

THE ROLE OF CRYPTO ASSET DIVERSIFICATION IN REDUCING RETAIL INVESTOR PORTFOLIO RISK

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Abstract

Crypto assets are often promoted to retail investors as a diversifier that can reduce portfolio risk. This study examines whether, and in what sense, this claim holds for Indonesian retail investors. Using daily data from 3 January 2018 to 30 June 2026, it adds allocations of 0 to 20% in Bitcoin to conservative, moderate, and aggressive portfolios of Indonesian stocks, government bonds, and gold, and compares a single coin crypto allocation with diversified crypto baskets. Risk is measured by volatility, Value at Risk, Expected Shortfall, maximum drawdown, and risk contributions, and differences in Sharpe ratios are tested with a stationary block bootstrap. The results show that crypto does not reduce total portfolio volatility: because its volatility is about 4 times that of stocks, even a 5% allocation raises the volatility of the moderate portfolio from 8.2% to 9.1% and accounts for 20% of its risk. However, its low correlation with traditional assets (0.24 with stocks) means that small allocations raise risk less than proportionally, improve the Sharpe ratio significantly, and even reduce the maximum drawdown and the worst monthly loss. Diversifying across several coins within the crypto allocation does not reduce risk, since crypto assets are highly correlated with one another (average correlation 0.75). Disciplined rebalancing is essential: without it, a 5% allocation drifted to as much as 42% of the portfolio and doubled its volatility. The findings suggest that crypto improves risk adjusted returns when held in small, rebalanced positions, rather than reducing risk in absolute terms.

Keywords: crypto assets; portfolio diversification; retail investors; portfolio risk; Bitcoin; rebalancing

INTRODUCTION

Crypto assets have become part of the investment landscape of Indonesian households. The Financial Services Authority (OJK), which has supervised crypto trading since January

2025, recorded 13.71 million crypto consumers in March 2025, and the number exceeded 20 million by the end of 2025, while the value of crypto transactions reached Rp482.23 trillion in 2025 (Investortrust, 2025; Bisnis.com, 2026). Many of these investors are young, invest small amounts through mobile applications, and also hold more traditional assets such as stocks, government bonds, mutual funds, and gold. A common argument in marketing and social media is that crypto is a diversifier: because its price does not move together with stocks and bonds, adding it to a portfolio is said to reduce overall risk.

Modern portfolio theory gives this argument some basis. Markowitz (1952) showed that combining assets that are not perfectly correlated reduces portfolio risk relative to the weighted risk of the individual assets. Studies have found that Bitcoin has low correlations with traditional assets and that small allocations can improve portfolio efficiency (Brière et al., 2015; Kajtazi & Moro, 2019; Platanakis & Urquhart, 2020). However, crypto assets are also among the most volatile assets ever traded, have experienced drawdowns of more than 70%, and tend to fall together with stocks during market stress (Corbet et al., 2018; Klein et al., 2018). Whether crypto actually reduces risk, rather than merely raising return per unit of risk, is therefore far from obvious.

Two further questions are relevant to retail investors. First, many investors diversify within crypto by holding several coins rather than only Bitcoin, in the belief that this spreads risk (Liu, 2019; Platanakis et al., 2018). Second, retail investors often do not rebalance, so that a small crypto allocation can grow into a large one after a rally (Barber & Odean, 2000). Existing studies mostly use institutional portfolios and developed market assets and rarely examine portfolios that resemble those of Indonesian retail investors.

This study addresses these gaps by asking: (1) How does adding crypto to typical Indonesian retail portfolios affect different measures of portfolio risk and risk adjusted return? (2) Does diversifying across several crypto assets reduce risk compared with holding Bitcoin only? (3) How do correlations behave in periods of stress, and how important is rebalancing? The study contributes by distinguishing clearly between absolute risk and risk adjusted performance, by using several risk measures including tail and drawdown measures, and by translating the findings into practical guidance for retail investors and regulators. Section 2 reviews the literature, Section 3 describes the method, Section 4 presents and discusses the results, and Section 5 concludes.

LITERATURE REVIEW

Portfolio Theory and Diversification

Markowitz (1952) showed that portfolio variance depends not only on the variances of individual assets but also on their covariances, so that combining imperfectly correlated assets reduces risk. The benefit of diversification increases as correlations fall, and most of the reduction in idiosyncratic risk is achieved with a moderate number of assets (Statman, 1987). Importantly, diversification lowers risk relative to the weighted average risk of the components, but adding a highly volatile asset can still raise the total risk of a portfolio. Choueifaty and Coignard (2008) proposed the diversification ratio, the weighted average volatility of the assets divided by the portfolio volatility, to measure how much of this averaging benefit a portfolio achieves. Risk can also be decomposed into the contribution of each asset (Maillard et al., 2010), which shows that a small allocation to a volatile asset can account for a large share of portfolio risk. Because returns are not normally distributed, tail risk measures such as Value at Risk (VaR) and the coherent Expected Shortfall (ES) complement volatility (Artzner et al., 1999; Jorion, 2007), and performance is assessed by the Sharpe (1966) and Sortino ratios (Sortino & Price, 1994).

Retail investors often fall short of this ideal. Goetzmann and Kumar (2008) document that individual investors hold underdiversified portfolios, and Barber and Odean (2000) show that they trade excessively and to their detriment. Perold and Sharpe (1988) show that rebalancing to fixed weights systematically sells assets that have risen and buys those that have fallen, which controls risk when asset returns diverge.

Crypto Assets in Portfolios

Brière et al. (2015) found that Bitcoin had very low correlations with traditional assets and that small allocations substantially improved the risk and return tradeoff of diversified portfolios. Bouri et al. (2017) concluded that Bitcoin is a good diversifier but a weak hedge and safe haven. Corbet et al. (2018) found that cryptocurrencies are relatively isolated from traditional financial assets, whereas Klein et al. (2018) found that, unlike gold, Bitcoin moves with equity markets during downturns. Kajtazi and Moro (2019) showed that Bitcoin improves portfolio performance mainly through higher returns rather than lower volatility, and Platanakis and Urquhart (2020) found that Bitcoin improves risk adjusted returns under several allocation models when estimation risk is considered. Baur et al. (2018) and Bianchi (2020) characterized Bitcoin mainly as a speculative asset with weak links to macroeconomic factors.

Diversification Within Crypto

Studies of crypto portfolios find that cryptocurrencies are strongly correlated with one another, driven by a common crypto market factor. Platanakis et al. (2018) found that naive equal weighting of cryptocurrencies performs about as well as optimized weights, consistent with DeMiguel et al. (2009) for traditional assets, and Liu (2019) found that optimized crypto portfolios do not outperform naive diversification out of sample. These findings suggest that holding many coins may offer limited risk reduction.

Research Framework

Based on this literature, this study expects that (i) crypto has low correlations with Indonesian stocks, bonds, and gold in normal periods but higher correlations with stocks in stress periods (Klein et al., 2018); (ii) small crypto allocations improve risk adjusted performance but raise absolute volatility because of crypto's very high volatility (Kajtazi & Moro, 2019); (iii) diversification within crypto provides little risk reduction because of high correlations among coins (Liu, 2019); and (iv) rebalancing is necessary to keep the risk of a crypto allocation under control (Perold & Sharpe, 1988).

METHOD

Data

The study uses daily data from 3 January 2018 to 30 June 2026, aligned to trading days on the Indonesia Stock Exchange (2,215 observations). Traditional assets are represented by the Jakarta Composite Index (JCI) for stocks, an Indonesian government bond total return index for bonds, and the gold price in rupiah. Crypto assets are represented by five large coins that were traded throughout the period: Bitcoin (BTC), Ethereum (ETH), BNB, XRP, and Cardano (ADA), all priced in rupiah. The risk free rate is the average one month rupiah deposit rate (4.53% per year on average). Daily simple returns are used throughout.

Portfolio Design

Three baseline portfolios represent typical retail risk profiles (Table 1). Crypto is added at weights of 0, 1, 2.5, 5, 10, and 20%, financed proportionally from the traditional assets. In the main analysis the crypto allocation is held in Bitcoin; in a second analysis it is held in four alternative crypto baskets: Bitcoin only; Bitcoin and Ethereum in equal shares; an equal weight basket of the five coins; and a basket weighted approximately by market capitalization (BTC 60%, ETH 22%, BNB 8%, XRP 6%, ADA 4%). Portfolios are rebalanced to their target weights at the start of each month; a buy and hold version is also examined.

Table 1. Baseline retail portfolios

Portfolio	Stocks (JCI)	Bonds	Gold	Crypto allocation
Conservative	20%	70%	10%	0 to 20%, taken proportionally
Moderate	50%	40%	10%	0 to 20%, taken proportionally
Aggressive	80%	10%	10%	0 to 20%, taken proportionally

Risk and Performance Measures

For each portfolio, the study computes the annualized geometric return, annualized volatility, the Sharpe ratio (excess return over the deposit rate divided by volatility), the Sortino ratio (excess return divided by downside deviation), daily historical VaR and ES at 95%, and the maximum drawdown, defined as the largest percentage fall from a previous peak. The contribution of crypto to portfolio variance is computed with the Euler decomposition,

$$RC_i = w_i(\Sigma w)_i / (w' \Sigma w) \quad (1)$$

where w is the weight vector and Σ the annualized covariance matrix, so that the contributions sum to one (Maillard et al., 2010). The diversification ratio is $DR = \Sigma w_i \sigma_i / \sigma_p$ (Choueifaty & Coignard, 2008); a higher value means that the portfolio benefits more from imperfect correlations.

Correlation Regimes and Statistical Tests

To examine correlations in turbulent markets, stress days are defined as the 10% of days with the lowest JCI returns (222 days), following the conditional correlation approach of Longin and Solnik (2001), and correlations are compared between stress and calm days. Differences in Sharpe ratios between portfolios with and without crypto are tested with the stationary block bootstrap of Politis and Romano (1994), with an average block length of 20 days and 2,000 resamples, which accounts for fat tails and serial dependence in the spirit of Ledoit and Wolf (2008).

RESULTS AND DISCUSSION

Descriptive Statistics and Correlations

Table 2 shows the risk and return of each asset. Bitcoin has the highest annualized return (26.9%) but also an annualized volatility of 64.8%, about 4 times that of stocks and 14 times that of bonds, and its maximum drawdown reached 75.6%. The other coins are even more volatile and had much lower geometric returns; XRP and ADA lost value over the period despite positive average daily returns, because large losses compound heavily at such volatility.

Stocks returned 3.4% per year, below the deposit rate, while bonds and gold provided moderate returns with low volatility.

Table 2. Descriptive statistics of daily returns (annualized)

Asset	Return	Volatility	Sharpe	VaR 95%	ES 95%	Max drawdown	Kurtosis
Stocks (JCI)	3.4%	15.2%	-0.00	1.47%	2.33%	-38.1%	7.17
Government bonds	4.7%	4.5%	0.04	0.44%	0.68%	-5.7%	5.91
Gold	5.2%	12.6%	0.10	1.28%	1.79%	-24.9%	5.31
Bitcoin (BTC)	26.9%	64.8%	0.63	6.11%	9.95%	-75.6%	7.47
Ethereum (ETH)	3.9%	80.9%	0.40	7.97%	12.36%	-94.2%	6.84
BNB	3.7%	87.3%	0.45	8.10%	13.16%	-95.9%	10.97
XRP	-8.6%	95.9%	0.36	9.07%	14.51%	-98.5%	8.31
Cardano (ADA)	-27.1%	99.5%	0.15	9.28%	14.95%	-99.8%	6.83

Note: Return is the annualized geometric return; VaR and ES are daily historical measures at 95%, reported as positive losses; maximum drawdown is negative by definition. Source: simulated data.

Table 3 reports the correlations of Bitcoin with the other assets. Its full sample correlation is 0.24 with stocks, 0.04 with bonds, and 0.09 with gold, which confirms its potential as a diversifier of traditional assets. However, the correlation with stocks nearly doubles from 0.16 on calm days to 0.30 on stress days, and on stress days Bitcoin lost 1.87% on average, about as much as stocks (1.78%), whereas gold and bonds were roughly flat. The diversification benefit therefore weakens precisely when it is needed most. By contrast, the correlations among crypto assets are very high, between 0.78 and 0.81 with Bitcoin, and remain high in stress periods. Figure 1 shows that the correlation with stocks fluctuates over time and rises in turbulent episodes, while the correlation with Ethereum stays persistently high.

Table 3. Correlations of Bitcoin with other assets in calm and stress periods

Asset	Full sample	Calm days	Stress days	Mean return on stress days (%)
Stocks (JCI)	0.241	0.157	0.304	-1.782
Government bonds	0.036	0.030	-0.018	-0.060
Gold	0.090	0.107	0.009	0.009
Ethereum (ETH)	0.812	0.807	0.808	-2.271
BNB	0.808	0.801	0.809	-2.702
XRP	0.800	0.793	0.795	-3.047
Cardano (ADA)	0.784	0.775	0.796	-2.701
Bitcoin (BTC)				-1.868

Note: Stress days are the 222 days with JCI returns in the lowest decile. Source: simulated data.

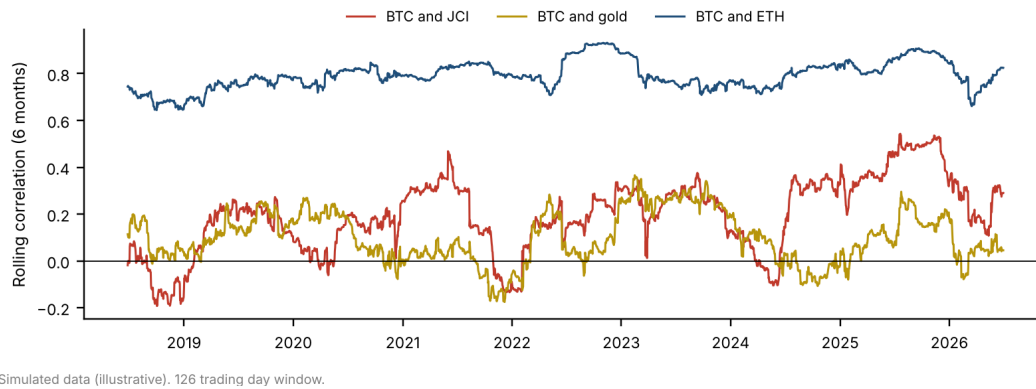


Figure 1. Rolling six month correlations of Bitcoin with stocks, gold, and Ethereum

Source: simulated data (illustrative).

Adding Crypto to Retail Portfolios

Table 4 reports the results for the moderate portfolio. Adding Bitcoin raises the annualized return steadily, from 4.4% without crypto to 6.5% with 5% and 12.4% with 20%. It also raises volatility, from 8.2% to 9.1% and 16.0%, and the daily ES, from 1.23% to 1.39% and 2.47%. In terms of volatility and tail risk, crypto therefore does not reduce portfolio risk at any allocation. The risk contribution shows why: a 5% allocation to Bitcoin accounts for 19.9% of the portfolio variance, and a 10% allocation for 44.8%, so that crypto quickly becomes the dominant source of risk.

Nevertheless, risk rises far less than proportionally. A 5% allocation adds 2.11 percentage points of return but only 0.96 percentage points of volatility, because of the low correlation with traditional assets, and the diversification ratio increases from 1.30 to 1.46. The Sharpe ratio rises from 0.02 to 0.24 and 0.39 with 10%. Moreover, small allocations reduce some forms of risk that matter to retail investors: the maximum drawdown falls from 17.8% without crypto to 16.3% with 2.5% and 16.6% with 5%, and the worst monthly loss falls from 6.4% to 5.9%, because Bitcoin's strong recoveries offset part of the losses of traditional assets in the deepest drawdown episodes. Beyond 5%, both measures deteriorate again; with 20% the worst monthly loss reaches 10.7%.

Table 4. Moderate portfolio with different Bitcoin allocations

BTC	Return	Volatility	Sharpe	Sortino	ES 95%	MDD	Worst month	BTC risk share	DR
0%	4.41%	8.19%	0.015	0.021	1.23%	-17.8%	-6.4%	0.0%	1.30
1%	4.84%	8.29%	0.066	0.090	1.25%	-17.2%	-6.3%	2.5%	1.35
2.5%	5.48%	8.53%	0.137	0.188	1.28%	-16.3%	-6.1%	7.9%	1.40
5%	6.53%	9.15%	0.242	0.334	1.39%	-16.6%	-5.9%	19.9%	1.46
10%	8.57%	11.00%	0.391	0.544	1.69%	-19.1%	-6.7%	44.8%	1.47
20%	12.41%	16.02%	0.528	0.738	2.47%	-24.9%	-10.7%	74.7%	1.35

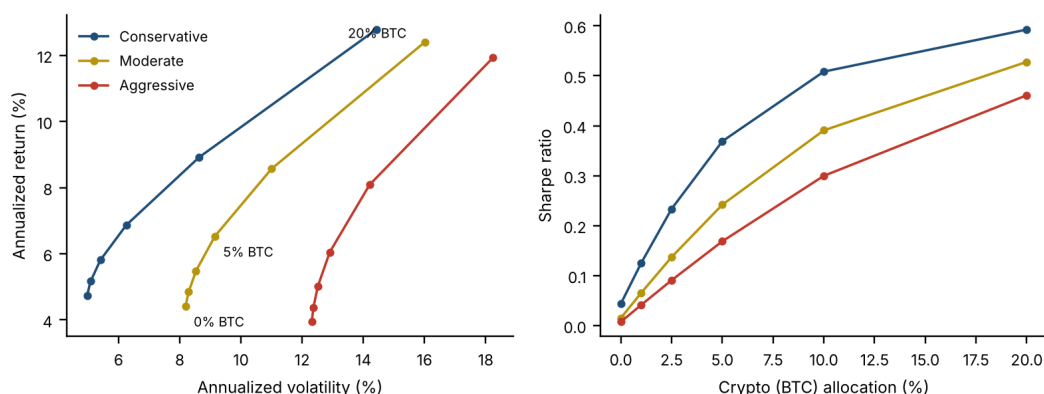
Note: Moderate portfolio (50% stocks, 40% bonds, 10% gold) with Bitcoin added proportionally; monthly rebalancing. MDD = maximum drawdown. BTC risk share is the Euler contribution of Bitcoin to portfolio variance; DR is the diversification ratio. Source: simulated data.

Table 5 and Figure 2 show that the same pattern holds for all three profiles. The effect on risk is proportionally largest for the conservative portfolio, whose volatility rises from 5.0% to 8.6% with 10% crypto, an increase of 74%, while for the aggressive portfolio the increase is 15%. The bootstrap tests indicate that a 5% allocation significantly improves the Sharpe ratio of the moderate (p = 0.038) and aggressive portfolios (p = 0.043), whereas for the conservative portfolio the improvement is significant only at the 10% level (p = 0.056). For 10% allocations, the point estimates of the gain are larger, but the 95% confidence intervals narrowly include zero for all three profiles (p between 0.055 and 0.063), reflecting the large estimation uncertainty created by crypto's volatility.

Table 5. Effect of Bitcoin allocations across risk profiles

Profile	BTC	Return	Volatility	Sharpe	MDD	Δ Sharpe	95% CI	p
Conservative	0%	4.73%	4.97%	0.044	-7.9%			
	5%	6.87%	6.25%	0.369	-9.3%	0.325	-0.010 to 0.669	0.056
	10%	8.92%	8.64%	0.508	-12.6%	0.464	-0.041 to 0.956	0.063
Moderate	0%	4.41%	8.19%	0.015	-17.8%			
	5%	6.53%	9.15%	0.242	-16.6%	0.227	0.008 to 0.449	0.038
	10%	8.57%	11.00%	0.391	-19.1%	0.375	-0.005 to 0.757	0.057
Aggressive	0%	3.94%	12.31%	0.008	-29.8%			
	5%	6.05%	12.90%	0.169	-27.4%	0.161	0.005 to 0.315	0.043
	10%	8.09%	14.20%	0.300	-26.0%	0.292	-0.003 to 0.574	0.055

Note: MDD = maximum drawdown. Δ Sharpe is the difference in annualized Sharpe ratio relative to the same profile without crypto; confidence intervals and p values from a stationary block bootstrap (2,000 resamples, mean block length 20 days). Source: simulated data.



Simulated data (illustrative). Each line adds 0, 1, 2.5, 5, 10, and 20% BTC, monthly rebalancing.

Figure 2. Risk, return, and Sharpe ratio of retail portfolios with increasing Bitcoin allocations
 Source: simulated data (illustrative).

Diversification Within the Crypto Allocation

Table 6 compares four ways of holding the crypto allocation. Because the coins are highly correlated, diversification within crypto yields only a small averaging benefit: the diversification ratio of the equal weight basket is only 1.12, compared with 1.30 for the moderate portfolio of stocks, bonds, and gold. More importantly, the basket is not less risky than Bitcoin alone: its volatility is 76.4% against 64.8% for Bitcoin, its maximum drawdown is 91.9% against 75.6%, and its return is lower. Adding coins that are individually more volatile than Bitcoin raises, rather than lowers, the risk of the crypto allocation, and the small correlation benefit is not enough to offset this. When the baskets are used as a 5% allocation in the moderate portfolio, Bitcoin alone produces the lowest volatility (9.15%), the lowest maximum drawdown, and the highest Sharpe ratio.

Table 6. Crypto baskets and their effect in the moderate portfolio

Crypto basket	Return	Volatility	ES 95%	MDD	DR	Port. vol.	Port. Sharpe	Port. MDD
BTC only	26.9%	64.8%	9.95%	-75.6%	1.000	9.15%	0.242	-16.6%
BTC and ETH	18.1%	69.4%	10.76%	-82.3%	1.050	9.31%	0.218	-17.9%
Equal weight	7.3%	76.4%	11.71%	-91.9%	1.121	9.56%	0.200	-17.6%
Cap weighted	20.0%	68.2%	10.54%	-83.1%	1.076	9.29%	0.226	-17.2%

Note: BTC and ETH in equal shares; equal and cap weighted baskets contain five coins. Left: the crypto basket alone. Right (Port.): the moderate portfolio with a 5% allocation to the basket; monthly rebalancing. MDD = maximum drawdown; DR = diversification ratio. Source: simulated data.

The Importance of Rebalancing

Table 7 compares the moderate portfolio with a 5% Bitcoin allocation under monthly rebalancing and under buy and hold. With monthly rebalancing, the Bitcoin share never exceeded 7.2% of the portfolio. Without rebalancing, Bitcoin's rallies allowed its share to drift to as much as 41.5%, and it stood at 23.0% at the end of the period. As a result, the buy and hold portfolio had about the same return (6.65% versus 6.53%) but twice the volatility (19.06% versus 9.15%), roughly double the ES, a maximum drawdown of 32.9% instead of 16.6%, and a lower Sharpe ratio. Rebalancing thus turns crypto from a growing source of risk into a controlled satellite position.

Table 7. Moderate portfolio with 5% Bitcoin: monthly rebalancing versus buy and hold

Strategy	Return	Volatility	Sharpe	ES 95%	MDD	Max BTC share	Final BTC share
Monthly rebalancing	6.53%	9.15%	0.242	1.39%	-16.6%	7.2%	4.1%
Buy and hold	6.65%	19.06%	0.196	3.09%	-32.9%	41.5%	23.0%

Note: MDD = maximum drawdown. Source: simulated data.

Discussion

Does crypto reduce risk? The answer depends on how risk is defined. In terms of volatility and tail risk, adding crypto never reduces the risk of a retail portfolio, because its volatility is so high that the averaging effect of a low correlation cannot offset it. This is consistent with Kajtazi and Moro (2019), who found that Bitcoin improves portfolios mainly through returns. In terms of risk per unit of return, however, small allocations improve portfolio efficiency, as found by Brière et al. (2015) and Platanakis and Urquhart (2020), and they can reduce drawdowns and the worst monthly losses when crypto recovers while traditional assets are still falling. The claim that crypto reduces risk is therefore misleading if it suggests that a portfolio becomes less volatile, but it has some substance for small allocations in terms of risk adjusted return and drawdowns.

Stress periods. The rise in correlation with stocks on stress days confirms Klein et al. (2018) and is consistent with the evidence of rising correlations in falling markets (Longin & Solnik, 2001). Crypto is a diversifier in normal times but not a safe haven (Bouri et al., 2017); gold and bonds play that role better. Retail investors should not expect crypto to protect them in a market crash.

Diversification within crypto. The finding that a basket of coins is riskier than Bitcoin alone agrees with Liu (2019) and Platanakis et al. (2018), and reflects the strong common factor in crypto returns. Diversification works by combining assets with low correlations; combining assets that move together, each more volatile than the last, adds risk. Holding many coins therefore gives retail investors a false sense of diversification.

Implications. For retail investors, the results support treating crypto as a small satellite position, of roughly 1 to 5% of the portfolio, financed from all asset classes, concentrated in the largest and least volatile coin, and rebalanced regularly. For crypto exchanges and financial planners, risk communication should emphasize that crypto increases portfolio volatility and contributes disproportionately to risk. For OJK, the findings support investor education that explains diversification correctly and discourages the marketing of crypto as a risk reducing asset.

CONCLUSION

This study examined the role of crypto asset diversification in reducing the portfolio risk of Indonesian retail investors. In this illustrative analysis, adding Bitcoin to conservative, moderate, and aggressive portfolios always raises volatility and tail risk, and a 5% allocation accounts for about 20% of the risk of the moderate portfolio. Because of its low correlation

with traditional assets, however, small allocations raise risk less than proportionally, significantly improve the Sharpe ratio, and reduce the maximum drawdown and the worst monthly loss. The diversification benefit weakens in stress periods, when the correlation with stocks rises. Spreading the crypto allocation over several coins does not reduce risk, because crypto assets are highly correlated and individually more volatile than Bitcoin, and rebalancing is essential to prevent a small allocation from growing into a dominant source of risk. Crypto therefore improves risk adjusted returns when held in small, rebalanced positions, rather than reducing risk in absolute terms.

The study has limitations. Most importantly, the present results are based on simulated returns, and the analysis must be repeated with actual market data before substantive conclusions can be drawn. In addition, the results depend on the sample period, which includes strong crypto rallies; transaction costs, taxes, and exchange fees were not considered; and the portfolios are stylized rather than observed holdings of actual investors. Future research could use account level data from Indonesian brokers and crypto exchanges, consider additional assets such as mutual funds and stablecoins, include transaction costs and taxes, and evaluate optimized allocations out of sample.

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