



Dynamics Of Average Cost Of Capital (Wacc) In Mining Companies ASEAN Exchange: Commodity Perspective And Economic Changes Due To The Covid-19 Pandemic

Umar Rivaldy Pulukadang ¹, Dewi Hanggraeni ²

¹Program Studi Manajemen Fakultas Ekonomi dan Bisnis, Universitas Indonesia, Indonesia

² Program Studi Manajemen Fakultas Ekonomi dan Bisnis, Universitas Indonesia, Indonesia

Email: ¹ rifaldipulukadang@outlook.com ;² dewi.hanggraeni@ui.ac.id

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WACC, Systematic Risk, Cost of Capital, Expected Rate of Return, Mining Companies, ASEAN EXCHANGE, COVID-19.

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ABSTRAK

This study analyzes the dynamics of systematic risk (Beta), expected rate of return (Ke), and Weighted Average Cost of Capital (WACC) in 108 mining companies in ASEAN EXCHANGE, comparing the pre-COVID-19 period (2017–2019) and Post-COVID-19 (2020–2022). This study uses quantitative analysis to examine the effects of commodity classification and exchange location (ExchangeCode), including ANOVA and ANCOVA. The results show high Beta variability. Although the average sector Beta increases post-pandemic, the change between periods is not statistically significant at the firm level. ExchangeCode is consistently a substantial determinant of Beta, while Commodity and Status are generally insignificant. Aggregate expected returns (Ke) increase moderately post-COVID, with varying trends across commodities. Beta is shown to be the dominant predictor of Ke, followed by ExchangeCode, which has a significant effect, while other factors have little impact in the ANCOVA model. The average sector WACC decreases slightly post-COVID, likely due to loose monetary policy, but significant variation across exchanges remains (e.g., high IDX, low SGX). The effects of exchange Code, Commodity, and Status on WACC are statistically proven to be small. In conclusion, exchange location and systematic risk (Beta) are crucial factors that influence the cost of equity capital and risk profile of ASEAN mining companies, which are more dominant than commodity type or uniform impact of the pandemic. Changes in WACC are more macroeconomic, but the effect is heterogeneous across markets.

INTRODUCTION

Post-COVID-19 pandemic, there is an increase in market demand for mineral and coal mining products and their derivatives. This increase in demand also contributes significantly to countries in the ASEAN region that have rich mining resources (Firdaus et al., 2020). The ASEAN Minerals Cooperation Action Plan (AMCAP) estimates that demand for mining products and their derivatives in the ASEAN region will increase amidst global risks (ASEAN, 2022).

Several countries in the ASEAN region have experienced a surge in economic activity in the mining sector following the impact of the COVID-19 pandemic. Subside. The ASEAN EXCHANGE group, which includes Indonesia, Malaysia, Thailand, the Philippines, Singapore, and Vietnam, is rapidly growing (Adrian et al., 2022). In 2022, the Asian Development Bank (ADB) disbursed these six countries \$6 billion in funds. In detail, \$5 billion was allocated as government-insured loans, while \$1 billion came from unsecured private investment (Asian Development Bank, 2022). This phenomenon is directly proportional to the increase in the stock prices of mining companies on the IHSG (Composite Stock Price Index) and other ASEAN Stock Exchanges. However, this is also accompanied by market volatility, thus affecting the mining company's level of risk. The Committee for Mineral Reserve International Reporting Standards (CRISCO) provides a classification based on the factors of mining commodity and geological, economic, and industrial characteristics. Where the classification consists of metal mineral commodities, non-metallic minerals, and coal (MAULANI, 2022). the dynamics of the stock price of each mining company will vary, mainly if classified by commodity. In 2020-2022, mining companies with coal commodities tended to experience higher stock price increases than mineral mining companies (Budiman et al., 2023; Ekadjaja, 2023; Ramadhan & Munawaroh, 2022). This indicates that mining companies have different levels of risk, one of which is influenced by the type of mining commodity (Baur, 2014). Risks in the commodity market can be classified as Systematic Risks. A systematic risk factor is the risk of securities that influence the entire market or a particular market segment so that it cannot be eliminated by forming a diversified portfolio. Systematic Risk is external; that is, it occurs due to factors outside the company. The beta coefficient of stocks is the most effective tool for finding Systematic risk (Aguita, 2021; Asmarawati et al., 2022; Tendean, 2022).

Beta is a financial parameter that measures the volatility of a stock against a market. This is because beta can be an indicator in the form of a company's unique risk (Jain, 2022). Generally, a larger beta value has bigger volatility, giving investors potential risk and bigger profit. Companies with smaller beta tend to have lower volatility and smaller profits. The CAPM (Capital Asset Pricing Model) formula states that the expected return from an investment equals the risk-free rate of return plus the market risk premium multiplied by beta. By knowing the beta comparison of each company that has different commodities in the mining industry, investors can be more selective in considering investment plans in the mining industry. In addition, the beta value of each classification of coal, metal, and non-metal mining commodities can be applied in the WACC calculation to calculate the mining model's financial plan for companies not listed on the stock exchange or limited liability companies (Private Equity). Research on the Weighted Average Cost of Capital (WACC) has been widely conducted in the context of corporate financial analysis, both nationally and internationally. A study by (Kamela, 2021) shows that WACC is an important indicator in investment decision-making and assessing company value. Meanwhile, (Rahmadini, 2024) underlines that macroeconomic fluctuations and commodity price volatility can affect the components of the cost of capital, especially the cost of debt and the cost of equity. In the mining industry, several studies have highlighted the impact of global commodity prices on firm value and business risk. Research by (Rahmah, 2024) found that the mining sector is very sensitive to movements in commodity prices such as coal, copper, and precious metals, which in turn impact capital structure and WACC. Another study by (Umar et al., 2023) showed that global economic instability triggered significant changes in the capital cost structure of commodity-based companies. However, there are still limited studies that specifically examine the dynamics of WACC in mining companies listed on ASEAN stock exchanges about economic changes due to the COVID-19 pandemic. This pandemic has put tremendous pressure on the

real sector, causing supply chain disruptions, market volatility, and changes in fiscal/monetary policies that affect the investment climate and business risks.

LITERATURE REVIEW

Correlation of Systematic risk (Beta) to CAPM (*Capital Asset Pricing Model*)

In financial theory, the Capital Asset Pricing Model (CAPM) determines an asset's expected return based on its systematic risk, which cannot be verified by diversification. One of the main components of the CAPM is beta (β), which measures a stock or portfolio's systematic risk relative to the market as a whole. CAPM is formulated as:

$$K_{and} = R_f + b \times (R_m - R_f)$$

- K_{and} is the expected return on an asset.
- R_f is the risk-free rate of return, such as government bonds.
- b is beta which is in the form of β .
- $(R_m - R_f)$ is the market risk premium.

CAPM states that the expected return on an asset is a function of the risk-free return plus an expected return premium to compensate for the additional risk of the asset compared to the market (Galagedera, 2007).

Systematic risk correlation (Beta) to WACC (*Weighted Average Cost of Capital*)

WACC (*Weighted Average Cost of Capital*) is a weighted average of the expected payment of a cost through equity, debt, and preferred stock components if potential, where this reflects the return expectations of investors and creditors towards the company. WACC has a significant role in the company's finances because there is one component in discounted *cash flow* (DCF), namely discount *rate* in the valuation method and comparison to WACC. WACC reflects the minimum rate of return of a project or investment, which must meet the expectations of investors and creditors from the funds planned to be issued or that have been realized. In addition, WACC functions as a strategic parameter in making financial decisions, influencing financing and investment plans, and optimizing financing structures. From a risk management perspective, a company's WACC also reflects market perceptions of its profile. Systematic risk because there are components β (Beta) in the form of a Systematic risk value in the WACC calculation. An increase in the beta value risk will directly increase the WACC and reduce the attractiveness of investment planning regarding the level of return on the company's plan. The WACC optimization process can support the company's valuation and be the basis for long-term financial decisions (Vo & Nguyen, 2021). The calculation to obtain the WACC value is as follows:

$$WACC = \left(\frac{AND}{V} \times K_{AND} \right) + \left(\frac{D}{V} \times K_D \times (1 - T_c) \right)$$

- AND is the market value of equity (*market value of equity*),
- D is the market value liability (*market value of debt*),
- V is the accumulation of value in equity and liability (total company capital) which can be formulated as; $V = E + D$,
- K_{AND} is the value of the cost of equity (*equity cost*)
- K_D is the cost of debt (*cost of debt*)
- T_c corporate tax value (*corporate tax*)

The correlation of beta to WACC is found in one of the calculation components, namely (*Equity Cost*). The basis of this calculation comes from calculating the rate of return using

the CAPM formula (*Capital Asset Pricing Model*). This matters because of formula there is a systematic risk component (***b***) where the formula is as follows:

$$K_{and} = R_f + b \times (R_m - R_f)$$

where:

- ***K_{and}*** is the expected return on an asset.
- ***R_f*** is the risk-free rate of return, such as government bonds.
- ***b*** is beta which is in the form of valueriskSystematic.
- ***(R_m-R_f)*** is the market risk premium.

Implications of increased Systematic risk (*b*) can affect increasing the expected level of return on equity (*K_{and}*). A larger WACC provides increased risk to investors and will justify the level of return on investment for the company or project. As a result, companies with a much larger beta will have more competitive challenges regarding investment acceptance or attractiveness from investors, especially in conditions of market uncertainty (Franc-Dabrowska et al., 2021).

Beta Correlation to Capital Market

Beta for commodities measures the sensitivity of commodity prices to changes in the overall market or a specific index (Hong & Sarkar, 2008). Unlike equities, where the S&P 500 is often used as a standard benchmark for calculating beta, commodities do not have a universal benchmark. This variability arises from differences in volatility and the driving factors that affect commodities, such as oil, gold, or industrial metals. The complexity of commodity betas arises because commodities, especially metals and energy, exhibit significant price fluctuations due to supply and demand dynamics. The beta of a commodity reflects how sensitive the price of the commodity is to market movements (Blöse & Shieh, 1995). For example, in gold mining stocks, beta tends to be higher than 1, indicating sensitivity to gold price fluctuations.

Studies show that gold mining stocks often have a gold beta greater than one, meaning that the stock prices of these companies are highly responsive to changes in gold prices ((Baur, 2014). Similarly, in industrial metals, beta varies by commodity, with factors such as production costs and supply chains affecting beta (Enslin et al., 2018; Lazzarino et al., 2022). The stock performance of commodity companies varies widely depending on the commodity type. For precious metals such as gold, stock prices tend to be more volatile in response to price changes due to gold's dual role as a commodity and a financial asset (Baranowski & Pera, 2023). While price sensitivity remains high for industrial metals such as copper and aluminum, broader economic indicators, such as industrial demand, play a significant role (Lazzarino et al., 2022). In the energy sector, oil and coal prices directly affect stock prices, especially during periods of high volatility (Talbot et al., 2013). During crises or periods of high economic uncertainty, commodity prices, mining company stocks, and overall market risk dynamics change significantly. For example, the 2007–2008 financial crisis showed how commodity prices, especially gold and energy, experienced sharp volatility (Creti et al., 2013). Gold, in particular, acted as a haven asset, while companies engaged in industrial metals and energy commodities showed price behavior that was more influenced by market dynamics than commodity price dynamics (Enslin et al., 2018; Lazzarino et al., 2022).

METHODS

This study will use a quantitative approach to determine the dynamics of mining companies with different commodity classifications during pre- and post-COVID-19 pandemic conditions. The analysis will use data on stock price movements and indexes on the stock exchange in certain periods, as well as macro data from each country of origin of the exchange and the company. The population for this study includes all mining companies that are still listed on all stock exchanges in the "ASEAN EXCHANGE" countries, namely IDX, KLSE, SGX, SET, HOSE, HNX, HNX - UPCoM, and PSE, with a specific period. The samples used include mining companies

that produce metal mineral commodities, non-metallic minerals, and coal. Companies that have diversification of more than one mining commodity will be grouped into the multi-commodity company group. The sample is also classified according to the mining company, which consists of owners, contractors, or both/combinations. The study collected 148 samples and filtered 40 into 108 that could be used in the analysis. The 40 filtered samples consisted of 19 companies listed outside the research period (more than 2022), 19 without complete financial reports, and one company delisting within the specified research period. The 108 samples are mining companies with complete financial reports on the ASEAN stock exchange.

EXCHANGE each before the specified research period. The number of samples from each exchange consists of IDX (*Indonesian Stock Exchange*) as many as 29 samples, KLSE (*Kuala Lumpur Stock Exchange*) as many as 11 samples, SGX (*Singapore Stock Exchange*) as many as 4 samples, SET (*Stock Exchange of Thailand*) as many as 4 samples, HOSE (*Ho Chi Minh Stock Exchange*) as much as 10 samples, HNX (*Hanoi Stock Exchange*) as many as 13 samples, UPCoM – HNX (*Unlisted Public Company Market – Hanoi Stock Exchange*) as many as 15 samples, and PSE (*Philippine Stock Exchange*) as much as 22 samples.

RESULTS

Beta Dynamics of "ASEAN EXCHANGE" Mining Companies in Various Scenario Period (For COVID-19, Pre COVID 19, and Period Combination)

Table 1. Summary Results of ANOVA Calculation of Variables Independent (Commodity, Status, and Exchange Code) Against Beta Various Scenarios

Main Effects / Interactions	Df	F (For)	p (For)	η^2 (Pra)	F (Post)
Commodity	3	1.01	0.39	0.04	0.17
Status	2	0.75	0.48	0.02	0.04
Exchange Code	7	2.57	0.020 *	0.2	1.92
Commodity:Status	6	0.26	0.95	0.02	0.35
Commodity:ExchangeCode	10	0.91	0.53	0.11	0.29
Status: CodeBursa	5	0.41	0.84	0.03	0.05

Main Effects / Interactions	p (Post)	η^2 (Post)	F (Overall)	p (Overall)	η^2 (Overall)
Commodity	0.916	0.007	0.05	0.987	0.002
Status	0.965	0.001	0.1	0.9	0.003
Exchange Code	0.079.	0.15	1.99	0.067.	0.16
Commodity:Status	0.91	0.03	0.19	0.977	0.02
Commodity:ExchangeCode	0.981	0.04	0.25	0.989	0.03
Status: CodeBursa	0.999	0.003	0.06	0.998	0.004

- *Significant At $\alpha = 0.05$
- . Marginal significant at $\alpha = 0.10$

Based on the post-hoc test valid for 'Kodi Bursa' because the main effect is significant at Beta_For ($p=0.020$) and marginally significant in Beta_Post ($p=0.079$) and Beta_Overall ($p=0.067$). This indicates that there are differences in the average Betas across exchanges. In contrast, 'Commodity' (all $p>0.39$) and 'Status' (all $p>0.48$) do not show significant effects in the ANOVA. Therefore, there is no sufficient statistical basis for further post-hoc tests on these two variables, as no overall group mean differences were detected.

Table 2. Summary Results of ANOVA Calculation of Variables Independent (Commodity, Status, and Exchange Code) Against Beta Various Scenarios

Results Turkey HSD on Beta_For, Post Beta, and Overall Beta

Period	Exchange Comparison	Average Difference (diff)	LCI 95%	UCI 95%	p adj	Information
For	IDX - HNX	1.117	0.199	2.035	0.007	Significant*
Post	KLSE - HNX	1.017	0.0316	2.003	0.038	Significant*
Post	SGX - KLSE	-1.292	-2.697	0.112	0.095	Significant Marginal
Overall	KLSE - HNX	0.938	0.0551	1.82	0.029	Significant*
Tukey HSD Summary Significant/Marginal Across Periods (p adj<0.1)						
Exchange Comparison	Period Beta	Average Difference (diff)	p adj	Information		
IDX - HNX	Beta_For	1.117	0.007	Significant*		
KLSE - HNX	Beta_Post	1.017	0.038	Significant*		
SGX - KLSE	Beta_Post	-1.292	0.095	Significant Marginal		
KLSE - HNX	Beta_Overall	0.938	0.029	Significant*		

The results of the ANOVA analysis in Table 3 repeated measures show that although the main effect of Period on Beta_Value initially appeared significant ($p=0.049$), Sphericity Test Mauchly revealed a highly significant violation of the sphericity assumption ($p=1.14e-102$). This violation requires the use of a corrected p-value. After collection Greenhouse-Geisser and Huynh-Feldt, the corrected p-value for the Period effect is 0.083. Since this corrected p-value is greater than the standard significance level of 0.05, it is concluded that there is no difference in the means of Beta_Value which is statistically significant across the three measurement periods (Beta_Pre, Beta_Post, Beta_Overall). This conclusion is supported by the tiny effect size ($ges = 0.007$), indicating that the Period factor only explains 0.7% of the variance in Beta_Value, showing minimal practical impact.

Table 3. Main ANOVA Results of Period Effect, Sphericity Test, and Sphericity Correction Variable "KodeBursa" against Beta various period scenarios

Main ANOVA Results of Period Effect							
Effect	DF	DFd	F-value	p-value (uncorrected)	Signif. ($p<.05$)	ges (Generalized Eta Squared)	Eta
Period	2	212	3.06	0.049	*	0.007	
Sphericity Test Results							
Effect	In (Statistic Mauchly)			p-value	Signif. ($p<.05$)		
Period	0.011			1.14E-102	*		
Results Correct Sphericity							
Effect	GGe(ϵ)	DF [GG]	p-value [GG]	Signif. $p[GG]<.05$	HFe (ϵ)	DF [HF]	p-value [HF]
Period	0.503	1.01, 106.61	0.083		0.503	1.01, 106.63	0.083

Expected Rate of Return (Ke) of "ASEAN EXCHANGE" Mining Companies for Each Commodity in Various Periods (Pre COVID-19, Post COVID-19, and PeriodCombination)

The ANOVA calculations show that exchange Code (listing place) consistently remains the most statistically significant factor and explains the most considerable portion of the variance in

expected returns (Ke) across all three analysis periods. Although Commodity does not reach formal statistical significance levels ($p > 0.05$) across all periods, the data indicate that commodity type still explains a small portion of the variance in Ke, especially in the pre-COVID-19 period ($\eta^2 \approx 0.06$). However, its contribution is much lower compared to the exchange Code. Variables Status No Shows a significant effect. It is crucial to emphasize that all these findings, including the minor role of Commodity and the dominance of KodeBursa, should be interpreted with great caution because previous diagnostic analyses have suggested violations of the basic assumptions of ANOVA (normality and homogeneity of variance), which could influence the validity and precision of these statistical conclusions."

Table 4. Results of ANOVA Calculation of Independent Variables Expectation Rate of Return (To) On Various Period Scenarios (Pre Covid-19, Post Covid-19, and Period Combination)

Results of ANOVA Calculation of Independent Variables on Factors Against "To_Pra" (For Covid-19)

Source of Variation	Sum Sq	Df	F Value	Pr(>F)	Significant
(Intercept)	0.01378	1	20.2391	1.93E-05	***
Commodity	0.003959	3	1.9382	0.128645	
Exchange Code	0.017637	7	3.7005	0.001399	**
Status	0.002487	2	1.8263	0.166614	
Residuals	0.064684	95			

Results of ANOVA Calculation of Independent Variables on Factors Against "To_Pasca" (Post Covid-19)

Source of Variation	Sum Sq	Df	F Value	Pr(>F)	Significant
(Intercept)	0.013289	1	19.2739	2.94E-05	***
Commodity	0.00003	3	0.0144	0.997616	
Exchange Code	0.019391	7	4.0178	0.000681	***
Status	0.000893	2	0.6478	0.525486	
Residuals	0.065499	95			

ANOVA Calculation Results Dependent variable factor on "The_Overall" (Combined period)

Source of Variation	Sum Sq	Df	F Value	Pr(>F)	Significant
(Intercept)	0.015292	1	28.9394	5.35E-07	***
Commodity	0.000314	3	0.1981	0.897423	
Exchange Code	0.015859	7	4.2873	0.00037	***
Status	0.000872	2	0.8254	0.441183	
Residuals	0.050201	95			

In Table 5, Exchange Code (stock listing) consistently shows a "medium to large" effect size (η^2 between 0.19 and 0.24) on expected returns (Ke) across all three periods. This means the Exchange Code explains the proportion of variance most substantial on Ke. In contrast, Commodity (η^2 0.01-0.06) and Status (η^2 0.01-0.04) only show "small" effect sizes, implying a much more minor contribution in explaining the variation in Ke.

Table 5. Partial Eta Results of ANOVA Calculation of Variables Independent Expectation Rate of Return (Ke) in Various Period Scenarios (Pre Covid-19, Post Covid-19, and Period Combination)

Parameter	To_Pra	To_Pasca	The_Overall	Interpretation Strength (Cohen)
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Parameter	To_Pra	To_Pasca	The_Overall	InterpretationStrength (Cohen)
Commodity	0.06	0.02	0.01	Small
Exchange Code	0.19	0.24	0.24	Currently to big
Status	0.04	0.01	0.02	Small

The results of the ANCOVA table 6 and the diagnostic plot show that the Beta variable consistently becomes a highly significant predictor of expected returns (Ke) across all three analysis periods, with Partial Eta² values above 0.65. This means that more than 65% of the variance in Ke is explained by changes in Beta, indicating the dominance of systematic risk as the main factor driving expected returns. Meanwhile, the variable Exchange Code shows minor to moderate significance (Partial Eta² between 0.15 -- 0.37), implying that the location of stock listing also influences, although its impact is not as significant as Beta. On the other hand, Stock Price, Status, and Commodity are statistically insignificant and have minimal partial effect values, indicating that they do not contribute significantly to explaining the variation in Ke.

Table 6 Summary Results of ANCOVA Expected Rate of Return (To) on various period scenarios (Pre Covid-19, Post Covid-19, and PeriodCombination)

No	Dependent Variable	Term	Df	Sum Sq	F Value	p Value	Partial Eta ²	Information
1	Ke_Overall_boxcox	(Intercept)	1	5.0352	10573.681	0	N/A	N/A
2	Ke_Overall_boxcox	Beta_Overall	1	0.095	199.4222	0	0.7296	Very Significant
3	Ke_Overall_boxcox	Exchange Code	7	0.0215	6.4542	0	0.3477	Significantly Small
4	Ke_Overall_boxcox	HargaSaham_Overall	1	0.0003	0.6623	0.4178	0.0534	Not Significant
5	Ke_Overall_boxcox	Status	2	0.0002	0.2193	0.8035	0.0047	Not Significant
6	Ke_Overall_boxcox	Commodity	3	0	0.0014	0.9999	0.0055	Not Significant
7	Ke_Overall_boxcox	Residuals	93	0.0443	N/A	N/A	N/A	N/A
8	Post_Boxcox	(Intercept)	1	5.0331	8846.643	0	N/A	N/A
9	Post_Boxcox	Beta_Post	1	0.1306	229.5647	0	0.7522	Very Significant
10	Post_Boxcox	Exchange Code	7	0.0285	7.1549	0	0.3764	Significantly Small
11	Post_Boxcox	StockPrice_Post	1	0.0002	0.4232	0.5169	0.0871	Not Significant
12	Post_Boxcox	Status	2	0.0001	0.1163	0.8903	0.0025	Not Significant
13	Post_Boxcox	Commodity	3	0.0003	0.1697	0.9166	0.0047	Not Significant
14	Post_Boxcox	Residuals	93	0.0529	N/A	N/A	N/A	N/A
15	To_Pra_boxcox	(Intercept)	1	0.0107	36.5692	0	N/A	N/A
16	To_Pra_boxcox	Beta_For	1	0.0374	127.7374	0	0.6569	Very Significant
17	To_Pra_boxcox	Exchange Code	7	0.0053	2.5766	0.0179	0.1591	Significantly Small
18	To_Pra_boxcox	Commodity	3	0.0011	1.2917	0.282	0.0623	Not Significant
19	To_Pra_boxcox	HargaSaham_Pra	1	0.0001	0.2061	0.6509	0.0034	Not Significant
20	To_Pra_boxcox	Status	2	0.0002	0.3129	0.7321	0.0067	Not Significant
21	To_Pra_boxcox	Residuals	93	0.0273	N/A	N/A	N/A	N/A

Weighted Average Capital Cost (WACC) of ASEAN EXCHANGE Mining Companies for Each Commodity in the Post-COVID-19 Period (January 2020 – December 2022)

Table 7 shows that mining companies' average combined Weighted Average Cost of Capital (WACC) on ASEAN exchanges decreased from 6.916% pre-COVID to 6.589% post-COVID (January 2020 – December 2022). This aggregate decline likely reflects the dominance of very loose global and regional monetary policies and a low interest rate era during most of the pandemic, which depressed the cost of capital components despite market volatility. Almost all exchanges showed a downward trend in WACC, with SGX, SET, and HNX experiencing the sharpest declines. However, HOSE (Vietnam) was a significant exception with an increase in WACC, possibly indicating specific market risk factors or different capital demand dynamics amid Vietnam's relatively strong economic growth. This variation highlights the heterogeneous response of ASEAN capital markets to drastically changing global economic and policy conditions.

Table 7. Average Cost of Capital Distribution (WACC) Sample pool on all commodities in various period scenarios (Pre COVID 19, Post Covid 19, and PeriodCombination)

Stock Exchange	Beta For	Post Beta	Beta Overall
Indonesia Stock Exchange (IDX)	7.933%	7.682%	7.785%
Bursa Malaysia (KLSE)	6.134%	5.976%	6.403%
Singapore Exchange (SGX)	5.551%	3.907%	4.227%
BursaEffect Thailand (SET)	7.470%	6.207%	6.551%
Bursa Ho Chi Minh (HOSE)	7.104%	8.639%	8.223%
Hanoi Stock Exchange (HNX)	7.184%	5.666%	6.183%
Bursa Efek UpCOM (UpCOM)	6.672%	6.593%	6.618%
Philiphine Stock Exchange (PSE)	6.115%	5.650%	5.802%
Overall Average	6.916%	6.589%	6.738%

Figure 1 shows the histogram of the distribution of mining companies weighted average cost of capital (WACC) on ASEAN exchanges before and after the COVID-19 pandemic. All three histograms show a near-normal distribution pattern, with a 6–7% peak and a slight shift between pre- and post-pandemic, indicating a decline in the aggregate WACC. This is in line with the monetary relaxation policies that were in place during the pandemic. There is no visual evidence of a drastic change in the distribution structure, reinforcing the finding that the WACC of the mining sector in ASEAN tends to be stable in the face of global economic disruption.

Figure 1. WACC Distribution Chart of ASEAN EXCHANGE Mining Companies against various period scenarios (Pre COVID-19, Post COVID-19, and Future Periods)Combination)

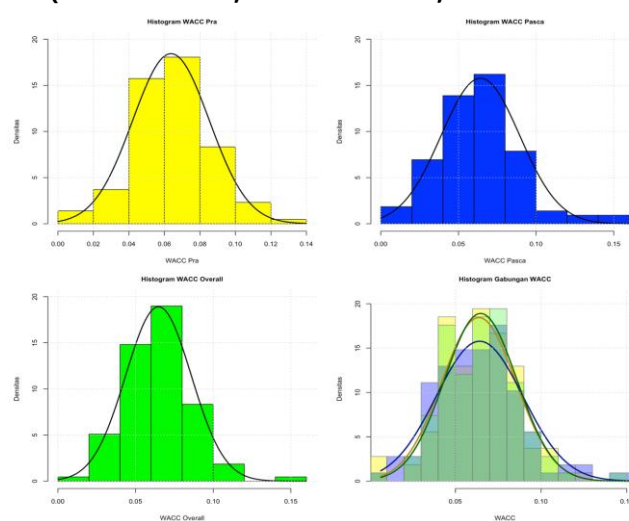


Table 8 shows that the weighted average cost of capital (WACC) of mining companies in ASEAN slightly declined from 7.32% in the pre-COVID period to 7.09% post-COVID before slightly increasing again to 7.50% for the combined period. Despite moderate fluctuations, the WACC distribution remains stable with a decreasing standard deviation in the combined period. The skewness values indicate a distribution close to symmetric, especially before the pandemic, with a slight positive skew post-COVID.

Table 8. The results of the distribution of the Average Cost of Capital (WACC) in various periods (ForCovid 19, Post Covid 19, andCombination Period)

Statistics	WACC_Pra	WACC_Post	WACC_Overall
Mean (Rate-rate)	0.07322	0.07087	0.07501

Standard Deviation	0.02787	0.03359	0.02375
Skewness	0.03413	0.58741	0.32094

Table 9 shows the distribution of WACC of mining companies in ASEAN in the pre-COVID-19 period based on commodities, stock exchanges, and ownership status. In general, companies with MULTI commodities have the highest average WACC (6.82%), followed by COAL (6.47%), MM (6.37%), and NMM (5.94%). This indicates that commodity diversification is followed by higher capital cost expectations, possibly due to operational complexity and diverse sector risks. Based on stock exchanges, IDX recorded the highest WACC (7.81%) with a low deviation, indicating high but stable capital risk in Indonesia. In contrast, HNX and SGX had lower WACC (~5.5%), reflecting more moderate risk perceptions. Regarding status, OWNER companies had the highest WACC (6.72%), which could be due to higher growth expectations or leverage. This pattern supports previous findings that geographical and structural differences in companies influence capital cost profiles significantly.

Table 9. Descriptive Results of Average Cost of Capital (WACC) Statistics by “Commodity”, “Exchange Code”, and “Status” in the Pre-COVID-19 period

Based on the Independent Variable of the “Commodity” Factor

Commodity	Number of Observations	Round-the-clock WACC	StDev WACC	Median WACC	Min WACC	Max WACC
COAL	24	0.0647	0.0218	0.066	0.0065	0.1014
MM	33	0.0637	0.0213	0.0653	0.0099	0.1043
MULTI	22	0.0682	0.0176	0.0684	0.0399	0.113
NMM	29	0.0594	0.0248	0.058	0.008	0.1275

Based on Variables Independent Factor “Exchange Code”

Exchange Code	Number of Observations	Round-the-clock WACC	StDev WACC	Median WACC	Min WACC	Max WACC
HNX	13	0.0558	0.02	0.0508	0.0268	0.1055
HOSE	10	0.0613	0.0186	0.0616	0.0389	0.1043
IDX	29	0.0781	0.0106	0.0785	0.0631	0.1031
KLSE	11	0.0586	0.0297	0.0503	0.0309	0.1275
WHY	22	0.0592	0.0168	0.0622	0.0099	0.0871
SET	4	0.0576	0.0422	0.0614	0.0065	0.1014
SGX	4	0.0555	0.0128	0.0502	0.0472	0.0746
UPCoM-HNX	15	0.0585	0.0268	0.0591	0.008	0.113

Based on the Independent Variable “Status” Factor

Status	Number of Observations	Round-the-clock WACC	StDev WACC	Median WACC	Min WACC	Max WACC
MULTI	15	0.0608	0.0286	0.0633	0.0099	0.1275
OWNER	57	0.0672	0.0188	0.0674	0.0268	0.1055
VENDOR	36	0.0594	0.0223	0.0612	0.0065	0.113

Based on Table 10, the ANOVA results show that there are no independent factors—either Commodity, Status, or Exchange Code—that have a significant effect on the expected rate of return (To) in the third scenario period: pre-COVID-19, post-COVID-19, and period combination. This is reflected in the p-value third value factors well above the threshold significant 0.05. This

finding reinforces previous results that show that differences in commodity classification, corporate ownership form, and stock exchange location do not explain significant variations in WACC or K_e . Although descriptively, there are fluctuations across groups and periods, statistically, the effects are minimal to small, as indicated by the Partial Eta Squared values. This suggests that mining companies' systematic risk or expected K_e is more likely to be influenced by factors other than these categories in the ASEAN capital market context—perhaps by numeric variables such as beta, leverage, or firm-specific financial performance.

Table 10. Results of ANOVA Calculation of Independent Variables Expectation Rate of Return (To) On Various Period Scenarios (Pre Covid-19, Post Covid-19, and Period Combination)

Based on Pre-COVID-19 Period Scenario

Source of Variation	Sum Sq	Df	Pr(>F)	Significant
(Intercept)	0.1277	1	1.81E-34	***
Commodity	0.0015	3	0.508043	Not Significant
Status	0.0008	2	0.533376	Not Significant
Exchange Code	0.0011	7	0.971711	Not Significant
Residuals	0.1849	286	-	

Based on Post COVID-19 Period Scenario

Source of Variation	Sum Sq	Df	Pr(>F)	Significant
(Intercept)	0.1215	1	2.43E-28	***
Commodity	0.001	3	0.741622	Not Significant
Status	0.0008	2	0.617191	Not Significant
Exchange Code	0.0023	7	0.897501	Not Significant
Residuals	0.2282	286	-	

Based on the COVID-19 Combined Period Scenario

Source of Variation	Sum Sq	Df	Pr(>F)	Significant
(Intercept)	0.122	1	1.66E-32	***
Commodity	0.0012	3	0.602285	Not Significant
Status	0.0003	2	0.8129	Not Significant
Exchange Code	0.0052	7	0.35966	Not Significant
Residuals	0.192	287	-	

P-value (Pr(>F)) below 0.05 = significant.

Table 11 shows that the influence of the Commodity, Status, and Exchange Code variables on the average cost of capital (WACC) is minimal to small in all periods, with only exchange Codeine in the combined period showing a small effect ($\eta^2 = 0.026$). This is different from Table 4.26, Where the Exchange Code contributes a moderate to a significant effect on the expected rate of return (K_e). This difference is logical because structurally, K_e is the main component in the WACC calculation, representing the cost of equity capital. At the same time, WACC also considers the capital structure and cost of debt. Thus, market variables such as the exchange Code tend to have a more direct impact on K_e . In contrast, its impact on WACC will be filtered by other factors such as leverage and debt proportion, explaining why its impact on WACC is weaker.

Table 11. Partial Eta Results of ANOVA Calculation of Variables Independent to Expectation Average Cost of Capital (WACC) in Various Period Scenarios (Pre Covid-19, Post Covid-19, and Period Combination)

Parameter	To_Pra	To_Pasca	The_Overall	Interpretation Strength (Cohen)
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Commodity	0.008	0.004	0.006	Very Small / No Effect
Status	0.004	0.003	0.001	Very Small / No Effect
Exchange Code	0.006	0.010	0.026	Small Significant

The ANCOVA results in Table 12 show that most variables do not significantly affect WACC, either in the Pre, Post, or Combined periods. In the Pre-COVID-19 period, all independent variables have a p-value > 0.05, indicating that none are significant, even variables such as RF_Pra, MRP_For, and E_For has a p-value > 0.9, indicating a minimal contribution in explaining the variance WACC_Pra. Something similar happened in the post-COVID-19 period, where no variable reached statistical significance. However, in the Combined period (WACC_Overall), several variables begin to show signals of significance: Share_Overall significant (p = 0.013), whereas the_Overall, Beta_Overall, and Intercept have a p-value close to 0.05, so it is categorized as "small significant." This means that when all periods are combined, the model becomes slightly more informative, especially regarding the effects of capital structure and expected rate of return.

Table 12. Summary Results of ANCOVA Expected Rate of Return (Ke) in various period scenarios (Pre Covid-19, Post Covid-19, and Combined Period) Blank

Dependent Variable	Source of Variation	Sum Sq	Df	F Value	Pr(>F)	Significant
WACC_Overall	(Intercept)	0.0036	1	3.7328	0.070196	Significantly Small
WACC_Overall	Exchange Code	0.0094	7	1.4074	0.265379	Not Significant
WACC_Overall	Commodity	0.001	3	0.3384	0.797795	Not Significant
WACC_Overall	Status	0.0026	2	1.3577	0.283779	Not Significant
WACC_Overall	Beta_Overall	0.0033	1	3.439	0.081105	Significantly Small
WACC_Overall	RF_Overall	0.0005	1	0.5705	0.460411	Not Significant
WACC_Overall	MRP_Overall	0.0009	1	0.8983	0.35653	Not Significant
WACC_Overall	The_Overall	0.004	1	4.2067	0.056005	Significantly Small
WACC_Overall	HargaSaham_Overall	0	1	0.0114	0.91625	Not Significant
WACC_Overall	Share_Overall	0.0073	1	7.6299	0.013322	Significant
WACC_Overall	E_Overall	0.0008	1	0.8318	0.374504	Not Significant
WACC_Overall	D_Overall	0.0004	1	0.4296	0.520967	Not Significant
WACC_Overall	TC_Overall	0.0016	1	1.6835	0.211795	Not Significant
WACC_Overall	IE_Overall	0	1	0.0208	0.887084	Not Significant
WACC_Overall	KD_Overall	0	1	0.0003	0.986133	Not Significant
WACC_Overall	Residuals	0.0163				
WACC_Post	(Intercept)	0	1	0.0449	0.834628	Not Significant
WACC_Post	Exchange Code	0.0043	7	1.1533	0.375512	Not Significant
WACC_Post	Commodity	0.0006	3	0.3846	0.765361	Not Significant
WACC_Post	Status	0.0009	2	0.8252	0.454064	Not Significant
WACC_Post	Beta_Post	0	1	0.0711	0.792807	Not Significant
WACC_Post	RF_Pasca	0.0007	1	1.3675	0.257491	Not Significant
WACC_Post	MRP_Post	0.0004	1	0.8007	0.382697	Not Significant
WACC_Post	To_Pasca	0.0003	1	0.6498	0.430711	Not Significant
WACC_Post	StockPrice_Post	0	1	0.0173	0.896779	Not Significant
WACC_Post	Share_Pasca	0.0014	1	2.5863	0.125191	Not Significant
WACC_Post	E_Pasca	0.0009	1	1.7127	0.207098	Not Significant
WACC_Post	D_Pasca	0.0001	1	0.181	0.675556	Not Significant
WACC_Post	TC_Pasca	0.0001	1	0.1698	0.685193	Not Significant
WACC_Post	IE_Post	0.0001	1	0.2159	0.647729	Not Significant
WACC_Post	KD_Pasca	0.0002	1	0.3616	0.55509	Not Significant
WACC_Post	Residuals	0.0095				

Dependent Variable	Source of Variation	Sum Sq	Df	F Value	Pr(>F)	Significant
WACC_Pra	(Intercept)	0.0005	1	0.6804	0.415753	Not Significant
WACC_Pra	Exchange Code	0.0063	7	1.2603	0.301714	Not Significant
WACC_Pra	Commodity	0.0004	3	0.198	0.896985	Not Significant
WACC_Pra	Status	0.0019	2	1.3238	0.280747	Not Significant
WACC_Pra	Beta_For	0.0001	1	0.0845	0.773257	Not Significant
WACC_Pra	RF_Pra	0	1	0.0015	0.969689	Not Significant
WACC_Pra	MRP_For	0	1	0.0069	0.934552	Not Significant
WACC_Pra	To_Pra	0.0005	1	0.6542	0.424777	Not Significant
WACC_Pra	HargaSaham_Pra	0.0002	1	0.2716	0.605974	Not Significant
WACC_Pra	Share_Pra	0.0002	1	0.2248	0.638701	Not Significant
WACC_Pra	E_For	0	1	0.0033	0.954247	Not Significant
WACC_Pra	D_For	0	1	0.0314	0.86061	Not Significant
WACC_Pra	TC_For	0.0001	1	0.1761	0.677652	Not Significant
WACC_Pra	IE_Pra	0	1	0.0197	0.889394	Not Significant
WACC_Pra	KD_For	0	1	0.0478	0.828355	Not Significant
WACC_Pra	Residuals	0.0221				

p < 0.05 Significant | p 0.05 - 0.5 Small Significant

DISCUSSION

Beta Dynamics of "ASEAN EXCHANGE" Mining Companies in Various Scenario Period (For COVID-19, Pre COVID 19, and Period Combination)

In general, the systematic risk landscape of the mining sector in ASEAN shows a significant shift between the pre-COVID-19 and during/post-COVID-19. Aggregated data from various stock exchanges indicate an increase in the average Beta from 0.725 to 0.900. This implies that mining companies have become more sensitive to overall market fluctuations following the pandemic. This increase in sensitivity, leading to Beta approaching 1, is not uniform across all exchanges; Bursa Malaysia (KLSE), Ho Chi Minh (HOSE), and Hanoi (HNX) show marked increases in Beta, while the Indonesia Stock Exchange (IDX) and especially the Singapore Exchange (SGX) have experienced declines. This change is also reflected in the characteristics of the Beta distribution, which shifted from positive skewness before the pandemic (0.301), indicating higher-risk stocks, to negative skewness post-pandemic (-0.418) despite a higher average Beta. This shift is likely driven by the massive economic disruption caused by the pandemic and the unprecedented fiscal and monetary policy responses, as widely documented in analyses of the impact of COVID-19 on regional and global economies.

ANOVA analysis shows 'Exchange Code' as the dominant factor that significantly influences Beta, where a post-hoc test confirms the systematic risk differences across major ASEAN exchanges (IDX, HNX, KLSE, SGX), highlighting the importance of micro market factors. In contrast, 'Commodity' and 'Status' do not show significant effects. Crucially, despite major macroeconomic events that differentiate the periods, repeated measures ANOVA analysis (after sphericity correction) concludes that there is no statistically significant change in the average Beta across periods (Pre, Post, Overall) for the same firm. This indicates that the average systematic risk of firms in ASEAN does not shift uniformly, possibly due to the heterogeneous impact of the events or the effectiveness of regional mitigation policies.

Expected Rate of Return (Ke) of "ASEAN EXCHANGE" Mining Companies for Each Commodity in Various Periods (Pre COVID-19, Post COVID-19, and PeriodCombination)

The study results indicate that Beta is consistently the most dominant predictor in explaining expected return rates (To) on the entire analysis period: pre-COVID-19, post-COVID-19, and the period combination. This is reflected in the very high Partial Eta² value, which is between 0.65 and 0.75, indicating that systematic risk represented by Beta explains more than 65% of the variation in Ke. In addition, the Stock Exchange Code variable also shows consistent significance with a small to medium effect (Eta² between 0.15–0.37), indicating that the location of the stock listing also plays a role in influencing return expectations, albeit with a more moderate impact.

In contrast, the variables Stock Price, Status, and Commodity do not contribute significantly to the model, either statistically ($p\text{-value} > 0.05$) or in terms of effect size (Eta² < 0.09). This insignificance indicates that these variables are not strong enough to explain the variation in expected returns in the ASEAN market in the context of the mining sector. In other words, structural factors such as exchange location and market sensitivity to risk are much more influential than the stock price value or the classification of the company's status and commodity.

Weighted Average Capital Cost (WACC) of ASEAN EXCHANGE Mining Companies for Each Commodity in the Post-COVID-19 Period (January 2020 – December 2022)

Analysis of the weighted average cost of capital (WACC) of mining companies listed on the stock exchanges of ASEAN countries shows a moderate decline from the pre-COVID to the post-COVID period (January 2020 – December 2022), namely from 6.916% to 6.589%. This decline reflects the impact of highly accommodative global and regional monetary policies during the pandemic. Central banks in the ASEAN region and globally have aggressively lowered their benchmark interest rates and implemented quantitative easing to maintain liquidity and lower borrowing costs. Consequently, the cost of the debt component in the WACC has fallen, while the cost of equity has also been affected by a decline in the risk-free rate. However, it remains exposed to market uncertainty and fluctuations in systematic risk.

While the general trend shows a decline in WACC, significant variations exist across countries and commodities. The Indonesia Stock Exchange (IDX) consistently recorded the highest WACC, decreasing from 7.933% to 7.682%. This could reflect higher market risk perceptions or specific domestic structural factors. In contrast, the Singapore Exchange (SGX) recorded the lowest WACC, decreasing from 5.551% to 3.907%, reflecting its more stable market characteristics and status as a regional financial center. Meanwhile, the opposite trend was seen in the Ho Chi Minh City Exchange (HOSE), Vietnam, where the WACC increased from 7.104% to 8.639%. This increase is likely related to the dynamics of rapid economic growth or increasing local market risk. Regarding commodities, the coal and multicommodity sectors showed higher average WACC than other mining sectors. Statistical analysis through the ANOVA test shows that categorical variables such as commodity type, ownership status, and exchange location (Exchange Code) have a relatively small influence on WACC variation. Exchange shows a small significant effect only in the combined period, indicating that the local market context still plays a role, although it is not a dominant factor. The stable and near-normal WACC distribution during

this crisis period reflects the resilience of the ASEAN mining sector, mainly due to the support of responsive monetary policy. This finding strengthens the results of Lim and Chia (2022), who concluded that differences in fiscal policy and political stability across ASEAN countries also affect risk perception and ultimately reflect disparities in WACC levels.

Further analysis using ANCOVA strengthens the findings. During the pre- and post-COVID periods analyzed separately, none of the independent variables, including beta, market risk, or capital structure, significantly explained the variation in WACC. This suggests that the crisis conditions and responsive policies during the pandemic acted as dominant factors that obscured the influence of the fundamental relationship. However, when all periods are combined, capital structure (represented by the variable *Share_Overall*) emerges as a significant factor, while the cost of equity (*The_Overall*) and systematic risk (*Beta_Overall*) show a minor significance. This finding underlines that fundamental factors play an important role in forming WACC in more stable market conditions and longer time horizons.

Overall, ASEAN mining companies' WACC dynamics during the pandemic result from a complex interaction between dominant macroeconomic policies, national capital market characteristics, and firm-specific conditions. While the statistical model provides meaningful quantitative insights, the results also suggest that the variation in WACC during the crisis period cannot be fully explained by the measured variables, underscoring the need for a qualitative approach and consideration of other external factors in the analysis of the cost of capital during a crisis. It is also important to note that the post-COVID period in this study ends in December 2022, before the full impact of global monetary policy tightening in response to the spike in inflation is realized, potentially changing the dynamics of the cost of capital again in subsequent periods.

CONCLUSION

1. ASEAN mining companies' systematic risk (beta) values show high variability across companies and exchanges, with some companies exhibiting aggressive betas and others defensive or hostile. Although the descriptive average sector beta increased post-COVID, statistical analysis (corrected repeated measures ANOVA), found no statistically significant difference in the average beta across pre-, post-, and pooled periods for the same company. The factor "Exchange Code" (location of the exchange) consistently proved to be a significant determinant of beta, especially before the pandemic and after applying robust statistical methods. In contrast, the type of "Commodity" and "Status" of the company generally did not significantly affect beta.
2. ASEAN mining companies' expected rate of return (K_e), estimated via CAPM, increased moderately in aggregate post-COVID, but the trend varied across commodity sub-sectors; non-metallic minerals and metals experienced an increase in average K_e , coal slightly increased, while multi-commodities declined. ANCOVA analysis confirmed that "Beta" (systematic risk) is the dominant and highly significant predictor of K_e across all periods. "Exchange Code" also consistently shows a significant influence with small to medium effects. Other factors such as "Stock Price," "Status," and "Commodity" are generally not significant after controlling for the influence of Beta and Exchange Code.

3. Overall, the average WACC of ASEAN mining companies has declined slightly post-COVID, most likely due to loose global monetary policy. However, there is significant variation between exchanges, with IDX consistently having high WACC and SGX low, while HOSE shows an increase. Coal and multicommodity companies tend to have higher WACC. ANOVA results show that the factors "Commodity," "Status," and "Exchange Code" have only a very small to negligible statistical impact on the variation of WACC, with "Exchange Code" showing a small significant effect only in the combined period, indicating limited explanatory power of these categorical factors on WACC. Explanatory Limitations of WACC and Stock Market Pattern: The analyzed factors (including Beta, Ke, and Stock Code) have minimal influence on WACC in the final model (ANCOVA-PCA); descriptively.

LIMITATIONS

The main constraints in this study include obtaining uniform and complete financial data from all mining companies in various ASEAN stock exchanges, given the differences in reporting standards and availability of historical data. In addition, the "post-COVID-19" period (January 2020 - December 2022) is very dynamic, with various phases of the pandemic and policy responses, making it challenging to define a stable and homogeneous post-pandemic condition for analysis. Limited access to in-depth qualitative data from cross-border corporate management is also an operational constraint.

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