscape. The Indonesian government actively promotes sustainable mining practices through various policies and regulations, including reclamation obligations, environmental reporting, and industrial downstreaming. These policies directly affect cost structures and financing needs, thereby influencing operational performance as reflected in EBITDA (Pramono & Dirgantari, 2023).

From an academic perspective, this study contributes to expanding research on EBITDA determinants, which remains relatively limited, particularly in developing country contexts such as Indonesia. The study also integrates financial and sustainability perspectives within a single empirical model, enriching literature that has traditionally treated these aspects separately.

From a practical perspective, the findings are expected to serve as references for mining company management in formulating balanced financing policies, environmental cost management, and growth strategies. Additionally, the results may inform investors, creditors, and regulators in evaluating mining company performance and sustainability in Indonesia (Myriam et al., 2025).

The characteristics of mining companies listed on the Indonesia Stock Exchange further justify this study. These firms typically have large asset structures, reliance on long-term debt, and high exposure to environmental issues. These conditions make the mining sector a relevant context for examining the relationship between long-term debt, environmental cost, firm growth, and EBITDA (Zhang & Mao, 2024).

Although several studies have explored the effects of leverage, environmental cost, and growth on profitability either separately or in specific financial variable combinations, there remains a lack of research integrating these three variables simultaneously in relation to EBITDA among mining companies listed on the Indonesia Stock Exchange (IDX). This gap is particularly evident in studies focusing on EBITDA as an operational performance indicator rather than other financial ratios (such as ROA or ROE). This distinction is important because EBITDA provides a more focused view of core operations by minimizing the influence of interest and depreciation expenses common in asset-intensive industries like mining.

Therefore, this study aims to empirically examine: (1) the effect of long-term debt on EBITDA, (2) the effect of environmental cost on EBITDA, and (3) the effect of firm growth on EBITDA in mining companies listed on the IDX. This research not only fills gaps in EBITDA-focused literature but also provides practical insights for managers and stakeholders regarding trade-offs among financing, environmental cost, and growth in managing operational profitability in the mining industry. Consequently, this study is expected to contribute both theoretically to the development of finance and sustainability literature and practically to managerial decision-making and corporate policy formulation in Indonesia's mining sector. Additionally, beyond financial challenges, mining companies face increasing environmental management demands. Mining activities inherently have significant environmental impacts, requiring companies to allocate substantial environmental costs, including post-mining land reclamation, waste management, pollution control, and regulatory compliance.

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2. RESEARCH METHODS

2.1 Basic Research Framework

This study employs a quantitative approach to analyze the effects of long-term debt, environmental cost, and firm growth on EBITDA in mining companies listed on the Indonesia Stock Exchange (IDX). The quantitative approach is chosen because the study is causal-associative in nature, aiming to measure the extent to which variations in the independent variables statistically explain variations in EBITDA as the dependent variable. EBITDA is selected as a measure of operational performance because it provides a clear representation of earnings generated from core business activities before non-operational expenses such as interest, taxes, depreciation, and amortization.

The population of this study consists of all mining companies listed on the Indonesia Stock Exchange during the 2021–2024 period. The four-year observation period is selected to capture economic fluctuations in the post–COVID-19 pandemic era, thereby producing more representative and reliable results. The sample is determined using purposive sampling, including only companies that meet the following criteria: (1) publishing complete financial statements for four consecutive years, (2) disclosing information related to environmental costs, and (3) reporting EBITDA components in their financial statements. The application of these criteria is consistent with quantitative research practices in finance that rely on secondary data to ensure data consistency and quality (Kurniawan & Ismanto, 2025).

The variables used in this study consist of one dependent variable and three independent variables. The dependent variable is EBITDA, while the independent variables include long-term debt (LTD), measured as the ratio of total long-term liabilities to total assets; environmental cost (EC), measured based on total disclosed environmental expenditures; and firm growth (FG), measured by the annual growth rate of total assets. Based on the literature review and theoretical framework, the research hypotheses are formulated as follows:

a. H1: Long term debt has a significant relationship with EBITDA..
b. H2: Environmental cost has a significant relationship with EBITDA.
c. H3: Firm growth has a significant relationship with EBITDA.

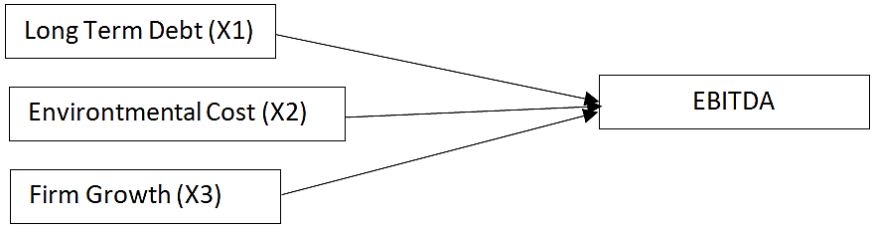

Figure 1. Conceptual Framework

The research framework illustrates the direction of influence of the independent variables on EBITDA. Long-term debt (LTD) and environmental cost (EC) are expected to exert negative effects on EBITDA, while firm growth (FG) is expected to have a positive effect, as supported by previous empirical studies examining the relationship between leverage, environmental expenditures, and firm growth on corporate profitability (Metta et al., 2025)

2.2 Operational Definitions of Variables

This study employs three independent variables—long-term debt, environmental cost, and firm growth—and one dependent variable, EBITDA. These variables are commonly used in quantitative corporate finance research to measure capital structure, environmental expenditures, firm growth, and operational performance, particularly in the energy and mining sectors.

2.2.1 Long-Term Debt

Long-term debt is defined as corporate obligations with maturities exceeding one year that are used to finance long-term investments and operational activities (Aurelia et al., 2022). In financial studies, long-term debt is frequently proxied by leverage and is considered a critical factor influencing firm performance, including profitability and financing decisions (Pitaloka et al., 2022).

In this study, long-term debt is measured using the ratio of total long-term liabilities to total assets, as reported in the annual statement of financial position of mining companies.

$$\text{Long-Term Debt (LTD)} = \frac{\text{Long-Term Liabilities}}{\text{Total Assets}} \quad (1)$$

2.2.2 Environmental Cost

Environmental cost refers to expenditures incurred by companies to manage the environmental impacts of their operational activities, such as land reclamation, waste management, environmental restoration, and environmental reporting (Kurniawan & Ismanto, 2025). Prior studies indicate that environmental costs are an essential component in assessing corporate sustainability and may affect firm profitability, particularly when such costs are not managed efficiently.

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In this study, environmental cost is measured using the provision for mine reclamation and mine closure disclosed in the statement of financial position of mining companies. To minimize scale differences across firms, the reclamation provision is normalized by total assets.

$$\text{Environmental Cost (EC)} = \frac{\text{Reclamation and Mine Closure Provision}}{\text{Total Assets}} \quad (2)$$

2.2.3 Firm Growth

Firm growth reflects a company's ability to expand its scale of operations or asset base over time. Corporate growth is commonly associated with business prospects, operational expansion, and potential improvements in operational performance, and it also plays a significant role in corporate financing decisions, including the use of long-term debt (Wibowo, 2021).
In this study, firm growth is measured using total asset growth, calculated as the difference between total assets in the current period and total assets in the previous period, divided by total assets in the previous period.

$$\text{Firm Growth (FG)} = \frac{\text{Total Assets}_t - \text{Total Assets}_{t-1}}{\text{Total Assets}_{t-1}} \quad (3)$$

2.2.4 EBITDA

EBITDA (Earnings Before Interest, Taxes, Depreciation, and Amortization) is a financial performance indicator that reflects a firm's ability to generate operating earnings before accounting for financing costs, taxation, and non-cash expenses (Maria-Gorretti, 2020). EBITDA is widely used to evaluate pure operational performance because it is less influenced by capital structure and accounting policies.
In this study, EBITDA is obtained directly from the annual financial statements of the sampled mining companies and is used as the dependent variable (Riska et al., 2024). To reduce scale differences across firms and enhance analytical consistency, EBITDA is normalized by total assets.

$$\text{EBITDA} = \frac{\text{Operating Income} + \text{Depreciation} + \text{Amortization}}{\text{Total Assets}} \quad (4)$$

Table 1. Operasional Variable

No	Variable	Variable Definition	Indicator / Proxy	Measurement Formula
1	Long Term Debt	The degree of dependence of mining companies on long-term financing used to fund assets and operational activities	Long-term liabilities	Long-Term Liabilities / Total Assets
2	Environtmental Cost	Environmental obligations of mining companies arising from natural resource exploitation activities, particularly related to land reclamation and mine closure	Reclamation and mine closure provision	Reclamation and Mine Closure Provision / Total Assets
3	Firm Growth	The rate of growth in the operational capacity and scale of mining companies over time	Total asset growth over time	(Total $Aset_t$ − Total $Aset_{t-1}$) / Total $Aset_{t-1}$
4	Ebitda	The ability of mining companies to generate operating earnings from core business activities before interest, taxes, depreciation, and amortization	Normalized EBITDA	(Operating Income + Depreciation + Amortization) / Total Assets

3. RESULTS AND DISCUSSION

3.1 RESULT

The Chow test is conducted to determine the most appropriate panel data regression model between the Common Effect Model (CEM) and the Fixed Effect Model (FEM). This test aims to identify whether there are significant differences in characteristics across cross-sectional units (companies).

Based on the results of the Chow test, the probability value of the cross-section F statistic is less than 0.05, indicating the presence of significant differences in characteristics among mining companies. Consequently, the Fixed Effect Model (FEM) is deemed more appropriate than the Common Effect Model.

This finding suggests that each mining company possesses unique characteristics that cannot be ignored, such as differences in management practices, firm size, technology adoption, and operational policies. By controlling for these unobserved, firm-specific effects, the Fixed Effect Model is able to provide more accurate and unbiased parameter estimates.

Therefore, the panel data regression model employed in this study is the Fixed Effect Model (FEM). This study aims to analyze the effects of long-term debt, environmental cost, and firm growth on EBITDA of mining companies in Indonesia using panel data regression with the Fixed Effect Model.

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Dependent Variable: EBITDA01
Method: Panel Least Squares
Date: 01/03/26 Time: 07:06
Sample: 2021 2024
Periods included: 4
Cross-sections included: 65
Total panel (balanced) observations: 260

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.505416	0.037613	13.43713	0.0000
LONG_TERM_DEBT01	-1.655919	0.195552	-8.467923	0.0000
ENVIRONTMENTAL_COST01	1.033983	0.175866	5.879389	0.0000
FIRM_GROWTH01	2.62E-10	1.68E-10	1.561424	0.1201

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.871942	Mean dependent var	0.482763
Adjusted R-squared	0.827255	S.D. dependent var	0.725389
S.E. of regression	0.301490	Akaike info criterion	0.659733
Sum squared resid	17.45212	Schwarz criterion	1.590989
Log likelihood	-17.76535	Hannan-Quinn criter.	1.034110
F-statistic	19.51226	Durbin-Watson stat	2.640127
Prob(F-statistic)	0.000000		

Figure 2. Fixed Effect Model (FEM)

This study aims to analyze the effect of Long-Term Debt, Environmental Cost, and Firm Growth on EBITDA in mining companies in Indonesia. The analysis employs panel data regression, as the research data comprise both a time-series dimension and a cross-sectional dimension across firms. To obtain the most appropriate estimation model, a model selection test is first conducted, followed by regression analysis, partial tests, simultaneous tests, and the coefficient of determination test.

3.3 Panel Data Regression Model Selection Test

The initial step in panel data regression analysis is to determine the most appropriate model between the Common Effect Model (CEM) and the Fixed Effect Model (FEM). This test is conducted using the Chow test. The results of the Chow test show a probability value of 0.000 (< 0.05); therefore, the null hypothesis stating that the Common Effect Model is more appropriate is rejected. Accordingly, it can be concluded that the Fixed Effect Model (FEM) is more suitable than the Common Effect Model.

The selection of the Fixed Effect Model indicates that there are significant differences in characteristics among mining companies that cannot be ignored. These differences may include firm size, management policies, cost structures, risk levels, and firm-specific operational strategies. Therefore, the use of the Fixed Effect Model is considered capable of providing more accurate estimates in explaining the influence of the independent variables on the EBITDA of mining companies in Indonesia.

3.3 Results of Panel Data Regression Estimation Using the Fixed Effect Model

Based on the results of the panel data regression estimation using the Fixed Effect Model (FEM), the following regression equation is obtained:

EBITDA = 0,505416 − 1,655919 (*Long Term Debt*) + 1,033983 (*Environmental Cost)* + 2,62E−10 (*Firm Growth*)

The regression equation shows the relationship between Long Term Debt, Environmental Cost, and Firm Growth on EBITDA by considering the fixed effects of each company. The constant value (C) of 0.505416 with a probability of 0.000 indicates that the constant is statistically significant at the 5% significance level. This means that if Long Term Debt, Environmental Cost, and Firm Growth are equal to zero, the EBITDA of mining companies is theoretically 0.505416 units. Although this condition is hypothetical and rarely occurs in practice, the constant value provides a basic illustration of the level of EBITDA that can be achieved without the influence of the independent variables included in the model.

The significant constant indicates that there are other factors outside the model that inherently affect the EBITDA of mining companies, such as management efficiency, human resource quality, production technology, and market conditions. Thus, the constant serves as a starting point in understanding the operational performance of mining companies.

The coefficient of Long Term Debt is -1.655919 with a probability of 0.000, indicating that this variable has a negative and significant effect on EBITDA. The negative coefficient value indicates that any increase in Long Term Debt will reduce the EBITDA of mining companies. This suggests that the financial burden arising from long-term

debt, such as interest expenses and principal repayment obligations, can suppress the company's operational performance. The negative effect of Long Term Debt on EBITDA indicates that the long-term financing structure in mining companies tends not to be optimally managed. Long-term debt is indeed required to support fixed asset investment and mine development; however, if it is not balanced with adequate operating cash flow capacity, such debt instead becomes a burden that pressures operational performance. In practice, mining companies often face periods of declining commodity prices that reduce revenues, while interest and principal repayment obligations remain fixed. This condition explains why an increase in Long Term Debt has a negative impact on EBITDA. In addition, the results of this study also indicate that mining companies in Indonesia tend to be more vulnerable to financial risk compared to other sectors. This is due to high fixed costs, dependence on limited natural resources, and environmental and social risks inherent in mining activities. Therefore, the results of this study provide a signal that long-term debt-based financing policies need to be adjusted to the risk characteristics of the industry so as not to sacrifice operational performance.

The coefficient of Environmental Cost is 1.033983 and is significant at the 5% significance level. This positive value indicates that an increase in environmental costs actually contributes to an increase in EBITDA. This finding indicates that environmental expenditures are not merely a burden, but can function as an investment that supports increased operational efficiency, reduced environmental risk, and enhanced stakeholder trust. The results of this study show that for mining companies, environmental expenditures can become a source of competitive advantage. Effectively allocated environmental costs can improve production process efficiency, reduce the potential for operational disruptions due to social conflicts, and lower the risk of environmental sanctions and fines.

In the Indonesian context, mining companies with a high commitment to environmental management tend to find it easier to obtain operating permits and gain support from local governments and surrounding communities. This has a positive impact on business continuity and revenue stability. Therefore, the positive effect of Environmental Cost on EBITDA reflects that environmental sustainability and operational performance are not mutually exclusive objectives, but rather can reinforce each other.

Meanwhile, the coefficient of Firm Growth is 2.62E-10 with a probability of 0.1201, meaning it is not statistically significant. This indicates that firm growth does not have a direct effect on the EBITDA of mining companies during the research period. In other words, an increase in firm growth is not necessarily followed by an increase in operational performance in the short term. The insignificant effect of Firm Growth on EBITDA indicates that company growth does not automatically improve operational performance. Growth measured through asset increases or business expansion often requires a relatively long time before making a real contribution to operating profits. In the early stages of growth, companies instead face increased exploration costs, infrastructure development costs, and asset maintenance costs, which can suppress EBITDA in the short term. This finding indicates that growth in mining companies has a lagging effect, where its impact on operational performance will only be visible after investment projects reach the optimal production stage. Therefore, the results of this study emphasize the importance of distinguishing between short-term growth and short-term operational performance in financial analysis of mining companies.

3.4 Partial Test Results (t-test)

The t-test is conducted to determine the partial effect of each independent variable on EBITDA. The t-test results show that Long Term Debt has a t-statistic value of -8.467923 with a probability of $0.000 < 0.05$, so it can be concluded that Long Term Debt has a negative and significant effect on EBITDA. This result indicates that the greater the long-term debt owned by mining companies, the greater the financial burden that must be borne. This burden ultimately suppresses the company's ability to generate operating profits.

This finding is consistent with capital structure theory, particularly the trade-off theory, which states that excessive use of debt can increase financial risk and reduce company profitability. In the context of mining companies that have high business risk and commodity price fluctuations, uncontrolled use of long-term debt can worsen operational performance.

The t-test results for Environmental Cost show a t-statistic value of 5.879389 with a probability of $0.000 < 0.05$, so it can be concluded that Environmental Cost has a positive and significant effect on EBITDA. This result indicates that environmental expenditures do not always constitute a burden that reduces profits, but can become a long-term investment that improves operational performance.

In the context of mining companies, compliance with environmental regulations, waste management, and reclamation activities can increase production efficiency, reduce potential social conflicts, and strengthen corporate legitimacy in the eyes of society and regulators. This condition ultimately contributes to an increase in EBITDA.

The t-test results for Firm Growth show a t-statistic value of 1.561424 with a probability of $0.1201 > 0.05$, so it can be concluded that Firm Growth does not have a significant effect on EBITDA. This indicates that company growth is not always followed by an increase in EBITDA, especially in the mining sector, which requires large investments and has long payback periods.

Asset or sales growth in mining companies is often accompanied by increased operating costs, maintenance costs, and financing costs. Therefore, the benefits of company growth can only be realized in the long term and are not immediately reflected in short-term operational performance.

3.5 Simultaneous Test Results (F-test)

The F-test is conducted to determine the simultaneous effect of independent variables on the dependent variable. Based on the regression results, the Prob(F-statistic) value is 0.000 < 0.05, indicating that Long Term Debt, Environmental Cost, and Firm Growth simultaneously have a significant effect on EBITDA. The F-test in this study is used to determine whether Long Term Debt, Environmental Cost, and Firm Growth simultaneously affect the EBITDA of mining companies in Indonesia. Based on the results of panel data regression estimation using the Fixed Effect Model (FEM), the Prob(F-statistic) value is 0.000, which is smaller than the 5% significance level (0.05). Thus, it can be concluded that the regression model used is statistically significant, meaning that all independent variables jointly influence EBITDA.

The results of this F-test indicate that the operational performance of mining companies is not influenced by a single factor, but rather is the result of interactions between long-term financing policies, environmental cost management, and firm growth strategies. Although partially Firm Growth does not have a significant effect, its presence in the model still contributes to variations in EBITDA when combined with other variables. This confirms that simultaneous analysis is important in understanding the dynamics of operational performance in capital-intensive and complex mining companies.

The significant F-test result also indicates that the research model has been well formulated and is feasible to be used as a basis for analysis. Therefore, the results of this study can provide an empirical contribution in explaining the factors affecting EBITDA and serve as a strong foundation for managerial decision-making and future research development in the mining sector.

3.6 Coefficient of Determination (R-Squared)

The R-squared value of 0.871942 indicates that 87.19% of the variation in EBITDA of mining companies in Indonesia can be explained by Long Term Debt, Environmental Cost, and Firm Growth. Meanwhile, the remaining 12.81% of EBITDA variation is explained by other factors outside the research model, such as global commodity prices, macroeconomic conditions, management efficiency, production technology, and government policies.

This high coefficient of determination indicates that the model has very strong explanatory power. Thus, the results of this study can be used as a reliable basis for managerial decision-making, investment analysis, and the development of further research in the fields of finance and accounting in the mining sector. The high R-squared value indicates that the panel data regression model used has a very strong ability to explain the dependent variable. In other words, the combination of the three independent variables constitutes the dominant factors influencing the operational performance of mining companies as measured by EBITDA.

The high coefficient of determination also indicates that the selection of the Fixed Effect Model (FEM) is appropriate in capturing differences in characteristics among mining companies. FEM is able to accommodate firm heterogeneity, such as differences in business scale, asset structure, operational efficiency levels, and mine location characteristics, which cannot be directly observed but affect EBITDA. Therefore, this model provides more accurate estimates compared to the common effect model.

Although the R-squared value is very high, there is still 12.81% of EBITDA variation explained by other factors outside the research model. These factors may include global commodity prices, operational efficiency, management quality, production technology, government policies, and macroeconomic conditions. This opens opportunities for future research to include additional variables so that modeling the operational performance of mining companies becomes more comprehensive.

4. CONCLUSION

This study aims to analyze the effects of long-term debt, environmental cost, and firm growth on EBITDA of mining companies in Indonesia using panel data regression with the Fixed Effect Model (FEM). The results show that, simultaneously, the three independent variables have a significant effect on EBITDA, indicating that the operational performance of mining companies is influenced by a combination of financing policies, environmental cost management, and firm growth strategies. Partially, long-term debt has a negative and significant effect on EBITDA, indicating that an increase in long-term debt usage tends to suppress operational performance due to higher financial burdens and increased business risk. In contrast, environmental cost has a positive and significant effect on EBITDA, indicating that environmental expenditures constitute a strategic investment that can improve operational efficiency, strengthen corporate legitimacy, and support the sustainability of mining company performance. Meanwhile, firm growth does not have a significant effect on EBITDA, indicating that company growth does not necessarily provide a direct impact on short-term operational performance, particularly in the capital-intensive mining industry. This study has limitations as it focuses only on the mining sector and employs limited variables, without considering external factors such as commodity prices, macroeconomic conditions, and corporate governance quality. Therefore, future research is recommended to expand sectoral coverage, incorporate additional relevant variables, and use alternative performance proxies to obtain more comprehensive results.

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