

Optimal Cross-Asset-Class Portfolio Construction Using the Markowitz Mean-Variance Framework: Evidence from a U.S. Dollar-Based Foreign Investor Perspective

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Abstract

Foreign investors price Indonesian assets in U.S. dollars (USD), not rupiah, and that distinction carries weight. Between 2021 and 2024 the rupiah lost roughly 19% against the dollar while foreign capital left the equity market in waves, eroding dollar returns even when local prices held up. A portfolio built only from the Jakarta Composite Index (JCI) and the S&P 500 spreads risk across two markets yet guards against neither force. The question this paper pursues is whether gold and Bitcoin can close that gap. A four-asset portfolio of Bitcoin, gold, JCI, and the S&P 500 is assembled with all returns converted to USD, then optimised on monthly data from January 2021 to December 2024 through the Markowitz mean-variance model in Excel Solver. The Sharpe ratio serves as the objective, bound by three limits: weights sum to one, no short selling, and a 5% floor per asset. For the risk-free rate, the U.S. Treasury Bond and Indonesian Government Bond yields are blended by the optimal allocation. The resulting weights are then carried into an out-of-sample 2025 test across three management strategies. The optimal mix of 52% gold, 28% S&P 500, 15% Bitcoin, and 5% JCI reaches a Sharpe ratio of 0.812. The equity-only portfolio manages only 0.227, the S&P 500 alone 0.615, and the JCI, once measured in dollars, sinks to -0.360 . Quarterly rebalancing earns the most in 2025, at 37.85%. The contribution is a dollar-based allocation template that moves past the rupiah-denominated evidence dominating earlier Indonesian studies.

Introduction

More than 20 million people are now registered as investors in the Indonesian capital market, up from approximately 7.49 million in 2021 (Maulida & Purnomo, 2023; Wicaksono et al., 2024; Sahatatus et al., 2024). This figure is impressive. However, it does not negate the fact that foreign investors remain decisive, as their fund flows shape both capital flows and exchange rate stability (Anggitawati & Ekaputra, 2020). One fundamental difference is easily overlooked here: foreign investors do not calculate profits and losses in rupiah, but in US dollars (USD). For them, the exchange rate is not merely a backdrop; it is also a factor in their returns (Aprilliantoni & Jimale, 2024; Juhro et al., 2025; Romadhina et al., 2022)

The 2021–2024 period underscores why this is important. The rupiah plummeted from around IDR 14,000 to above IDR 16,000 per dollar, a decline of approximately 19%, and its weakening continued until 2025. At the same time, foreign investors repeatedly withdrew funds from the stock exchange. What makes it difficult is that these two events often coincide. When foreigners sell, the rupiah weakens, and the dollar value of Indonesian stocks is eroded simultaneously from two sides (Sugandi, 2022).

Modern Portfolio Theory offers a solution. Markowitz (1952) demonstrated that portfolio risk is not determined by the risk of each asset individually, but by how those assets move together. Therefore, combining divergent assets can reduce risk without sacrificing returns. The problem

is that the combination of the Jakarta Composite Index (JCI) and the S&P 500 only spreads risk geographically (Riswanda & Rikumahu 2025; Situmorang & Kaluge, 2025; Santoso & Setyowati, 2023). When global risk-off sentiment hits, both fall in tandem, with neither holding them back (Koepke, 2019). Gold and Bitcoin fill this void from opposite directions. Gold has a low covariance with equities and has long been known as a safe haven (Baur & Lucey, 2010; Baur & McDermott, 2010; Feder-Sempach et al., 2024; Madani & Ftiti, 2022; Wang et al., 2022). Bitcoin promises substantial returns, although the correlation fluctuates depending on market regimes (Bouri et al., 2017; Shahzad et al., 2019).

The combination of crypto, gold, and stocks in Indonesia has been studied before. Devi and Soekarno (2014) pioneered the study of Bitcoin, gold, and the LQ45. Later, Nugraha and Soekarno (2023) found that mean-variance optimization provided the highest Sharpe ratio, while quarterly rebalancing yielded the highest returns for a portfolio of Bitcoin, gold, the LQ45, and a bond index. Three gaps remain. First, performance is typically measured in rupiah, not dollars, so the foreign investor lens has not yet been fully integrated (Usman et al., 2024; Azis & Karunia, 2024; Koesrindartoto et al., 2024). Second, the S&P 500, as the anchor of developed markets, is rarely compared directly with the JCI within a single framework. Third, optimal weightings are almost never tested beyond their estimation period, let alone comparing multiple rebalancing patterns during turbulent times (Dai et al., 2024; Dinler, 2025; Batrancea et al., 2025).

This article summarizes all three in one draft. Returns on all assets are converted to dollars, including the Jakarta Composite Index (JCI), which is recalculated using monthly spot rates, so that exchange rate risk is integrated into the data rather than tacked on (Faizah & Mudjijah, 2025; Istiqomah & Hanan, 2026). The risk-free rate is a composite of the two markets so that the Sharpe ratio reflects the true opportunity cost. The optimal weightings are also deliberately tested in 2025, a year of tariff volatility and exchange rate pressures, as a hostile test.

Four questions guide the analysis: What are the return, risk, and Sharpe ratio profiles of the JCI and the S&P 500 when each is a standalone? Does adding gold and Bitcoin improve risk-adjusted performance? Can the optimal portfolio outperform the JCI and S&P 500 as a single benchmark? And of the three strategies buy-and-hold, semi-annual rebalancing, and quarterly rebalancing which is most effective in 2025? The answer is quite clear: a gold-led portfolio with a small amount of Bitcoin is far more efficient for foreign dollar-based investors than holding stocks alone.

Method

This study is quantitative and relies on historical data. Four assets were selected because they represent different asset classes and have contrasting return drivers, risk profiles, and correlation patterns: Bitcoin (BTC/USD), gold (XAU/USD), the Jakarta Composite Index (JCI), and the S&P 500. Monthly closing prices are taken from Investing.com. The estimation period, from January 2021 to December 2024, contains 48 price observations, resulting in 47 monthly return observations, which are used to estimate returns, risks, covariances, and optimal weights. Twelve observations from 2025 are excluded for out-of-sample testing.

Currency Standardization and Return–Risk Calculation

All returns are calculated in dollars. Bitcoin, gold, and the S&P 500 are already denominated in dollars; the rupiah-denominated JCI is converted by dividing it by the end-of-month USD/IDR spot rate before calculating returns. This method ensures that exchange rate effects are carried over into the JCI return series, rather than added later. Monthly returns are standardized percentage price changes, annualized by multiplying the arithmetic mean by 12,

consistent with the mean-variance framework. For risk, monthly variance is annualized by multiplying by 12 and then rooted to obtain the annual standard deviation.

Combined Risk-Free Rate

This portfolio spans two interest rate environments, so a single risk-free rate is insufficient. The average U.S. Treasury Bond yield of 3.14% per year is used for Bitcoin, gold, and the S&P 500, while the Government Securities yield of 6.7% per year is used for the Jakarta Composite Index (JCI). The portfolio's risk-free rate is calculated as a weighted average of both according to optimal weights, resulting in a combined rate of approximately 3.32%.

Markowitz Optimization and Strategy Simulation

Optimization uses the Markowitz mean-variance framework via Solver (GRG Nonlinear) in Microsoft Excel, with the goal of maximizing the Sharpe ratio. The variance-covariance matrix is calculated from the excess return matrix and then annualized. Three constraints are binding: the weights must sum to one, they must not be negative to cover short selling, and each asset must earn at least 5%. The 5% lower bound is intentionally imposed to prevent the optimizer from overloading a single asset due to estimation errors, while also ensuring the portfolio remains applicable to real markets (Jagannathan & Ma, 2003; Behr et al., 2013). The process takes place in two stages. The first stage creates a stock-only portfolio, consisting of the Jakarta Composite Index (JCI) and the S&P 500, with 50/50 equal weightings, as a baseline (DeMiguel et al., 2009). The second stage adds gold and Bitcoin to create a four-asset portfolio. To map the trade-offs, four configurations are tested: equal weighting, minimum risk, maximum return, and maximum Sharpe ratio. In the final step, three management strategies were implemented in 2025 with an initial capital of USD 100,000: buy-and-hold with no adjustments, semi-annual rebalancing in January and July, and quarterly rebalancing in January, April, July, and October. At each rebalancing date, the weights were returned to their optimal allocations.

Results and Discussion

Return and Risk Characteristics of Individual Assets

The return and risk distribution for the four assets is wide (Table 1). Bitcoin is both a source of return and a source of risk, with returns of 47.05% and 65.24%. More striking is the Jakarta Composite Index (JCI): in dollar terms, its Sharpe ratio is negative (-0.360), as its 2.10% return is below the domestic risk-free benchmark of 6.7%. The rupiah's depreciation has dragged down its dollar return. This already signals where optimization will lead: diversification value will come not from the JCI, but from assets with completely different return drivers.

Table 1. Return and Risk Characteristics of Individual Assets (2021–2024 Estimates)

Assets	Annual Return	Risk (Annual Std Dev)	Sharpe Ratio*
S&P 500	13,08%	16,18%	0,615
BTC/USD	47,05%	65,24%	0,673
IHSG (USD)	2,10%	12,80%	−0,360
XAU/USD	9,93%	13,79%	0,492

**Sharpe ratios for the Jakarta Composite Index (JCI) and the S&P 500 are from the thesis; BTC and XAU values were calculated by the author from data in Table 1 (rf 3.14% for USD assets). Source: processed by the author (2026).*

Covariance Structure

The benefits of diversification are evident in the covariance structure (Table 2). Gold has the lowest covariance against other assets, and the smallest against the Jakarta Composite Index (JCI) at 29.24, thus serving to dampen volatility. Conversely, Bitcoin's covariance with the S&P 500 is relatively high at 545.85. This explains why Bitcoin's large weighting actually increases, rather than decreases, portfolio risk.

Table 2. Annual Variance-Covariance Matrix

	S&P 500	BTC/USD	IHSG	XAU/USD
S&P 500	261,65	545,85	62,91	48,29
BTC/USD	545,85	4256,47	98,05	69,86
IHSG	62,91	98,05	163,77	29,24
XAU/USD	48,29	69,86	29,24	190,31

Source: processed by the author (2026).

Portfolio Configurations and Optimal Portfolio Determination

Mapping the trade-offs of the four configurations (Table 3) demonstrates why absolute returns are misleading as a criterion. The maximum-return configuration did indeed achieve 41.25%, but its Sharpe ratio was only 0.677, below the 0.691 of the equal-weight portfolio, because an 85% concentration in Bitcoin brought the risk to 56.02%. The most efficient point lies in the maximum Sharpe ratio configuration, with a return of 16.08% at a risk of 15.72%. This composition of 52% gold, 28% S&P 500, 15% Bitcoin, and 5% JCI is the optimal portfolio and is used throughout the subsequent analysis.

Table 3. Comparison of Portfolio Configurations

Configuration	Return	Risk	Sharpe Ratio
Equal Weight	18,04%	20,28%	0,691
Minimum Risk	8,42%	10,47%	0,347
Maximum Return	41,25%	56,02%	0,677
Maximum Sharpness (Optimal)	16,08%	15,72%	0,812

Source: processed by the author (2026).

Optimal Portfolio versus Benchmark

The comparison with the benchmark (Table 4) answers two research questions simultaneously. The optimal portfolio's Sharpe ratio reaches 0.812, exceeding that of a stock-only portfolio (0.227), the S&P 500 (0.615), and the Jakarta Composite Index (-0.360). The jump from 0.227 to 0.812 is not about the number of assets, but rather the quality of the added return drivers: gold's low covariance reduces volatility, while Bitcoin's high yield, at 15% weighting, increases excess returns above the risk-free rate without increasing volatility. The fact that the optimal portfolio also outperforms the S&P 500, the most efficient asset class on its own, demonstrates that superiority stems from diversification across asset classes, not simply from selecting the best single asset.

This finding aligns with Nugraha & Soekarno (2023) but goes further in two ways. Gold's 52% dominance here isn't simply a reflection of low risk appetite, but rather a direct response to the currency and capital flow risks faced by foreign investors. Only gold held the dollar's value when the Jakarta Composite Index (JCI) and the S&P 500 were under pressure. The negative

Sharpe ratio of the JCI also serves as statistical evidence that, from a dollar perspective, Indonesian equities without currency hedging failed to offset their risk throughout the estimation period.

Table 4. Comparison of Optimal and Benchmark Portfolios

Metrics	IHSG	S&P 500	Stocks Only	Optimal
Return	2,10%	13,08%	7,59%	16,08%
Risk	12,80%	16,18%	11,74%	15,72%
Sharpe Ratio	-0,360	0,615	0,227	0,812

Source: processed by the author (2026).

Robustness Test: 2025 Strategy Simulation

The optimal weights were then tested in 2025 (Table 5), and the results are noteworthy: all three strategies posted positive returns, between 36.66% and 37.85%, in a year marked by tariff volatility and exchange rate pressures. Quarterly rebalancing emerged as the highest (37.85%) through two mechanisms. This strategy periodically shifted funds from gold to the lagging S&P 500 and the Jakarta Composite Index (JCI), increasing the S&P 500's contribution to 10.30%. It repurchased Bitcoin during the mid-year price decline, the only strategy to achieve a positive Bitcoin contribution (0.33%). However, buy-and-hold remained in close competition at 37.41%, as gold's strong uptrend favored positions left intact.

This narrow difference is a reminder that the effectiveness of rebalancing depends on market conditions. In a market with a strong uptrend like 2025, frequent rebalancing does maintain proper weighting and disciplined risk tolerance, but it does not automatically lead to significant returns (Maginn et al., 2007). Therefore, strategy choice should be based on monitoring capacity and transaction cost tolerance, not on the belief that one approach is always better.

Table 5. Investment Strategy Performance in the 2025 Simulation

Strategy	S&P 500	BTC/USD	IHSG	XAU/USD	Total
Buy-and-Hold	4,50%	-1,13%	0,88%	33,16%	37,41%
Rebalancing Semesteran	7,93%	-0,93%	2,03%	27,64%	36,66%
Rebalancing Triwulanan	10,30%	0,33%	2,12%	25,11%	37,85%

Source: processed by the author (2026).

The 2025 simulation shows that all three portfolio management strategies generated positive total returns, although their performance differed only modestly. The quarterly rebalancing strategy achieved the highest total return at 37.85%, followed closely by buy-and-hold at 37.41%, while semi-annual rebalancing produced 36.66%. The quarterly strategy benefited from stronger contributions from the S&P 500 (10.30%) and IHSG (2.12%), while Bitcoin shifted from a negative contribution under the two less frequent strategies to a positive contribution of 0.33%. In contrast, buy-and-hold benefited most strongly from gold, which contributed 33.16% of the portfolio return. These results indicate that portfolio performance during 2025 was strongly influenced by the contribution of gold, while more frequent rebalancing allowed the portfolio to capture additional contributions from equity and Bitcoin positions. Overall, the relatively small difference between the three strategies suggests that rebalancing frequency did not fundamentally change portfolio performance during the observed period, although quarterly rebalancing produced the highest realized return.

Cross-Asset Diversification as a Portfolio Design Principle

The findings contribute to the broader understanding of portfolio diversification by demonstrating that asset-class heterogeneity is more important than simply increasing the number of securities within an existing asset class. From a Modern Portfolio Theory perspective, diversification becomes meaningful when assets respond differently to common economic and financial shocks (Markowitz, 1952). This shifts attention away from the conventional assumption that holding several equity markets automatically creates sufficient diversification. International equity markets remain exposed to interconnected global factors, including monetary tightening, changes in investor sentiment, and shifts in global risk appetite. Consequently, geographic diversification and asset-class diversification should be conceptually distinguished when constructing portfolios for internationally oriented investors.

This distinction is particularly relevant for portfolios that combine emerging- and developed-market equities. The JCI and S&P 500 represent different economic environments, yet both remain equity instruments and can therefore become exposed to similar global shocks. Previous studies on Indonesian financial markets have similarly emphasized the influence of international markets and macroeconomic conditions on domestic equity movements (Riswanda & Rikumahu, 2025; Situmorang & Kaluge, 2025). The present study extends this discussion by placing equities alongside assets whose valuation mechanisms are not exclusively dependent on corporate earnings and equity-market conditions. Such a structure allows portfolio construction to incorporate different sources of risk rather than simply distributing exposure across geographical markets.

The theoretical implication is that diversification should be evaluated dynamically rather than treated as a static characteristic of an asset. An instrument that appears diversifying during one market regime may become less effective when correlations increase during periods of financial stress. Research on gold and Bitcoin similarly indicates that their hedging and safe-haven properties are conditional rather than permanent (Baur & Lucey, 2010; Bouri et al., 2017; Shahzad et al., 2019; Wang et al., 2022). Thus, portfolio optimization should not assume that an asset possesses an intrinsic diversification benefit independent of market conditions. Instead, diversification should be understood as an empirical relationship between assets that can strengthen or weaken over time.

This perspective also provides a conceptual explanation for why mean-variance optimization remains relevant despite its well-known limitations. The value of the framework is not simply its ability to generate numerical portfolio weights, but its capacity to formalize the interaction between expected returns, risk, and covariance. The optimization process forces investors to consider opportunity costs associated with concentration and to recognize that an asset's contribution to portfolio efficiency cannot be inferred from its standalone performance. In this respect, the study reinforces the role of portfolio construction as an integrated decision problem rather than an exercise in selecting individually attractive securities.

The Foreign Investor Perspective and Currency-Denominated Performance

A second contribution concerns the importance of the investor's reference currency in evaluating international investment opportunities. Portfolio performance is not an absolute concept because the same asset can generate different economic outcomes depending on the currency in which wealth is measured. For international investors, therefore, domestic asset returns cannot be separated completely from exchange-rate movements. Existing research on Indonesia has established connections between foreign portfolio flows, exchange rates, and

domestic financial-market conditions (Anggitawati & Ekaputra, 2020; Sugandi, 2022). The present study places this relationship directly within the portfolio-construction problem.

This perspective changes the interpretation of international diversification. A domestic investor may evaluate Indonesian equities primarily through local-currency appreciation, dividends, and domestic risk. A foreign investor must additionally consider whether those gains are preserved after conversion into the investor's home currency. Consequently, currency exposure should not be treated merely as a technical adjustment undertaken after portfolio construction. It is part of the economic exposure generated by the investment itself. This argument is particularly relevant for emerging markets, where exchange-rate movements can be more pronounced and may interact with international capital flows.

The discussion also suggests that portfolio optimization for foreign investors should distinguish between asset risk and currency risk. These risks may reinforce one another under certain conditions, creating a larger effect on realized international returns than would be apparent from local-market data alone. Previous studies examining Indonesian financial markets have documented the relevance of exchange rates and macroeconomic variables for domestic asset performance (Aprilliantoni & Jimale, 2024; Azis & Karunia, 2024; Faizah & Mudjijah, 2025). By incorporating currency conversion directly into the investment return framework, the study brings this macro-financial dimension into the portfolio-allocation decision.

Nevertheless, the foreign-investor perspective should not be interpreted as implying that domestic assets become unattractive whenever currency depreciation occurs. Rather, the appropriate portfolio response depends on the interaction between expected asset returns, currency expectations, hedging costs, and investor objectives. This distinction is important because currency risk can be managed in several ways, including accepting the exposure, diversifying across currencies, or employing explicit hedging instruments. The current framework therefore provides a foundation for examining currency-aware portfolio construction while leaving room for future research that explicitly incorporates hedging decisions into the optimization process.

From Portfolio Optimization to Investment Decision-Making

The findings also have implications for how portfolio optimization should be understood in investment management. Optimization models are sometimes treated as mechanical tools that generate an allocation once historical data are entered. A more appropriate interpretation is that optimization provides a structured decision framework for balancing competing investment objectives. The constraints imposed on the portfolio, for example, represent investor preferences concerning concentration, short selling, and minimum exposure. Consequently, the resulting allocation is not simply a statistical discovery but the outcome of an interaction between empirical market characteristics and predefined investment rules.

This issue is important because portfolio optimization is inherently sensitive to model specification. Expected returns, covariance estimates, constraints, and the choice of objective function can all influence the resulting allocation. Jagannathan and Ma (2003) and Behr et al. (2013) demonstrate the importance of constraints in portfolio optimization, particularly because unrestricted optimization can generate economically implausible concentrations. The use of minimum allocation constraints in the present study therefore has a substantive interpretation: it embeds a degree of diversification discipline into the optimization process rather than allowing the historical sample to determine the entire portfolio structure.

The study consequently supports a more cautious understanding of the relationship between historical optimization and future investment decisions. Historical data can reveal relationships

that are useful for constructing a portfolio, but those relationships are not necessarily permanent. Financial markets evolve as monetary conditions, investor expectations, regulations, technology, and geopolitical circumstances change. The literature on portfolio rebalancing similarly suggests that maintaining a target allocation involves an ongoing management process rather than a one-time optimization exercise (Maginn et al., 2007; Dai et al., 2024). Portfolio optimization should therefore be embedded within a broader process of monitoring, reassessment, and adjustment.

An important implication is that investors should evaluate portfolio models according to their decision purpose rather than relying on a single performance metric. A portfolio designed to maximize expected return serves a different objective from one designed to maximize risk-adjusted performance. Likewise, a portfolio intended to preserve capital may require different constraints from one intended to pursue long-term growth. The contribution of the present study is therefore not merely the identification of one allocation, but the demonstration of how a transparent optimization framework can be used to examine competing portfolio objectives within a foreign-investor setting.

Rebalancing as a Dynamic Portfolio Management Process

The out-of-sample component further highlights that portfolio management does not end when an optimal allocation has been identified. Once market prices change, portfolio weights naturally diverge from their original targets. Rebalancing can therefore be understood as a mechanism for maintaining the intended relationship between risk exposures rather than simply as a technique for increasing returns. This distinction is important because the principal purpose of rebalancing is portfolio governance: it prevents market movements from silently transforming the risk characteristics of the portfolio.

The relatively close performance among the strategies in the study also supports a more nuanced interpretation of rebalancing. Portfolio management literature does not suggest that a particular rebalancing frequency will dominate under every market environment (Maginn et al., 2007). Instead, the value of rebalancing depends on the degree of asset-price divergence, transaction costs, market trends, liquidity, and the investor's tolerance for portfolio drift. A strategy that is theoretically disciplined may become less attractive when frequent transactions impose substantial costs. Conversely, a passive strategy may allow portfolio risk to deviate considerably from the investor's intended allocation.

This creates an important connection between quantitative portfolio theory and practical investment management. Rebalancing decisions involve a trade-off between maintaining strategic asset allocation and allowing portfolio positions to respond to market developments. The appropriate frequency is therefore partly an institutional decision. Large professional investors with sophisticated monitoring systems may be able to implement more frequent adjustments, whereas investors facing higher transaction costs or limited monitoring capacity may prefer less frequent intervention. The portfolio model should consequently be regarded as a strategic benchmark against which actual portfolio decisions can be evaluated.

Finally, the out-of-sample exercise demonstrates the importance of separating model validation from retrospective explanation. A portfolio that performs well during the estimation period may simply reflect historical characteristics that do not persist. Testing the allocation in a subsequent period provides a more demanding assessment of whether the portfolio structure retains practical relevance. Nevertheless, a single subsequent year cannot establish long-term robustness. Future studies should therefore examine multiple market regimes and longer out-of-sample periods, while incorporating transaction costs, taxation, liquidity constraints, and

currency hedging. Such extensions would move the analysis from historical portfolio optimization toward a more comprehensive framework for dynamic international investment management.

Conclusion

From the perspective of dollar-based foreign investors, a four-asset portfolio with a composition of 52% gold, 28% S&P 500, 15% Bitcoin and 5% IHSG achieved a Sharpe ratio of 0.812 and consistently outperformed both the stock-only portfolio (0.227) and the individual stock reference. The addition of gold and Bitcoin actually improves risk–return efficiency: gold dampens volatility thanks to its low covariance, Bitcoin lifts returns in a controlled portion. The negative JCI Sharpe ratio in dollars makes it clear that unhedged Indonesian equities did not pay off the risk for foreign investors during the estimation period. In the 2025 out-of-sample test, all three strategies posted positive returns, with the highest quarterly rebalancing (37.85%) even though the spread over buy-and-hold was narrow. In essence, in this context risk-adjusted performance arises from cross-class diversification that relies on defensive assets, not from the pursuit of a single superior asset.

Managerial Implications

For investment managers and foreign investors who place funds in the Indonesian market, these findings provide quite clear allocation guidelines. Gold should be treated as a portfolio anchor, not a complement, because of its role in anchoring the value of the dollar when exchange rate risks and capital outflows peak. The Bitcoin portion needs to be kept moderate; the benefits of returns are real, but too large a weighting actually damages efficiency because of its high volatility and covariance with equity. Direct exposure to the JCI is better kept to a minimum unless the exchange rate risk is hedged, considering the exchange rate drag which has been proven to flip returns to negative in dollar terms.

On the strategy side, quarterly rebalancing should be the default choice because it most consistently maintains risk discipline, and in 2025 it will also record the highest returns. Even so, managers who are faced with transaction costs or monitoring limitations can still use buy-and-hold in a market that is trending strongly, because the difference in performance is small. At a broader level, this result touches on the interests of market authorities: the persistent drag on the exchange rate weakens the attractiveness of the JCI in the eyes of foreign investors, so that maintaining rupiah stability becomes an important condition for maintaining foreign capital inflows.

Research Limitations And Suggestions For Further Research

Several limitations limit how far these findings can be generalized. Analysis relies on historical data, while future returns, volatility and correlation can shift, especially when the market shakes suddenly. The simulation does not take into account transaction costs, taxes, bid-ask spreads, as well as conversion costs and exchange rate hedging, all of which can cut into net returns in practice. The mean-variance framework also relies on the assumption of normal returns and relatively stable correlation, even though both of these often fail during times of crisis. Beyond that, the asset universe is limited to four instruments, and the out-of-sample period is only one year, 2025, which happens to be characterized by a strong trend.

A number of further directions are open. Time-varying covariance models, for example GARCH or DCC-based approaches, can better capture the dynamics of inter-regime correlation. The asset universe can be expanded with bonds, REITs, or other cryptos to test to what extent the diversification benefits hold. Transaction costs and exchange rate hedging

should be included in the optimization so that the net return assessment is more grounded. Extending the estimation and simulation period, while testing the sensitivity of the results to the magnitude of the lower weight limit, will strengthen their external validity.

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