วารสารเศรษฐศาสตร์ประยุกต์และกลยุทธ์การจัดการ
ปีที่ 13 ฉบับที่ 2 พฤษภาคม-สิงหาคม 2569

Journal of Applied Economics and Management Strategy
Vol. 13, No. 2, May-August 2026

Equity–Cryptocurrency Substitution and Risk-Adjusted Portfolio Performance: A Comparative Study of Growth vs. Value Stocks Across Regions

Chavalit Kitkanasiri[1]

Received: February 27, 2026
Revised: August 25, 2026
Accepted: August 26, 2026

ABSTRACT

This study evaluates the risk-adjusted consequences of large-weight equity–cryptocurrency substitution and examines whether these effects differ systematically across equity styles (Growth vs. Value) and regions (Asia, Europe, and the Americas). Using daily data from January 1, 2021 to December 31, 2023, the analysis constructs style-segmented MSCI country equity indices and compares annual Sharpe ratios under four constant-mix, daily rebalanced strategies: (S1) 100% equity; (S2) 50% equity / 50% cryptocurrency; (S3) 50% equity / 50% global bonds; and (S4) 33.33% equity / 33.33% global bonds / 33.33% cryptocurrency. Five major non-stablecoin cryptocurrencies—Bitcoin (BTC), Ethereum (ETH), Ripple (XRP), Solana (SOL), and Binance Coin (BNB)—are evaluated individually to isolate coin-specific substitution effects. Performance is assessed annually and compared across Growth and Value portfolios within identical country–year–cryptocurrency environments to identify style-dependent outcomes. The results show that cryptocurrency substitution generally improves Sharpe ratios, but the effects are benchmark-, coin-, style-, and region-dependent. Improvements are more heterogeneous under direct 50% equity–crypto substitution, especially for Value portfolios, but become uniformly positive when crypto is introduced within an equity–bond benchmark. SOL provides the largest and most consistent improvements, while ETH and BNB are frequently strong and BTC is the least consistent. Growth portfolios benefit more than Value portfolios in Asia and the Americas, whereas Europe shows more style-neutral effects. Because cryptocurrency shocks are common within a given coin-year, statistical inference is interpreted as cross-market evidence rather than fully independent observations.

[1] Lecturer, School Science and Technology, University of Thai Chamber of Commerce.
E-mail: chavalit_kit@utcc.ac.th

Keywords: cryptocurrencies, Bitcoin, Ethereum, Solana, Ripple, Binance Coin, equity–crypto substitution, growth vs. value, Sharpe ratio, risk-adjusted performance, diversification

Background and Significance of the Research Problem

Cryptocurrencies have evolved from a niche innovation into an investable, volatile asset class with distinct return drivers. The question is how replacing substantial equity exposure with major cryptocurrencies affects risk-adjusted performance and whether effects differ between Growth and Value styles.

The Sharpe ratio measures excess return per unit of volatility. Prior research mainly treats cryptocurrencies as supplementary diversifiers in broad equity or multi-asset portfolios. Modest Bitcoin allocations may improve risk-adjusted performance through relatively low average correlations with traditional assets (Brière et al., 2015; Guesmi et al., 2019; Platanakis and Urquhart, 2020). However, crypto–equity dependence varies over time and may strengthen during market stress, making benefits regime-dependent (Bouri et al., 2017; Conlon and McGee, 2020; Ji et al., 2019). Cryptocurrency returns appear weakly explained by conventional equity factors (Liu and Tsyvinski, 2021), whereas Growth and Value portfolios differ in valuation, equity duration, volatility, and sensitivity to discount-rate and cash-flow shocks (Campbell and Vuolteenaho, 2004; Fama and French, 1993).

Nevertheless, studies emphasize marginal inclusion, provide little evidence of style-specific large-weight effects, rarely compare regions, and seldom assess coins separately rather than through one proxy. Whether substitution benefits vary by equity style, regional market structure, or coin-specific characteristics is unclear. This study compares large-weight substitution in Growth and Value portfolios across Asia, Europe, and the Americas and examines BTC, ETH, XRP, SOL, and BNB individually using constant-mix daily rebalancing.

Growth portfolios have high expected earnings growth, elevated valuation multiples, and longer equity duration, making them more sensitive to discount-rate changes and investor risk appetite and prone to higher variance and deeper drawdowns. Value portfolios, supported by lower valuations and stronger near-term cash flows, tend to be more defensive, with returns tied more closely to cash-flow news and cyclical breadth (Fama and French, 1993). These differences imply asymmetric crypto–style interactions.

Two mechanisms motivate segmentation. First, if major cryptocurrencies behave as risk-on assets, substitution may overlap more with Growth-style than Value-style exposure, amplifying cyclicality. Second, at substantial weights, a high-volatility asset can dominate portfolio variance. Growth's typically higher baseline volatility may make equal cryptocurrency weights generate different marginal risk contributions and Sharpe ratios across styles.

To preserve digital-asset heterogeneity, the study evaluates five major non-stablecoin cryptocurrencies—BTC, ETH, XRP, SOL, and BNB—separately (CoinMarketCap, 2024), accounting for differences in volatility regimes, liquidity, and market sensitivities (Ji et al., 2019; Narayanan et al., 2016). It tests structural substitution rather than marginal inclusion to determine how aggressive cryptocurrency tilts reshape risk-adjusted performance across styles and regions.

The study contributes by shifting attention to large-weight equity–cryptocurrency substitution, comparing Growth and Value portfolios across three regions, and identifying coin-specific effects. Large allocations may have long-term implications for portfolio volatility, drawdown risk, rebalancing needs, and risk budgeting. Economically, findings inform investors considering aggressive cryptocurrency exposure and policymakers monitoring the transmission of cryptocurrency-related risks into conventional portfolios.

Research Objectives

1. Evaluate how large-weight cryptocurrency substitution affects Sharpe ratios across equity and equity–bond portfolios in Asia, Europe, and the Americas.
2. Test whether these effects differ between Growth and Value styles within each region.

Literature Review

The study draws upon three areas of the literature: portfolio diversification and its implementation, cryptocurrencies as an asset class, and style investing. It aims to examine whether replacing a large part of portfolio holdings with cryptocurrency exposure leads to an improvement in Sharpe ratios and whether these effects differ between Growth and Value portfolios.

Portfolio Diversification

Modern portfolio theory provides the conceptual basis for evaluating the substitution of one asset class for another. In the mean–variance framework developed by Markowitz (1952), investors weigh expected return against variance, and efficiency is assessed in relation to the efficient frontier. The Sharpe ratio measures excess return per unit of total volatility and is employed to compare various portfolio setups (Sharpe, 1966). Caution is needed when drawing conclusions if returns are not normally distributed or if volatility varies over time. Lo (2002) shows that serial correlation and heteroskedasticity can result in misleading inferences based on the traditional Sharpe ratio, especially in the case of portfolios that include cryptocurrencies.

Cryptocurrencies as an Asset Class

Bitcoin and other major digital assets exhibit volatility clustering, heavy tails, and regime-like behavior that differs from that of traditional assets (Bariviera, 2017; Katsiampa, 2017). The integration effects thus depend not just on unconditional correlations but also on higher moments, volatility persistence, and state-dependent co-movement. Moreover, since cryptocurrency trading occurs continuously while equity indices are measured only on business days, there are timing asymmetries that can affect measured covariances and the outcomes of rebalancing.

Early studies viewed Bitcoin as a diversifying asset because it had low average correlations with traditional assets and produced better risk-adjusted portfolio performance when only small amounts were invested (Brière et al., 2015; Guesmi et al., 2019; Platanakis and Urquhart, 2020). Nevertheless, later research highlights conditional dependence. The safe-haven and hedging characteristics of Bitcoin vary depending on the economic environment and tend to weaken during major downturns in equity markets (Bouri et al., 2017; Conlon and McGee, 2020; Dyhrberg, 2016). Dynamic models show that correlations between crypto assets and equities vary over time and can become more intense during periods of stress (Diebold & Yilmaz, 2012; 2014; Engle, 2002), while copula analyses indicate that low average correlations might hide asymmetric tail dependence in the case of losses (Patton, 2006). The portfolio effects thus depend on the regime. Jayawardhana and Colombage (2024) find relatively low co-movement among cryptocurrency, equity, and debt markets across major regions, which supports the notion of diversification benefits; however, Ugolini et al. (2023) demonstrate that spillovers among cryptocurrency, DeFi, stock, and safe-haven assets change over time as financial conditions change.

Factor spanning is also important. Liu and Tsyvinski (2021) find that standard equity risk factors only weakly explain returns on cryptocurrencies and that different premia may be attributed to technology adoption, network growth, and investor attention. It therefore follows that substitution may alter systematic factor exposures rather than merely redistribute volatility. Liu et al. (2022) identify cryptocurrency market, size, and momentum factors as common factors driving returns, while Kogan et al. (2024) find that retail investors use momentum-like strategies when trading cryptocurrencies but adopt more contrarian trading strategies in stocks and gold. These patterns help to account for changes in exposures and return paths when constant-mix rebalancing is applied.

Style Investing and Equity-Style Segmentation

The distinctions between Growth and Value investment styles are well known. Fama and French (1993) document persistent differences associated with book-to-market returns, while Lakonishok et al. (1994) attribute the superior performance of Value stocks to behavioral mispricing. Campbell and Vuolteenaho (2004) split returns into cash-flow and discount-rate components and find that Growth portfolios are more sensitive to shocks in the discount rate, a finding that is consistent with their longer equity duration. Growth stocks generally have higher volatility and are more affected by sentiment, while Value stocks are more closely related to cash flow and are less exposed to speculative risk. It therefore follows that high-volatility cryptocurrency substitution might have an asymmetric impact on the different styles.

Momentum and profitability also interact differently with Growth and Value portfolios. Carhart (1997) identifies the role of momentum in cross-sectional returns, and Novy-Marx (2013) demonstrates that profitability further distinguishes style exposures. Since cryptocurrency returns can display strong trend persistence over certain periods, substitution effects may depend on volatility and on the joint evolution of momentum and discount-rate sensitivity.

Portfolio Implementation and Rebalancing Effects

By selling assets that are performing well and purchasing those that are performing poorly, constant-mix strategies bring portfolio weights back to their target levels. When volatility is high and mean reversion is present, this approach can exploit volatility and thus improve realized Sharpe ratios; however, in markets that are strongly trending or dominated by jumps, frequent rebalancing can reduce performance and increase turnover (Perold and Sharpe, 1988). In the case of cryptocurrencies with very high volatility, daily rebalancing connects return paths to the process of restoring weights, so that Sharpe-ratio outcomes become dependent on path dynamics rather than just on unconditional variance and correlation.

Liquidity also has an impact on the implementation process. Pástor and Stambaugh (2003) demonstrate that liquidity risk is priced in equity markets, whereas cryptocurrency markets introduce fragmentation, heterogeneous exchange depth, and funding dynamics based on derivatives. Although large-cap cryptocurrencies are more liquid than smaller digital assets, turnover and slippage remain important under daily rebalancing. Daily-rebalancing Sharpe-ratio improvements should therefore be interpreted as gross of costs if trading frictions are not taken into account.

Generally, when incorporating cryptocurrencies, one must consider non-normal returns, conditional and downside dependence, volatility persistence, factor exposures, liquidity, and the mechanics of rebalancing. These factors may vary between Growth and Value portfolios since the two investment styles differ in volatility, factor exposure, and responsiveness to economic shocks. Although most previous research has concentrated on relatively low levels of cryptocurrency inclusion, less attention has been paid to large-weight substitution and the way it interacts with equity style. This study addresses that gap by examining high-weight equity–crypto substitution, incorporating Growth–Value segmentation, carrying out regional disaggregation, and implementing constant-mix daily rebalancing. It therefore focuses on structural rather than marginal integration effects.

The Sharpe ratio is the main criterion used to evaluate substitution performance. Each strategy that involves a cryptocurrency is compared with its corresponding equity or equity–bond benchmark. The style differential examines improvements in the Sharpe ratio for Growth and Value portfolios within the same country, year, and cryptocurrency environment. This method examines whether replacing a large part of portfolio holdings with cryptocurrency exposure increases portfolio efficiency on a risk-adjusted basis and whether the economic effects of such substitution vary systematically across equity styles and regions.

Hypothesis

The hypotheses are stated in terms of Sharpe ratio differences induced by cryptocurrency substitution.

H_{01} (No Substitution Effect): Substituting equity exposure with a major cryptocurrency does not improve the Sharpe ratio of the relevant benchmark portfolio.

H_{11} (Substitution Effect): Substituting equity exposure with a major cryptocurrency improves the Sharpe ratio in at least one region/style setting.

H_{02} (No Style Differential): Sharpe ratio changes from cryptocurrency substitution do not differ between Growth and Value equity portfolios within a region.

H_{12} (Style Differential): Sharpe ratio changes from cryptocurrency substitution differ between Growth and Value equity portfolios within at least one region.

Research Scope

The sample spans January 1, 2021, to December 31, 2023, a period marked by post-pandemic normalization, rapid monetary tightening, elevated inflation volatility, and pronounced cryptocurrency boom–bust dynamics. These conditions provide a suitable setting for evaluating substitution effects because they include substantial discount-rate shocks, shifts in global risk appetite, Growth–Value performance differentials, and cryptocurrency regime changes.

The period also captures meaningful variation in the risk and return of both equity styles and cryptocurrencies. Although the three-year sample limits generalizability across all market cycles, it provides a focused setting for examining large-weight equity–cryptocurrency substitution during substantial macroeconomic and cryptocurrency-market stress. The study is therefore limited to 2021–2023, the regional groups of Asia, Europe, and the Americas, and five major non-stablecoin cryptocurrencies.

Research Methodology

Data

Equity data from Eikon Datastream comprise U.S. dollar–denominated MSCI Growth and Value Adjusted Price Indices for 15 countries, with five countries per region. By incorporating dividends, these indices capture total returns from capital appreciation and income. This adjustment is essential because Value portfolios typically have higher dividend yields than Growth portfolios; unadjusted indices would mechanically understate Value returns and distort Sharpe ratio comparisons. Adjusted indices therefore better reflect realized risk-adjusted performance, while a common U.S. dollar numeraire ensures cross-country comparability.

Markets across Asia, Europe, and the Americas were selected using three criteria. First, global significance: large, liquid economies representing substantial shares of global equity capitalization, global GDP, and the investable universe covered by benchmarks such as the MSCI All Country World Index (ACWI) ensure relevance for globally diversified strategies. Second, comparability: MSCI's uniform factor-based Growth–Value methodology minimizes cross-country construction inconsistencies, allowing Sharpe ratio differences to reflect economic rather than index-design variation. Third, structural heterogeneity: the sample includes developed markets—the United States, Germany, Japan, the United Kingdom, France, Canada, Italy, and Spain—and emerging markets—China, India, Brazil, Indonesia, Mexico, Colombia, and Taiwan. These markets differ in efficiency, liquidity, monetary policy transmission, investor composition, capital mobility, regulation, and sensitivity to global liquidity and dollar funding. Such differences may affect global risk transmission and cryptocurrency–equity style interactions across advanced and emerging financial systems.

Collectively, the sample provides a broad, economically meaningful, and regionally dispersed representation of the global investable equity universe, supporting generalizable conclusions for global and regional portfolios. Table 1 presents the selected indices by region.

Table 1 MSCI Growth and Value Adjusted Price Indices (USD), by Region. Each country includes both MSCI Growth and Value indices; all indices are denominated in USD.

Region	Countries
Asia	China, Japan, India, Indonesia, Taiwan
Americas	United States, Brazil, Canada, Mexico, Colombia
Europe	Germany, United Kingdom, France, Italy, Spain

Bond exposure uses the USD-denominated MSCI Global Bond Index (I31667) from Bloomberg Terminal. Its broad global fixed-income coverage supports a conventional equity–

bond comparison portfolio. For Sharpe ratios, the risk-free rate is the annual average 3-month U.S. Treasury bill yield in year *y* from Investing.com. Minimal credit risk and limited duration exposure make it an appropriate near-risk-free benchmark for USD-denominated assets.

CoinMarketCap (2024) provides prices for Bitcoin (BTC), Ethereum (ETH), Ripple (XRP), Solana (SOL), and Binance Coin (BNB). These major non-stablecoins are analyzed individually, not as a basket, because volatility regimes and market sensitivities differ (Ji et al., 2019).

Equity and bond indices follow business-day calendars, whereas cryptocurrencies trade continuously. To prevent asynchronous pricing effects, returns use a common business-day calendar. Non-trading-day cryptocurrency returns, including cumulative weekend returns, are assigned to the next equity trading day, maintaining a consistent portfolio rebalancing and measurement timeline across assets. Daily returns are simple close-to-close percentage returns.

Empirical Analysis

The study uses a structured portfolio comparison with daily constant-mix rebalancing and annual Sharpe ratio estimation (Perold and Sharpe, 1988; Sharpe, 1966; 1994). For each equity index, four strategies are assessed: S1, 100% equity; S2, 50% equity and 50% cryptocurrency; S3, 50% equity and 50% MSCI Global Bond Index (I31667); and S4, 33.33% each in equity, global bonds, and cryptocurrency. The cryptocurrency weights in S2 and S4 are intentionally high to evaluate substitution effects rather than marginal inclusion. All portfolios are rebalanced daily to maintain constant target weights. Let $r_{j,t}$ denote the daily return of asset j on day t, and let w_j denote its target portfolio weight. Under daily constant-mix rebalancing, the portfolio return on day t is calculated using the standard weighted-average portfolio return formula (Bodie et al., 2021):

$$R_{p,t} = \sum_{j=1}^{J} w_j \ r_{j,t}$$

This implementation implies that portfolio performance depends on the joint return path of constituent assets under repeated weight restoration.

Daily portfolio returns are computed first. Annual return for portfolio p in year y is calculated using geometric compounding of daily returns (Bodie et al., 2021):

$$R_{p,y}^{(ann)} = \prod_{t=1}^{N_y}(1 + R_{p,t}) - 1$$

Where N_y denotes the number of trading days in year y.

Annualized volatility is derived from the standard deviation of daily returns within the same year (Bodie et al., 2021):

$$\sigma^{(ann)}_{p,y} = \sigma_{daily} \times \sqrt{252}$$

Where σ_{daily} is the sample standard deviation of daily returns in year y, and 252 represents the standard approximation for the number of trading days in a year (Bodie et al., 2021).

This approach ensures that annual return reflects compounded performance, while volatility preserves the information contained in daily return dispersion.

The annual Sharpe ratio (Sharpe, 1966; 1994) for portfolio p in year y is defined as:

$$SR_{p,y} = \frac{R^{(ann)}_{p,y} - R_{f,y}}{\sigma^{(ann)}_{p,y}}$$

Where $R_{f,y}$ is the annual yield of the 3-month U.S. Treasury bill for year y.

Because all portfolio returns are expressed in U.S. dollars, the 3-month U.S. T-bill serves as an appropriate risk-free benchmark consistent with the currency denomination of the asset universe.

Sharpe ratios are computed separately for 2021, 2022, and 2023 to preserve regime-specific variation and avoid smoothing across distinct macroeconomic environments.

To measure the impact of substituting equity exposure with cryptocurrency, the Sharpe ratio improvement is defined as:

$$d^{(A)}_{i,y,c} = SR_{S2,i,y,c} - SR_{S1,i,y}$$

Where:

i indexes the country–style equity portfolio,

y indexes the year,

c indexes the cryptocurrency.

Within each region and style (Growth or Value), five countries observed over three annual subperiods yield 15 Sharpe improvement observations per coin.

The hypothesis test is:

$$H_0: \mathbb{E}\left[d^{(A)}\right] \leq 0 \text{ vs } H_1: \mathbb{E}[d^{(A)}] > 0$$

This comparison—hereafter referred to as “Test A”—constitutes the empirical implementation of Hypothesis H_{01} (No Substitution Effect) versus H_{11} (Substitution Effect), as defined in Section 4. Statistical significance is evaluated using a one-sided one-sample t-test of whether the mean Sharpe improvement is greater than zero within each region and style.

To assess whether cryptocurrency substitution enhances risk-adjusted performance relative to a conventional equity–bond allocation, Sharpe improvement is defined as:

$$\mathrm{d}^{(\mathrm{B})}_{\mathrm{i,y,c}} = \mathrm{SR}_{\mathrm{S4,i,y,c}} - \mathrm{SR}_{\mathrm{S3,i,y}}$$

i indexes the country–style equity portfolio,

y indexes the year,

c indexes the cryptocurrency.

The inference structure mirrors Test A. For each region and style, 15 observations per coin are used to test:

$$\mathrm{H_0}: \mathbb{E}\left[\mathrm{d}^{(\mathrm{B})}\right] \leq 0 \text{ vs } \mathrm{H_1}: \mathbb{E}[\mathrm{d}^{(\mathrm{B})}] > 0$$

This comparison—hereafter referred to as “Test B”—constitutes an additional empirical implementation of Hypothesis H_{01} (No Substitution Effect) versus H_{11} (Substitution Effect), applied to the equity–bond benchmark context. Statistical significance is evaluated using a one-sided one-sample t-test of whether the mean Sharpe improvement is greater than zero within each region and style.

To determine whether substitution effects differ systematically between Growth and Value portfolios, a paired comparison is conducted within identical country–year–cryptocurrency environments.

For each country k, year y, and cryptocurrency c, the style differential is defined as:

$$\Delta_{\mathrm{k,y,c}} = \mathrm{d}_{\mathrm{G,k,y,c}} - \mathrm{d}_{\mathrm{V,k,y,c}}$$

where G and V denote Growth and Value portfolios, respectively.

Because Growth and Value Sharpe improvements are computed within the same country–year–cryptocurrency cell, this paired structure isolates style-specific substitution effects while holding fixed the macroeconomic and cryptocurrency return environment. Within each region, these differentials are pooled across BTC/ETH/BNB/XRP/SOL, yielding n = 75 observations per region (5 countries × 3 years × 5 cryptocurrencies).

This comparison—hereafter referred to as “Test C” — constitutes the empirical implementation of Hypothesis H_{02} (No Style Differential) versus H_{12} (Style Differential), as defined in Section 4. The corresponding hypothesis test is:

$$\mathrm{H_0}: \mathbb{E}[\Delta] = 0 \text{ vs } \mathrm{H_1}: \mathbb{E}[\Delta] \neq 0.$$

Two-tailed one-sample *t* tests assess regional pooled Growth–Value differentials against zero, reflecting no directional assumption. Despite common coin-year cryptocurrency returns, daily rebalancing yields index-specific Sharpe effects via style volatility, dispersion, and time-varying co-movement, supporting cross-market panel inference with shared shocks. Assuming negligible costs relative to daily large-cap equity and major cryptocurrency returns, results reflect gross-of-cost constant-mix performance; frictions may attenuate Sharpe gains and economic significance. Rebalancing may induce turnover and volatility harvesting but stabilizes target risk weights. Without it—especially at 50% substitution—sharp cryptocurrency moves may cause drift, variance dominance, and allocation distortion; rebalancing preserves strategic design through risk control, not performance optimization.

Results

Table 2 reports mean Sharpe ratio improvements, d = SR(S2) - SR(S1) for each cryptocurrency by region and style (2021–2023); n=15 country-year observations per region–style–coin). Reported t-statistics come from one-sample right-tailed tests of H_0: E[$\triangle$SR] = 0 versus H_1: E[$\triangle$SR] > 0

Panel A (Growth) shows positive Sharpe improvements. Asia supports all coins: SOL (1.335), ETH (0.803), BNB (0.767), and BTC (0.539). Europe supports ETH, BNB, XRP, and SOL (1.153); BTC (0.346) is marginal. The Americas support ETH, BNB, XRP, and SOL; BTC (0.341) is positive but unsupported. Growth most consistently favors 50/50 substitution with SOL, ETH, or BNB.

Panel B (Value) is positive but uneven. Regional support follows: Asia—ETH (0.602), XRP (0.453), SOL (1.091); Europe—ETH (0.477), BNB (0.511), SOL (1.070), with marginal XRP; and the Americas—BNB (0.438), SOL (1.049), with weaker or marginal ETH and XRP. BNB is weaker in Asia; BTC is unsupported across regions (Asia: 0.339) and least reliable.

Strategy 2's 50% crypto weight makes risk crypto-dominated; low correlation alone is insufficient. Improvements reflect 2021–2023 coin return-to-risk profiles and daily constant-mix interactions, including path-dependent volatility harvesting. They identify coin–equity settings where returns or rebalancing offset volatility. SOL leads, ETH and BNB follow, and BTC trails, confirming coin-specific—not generic—effects.

Table 2 reports averages across three regimes. Weak or negative 2022 equity Sharpe ratios coincided with weaker or adverse country–coin cells; 2021 and 2023 were strongly positive. Test A shows average, not annual, gains in gross-of-cost, daily-rebalanced constant-mix—not buy-and-hold—performance.

Table 2 Equity–crypto substitution (50% equity / 50% cryptocurrency) vs. 100% equity, by region and style

Panel A. Growth portfolios

Cryptocurrency	Asia	Europe	Americas
BTC	0.539**	0.346*	0.341
	(1.94)	(1.59)	(1.27)
ETH	0.803***	0.547***	0.576**
	(3.33)	(3.29)	(1.80)
BNB	0.767**	0.573**	0.580**
	(2.43)	(2.38)	(2.38)
XRP	0.685***	0.341**	0.467**
	(3.17)	(2.45)	(2.05)
SOL	1.335**	1.153**	1.202**
	(2.58)	(2.61)	(2.31)

Panel B. Value portfolios

Cryptocurrency	Asia	Europe	Americas
BTC	0.339	0.289	0.207
	(1.33)	(1.12)	(0.68)
ETH	0.602**	0.477**	0.432*
	(2.52)	(2.26)	(1.57)
BNB	0.563*	0.511**	0.438**
	(1.70)	(1.91)	(1.86)
XRP	0.453**	0.274*	0.319*
	(1.99)	(1.63)	(1.64)
SOL	1.091**	1.070**	1.049**
	(2.17)	(2.14)	(2.03)

Note: Each cell reports the mean Sharpe ratio improvement $\Delta SR = SR(S2) - SR(S1)$, computed from annual Sharpe ratios for 2021–2023 across five countries per region (n = 15 observations per region–style–coin). t-statistics from one-sample right-tailed t-tests of H_0: $E[\Delta SR] = 0$ versus H_1: $E[\Delta SR] > 0$ are shown in parentheses. *, **, *** denote significance at the 10%, 5%, and 1% levels (one-tailed p-values).

The benchmark sensitivity visible in Test A motivates Test B: adding a stabilizing bond sleeve may change the return–risk mapping and make Sharpe improvements more uniform, which is examined in Table 3.

Table 3 reports mean Sharpe ratio improvements, d=SR(S4)-SR(S3), where S3 is the equity–bond benchmark (50% equity / 50% global bonds) and S4 substitutes one third of that benchmark into a cryptocurrency sleeve (33.33% equity / 33.33% bonds / 33.33% cryptocurrency). Results are computed from annual Sharpe ratios for 2021–2023 across five countries per region (n=15 country year observations per region–style–coin). Reported t statistics come from one sample right tailed tests of H_0:E[d]≤0 versus H_1:E[d]>0. It exhibits uniform substitution effects. In Panel A (Growth), all five cryptocurrencies generate positive, statistically significant mean Sharpe ratio improvements across Asia, Europe, and the Americas. Effects near or above 1.0 indicate risk-adjusted gains from a one-third cryptocurrency sleeve under constant-mix implementation. Gains include SOL in Europe (1.410) and the Americas (1.583) and XRP in Asia (1.642); signs and significance remain stable across coins and regions.

Panel B (Value) contrasts with Test A: mixed equity-only evidence becomes uniformly positive under the equity–bond benchmark. BTC improvements are significant in Asia (0.708), Europe (0.529), and the Americas (0.539). Adding bonds and reducing exposure from 50% to 33.33% extends improvements across styles and regions.

Relative to equity alone, lower baseline volatility and a smaller sleeve limit cryptocurrency’s contribution to total risk, allowing incremental returns and constant-mix rebalancing to raise Sharpe ratios. During 2021–2023 with daily rebalancing, cryptocurrency functions better as a balanced-portfolio diversifier than as a one-half equity substitute. Results, gross of costs, do not guarantee annual gains or persistence under trading frictions, but provide cross-market evidence across regions, coins, and styles.

Table 3 Equity–bond–crypto substitution (33.33%/33.33%/33.33%) vs. equity–bond (50%/50%), by region and style

Panel A. Growth portfolios			
Cryptocurrency	Asia	Europe	Americas
BTC	0.782***	0.555***	0.642***
	(3.72)	(3.19)	(2.99)
ETH	1.049***	0.781***	0.917***
	(3.14)	(4.73)	(2.86)
BNB	1.071***	0.816***	0.912***
	(5.02)	(3.00)	(4.28)
XRP	1.642***	0.581***	0.818***
	(3.43)	(3.62)	(3.80)
SOL	0.964***	1.410***	1.583***
	(4.58)	(3.30)	(3.33)

Table 3 (Continue)

Panel B. Value portfolios			
Cryptocurrency	**Asia**	**Europe**	**Americas**
BTC	0.708***	0.529***	0.539**
	(3.77)	(2.67)	(2.44)
ETH	0.975***	0.741***	0.805***
	(2.82)	(3.90)	(2.97)
BNB	1.000***	0.785***	0.803***
	(4.67)	(2.73)	(4.49)
XRP	1.534***	0.545***	0.702***
	(3.34)	(3.10)	(4.41)
SOL	0.864***	1.361***	1.463***
	(3.83)	(2.93)	(3.22)

Note: Each cell reports the mean Sharpe ratio improvement $\triangle SR$ = SR(S4) – SR(S3), computed from annual Sharpe ratios for 2021–2023 across five countries per region (n = 15 observations per region–style–coin). S3 is 50% equity / 50% global bonds; S4 is equal-weight equity / global bonds / cryptocurrency (33.33%/33.33%/33.33%). t-statistics from one-sample right-tailed t-tests of H0: E[$\triangle SR$] = 0 versus H1: E[$\triangle SR$] > 0 are shown in parentheses. *, **, *** denote significance at the 10%, 5%, and 1% levels (one-tailed p-values).

Table 4 tests whether the Sharpe improvement from crypto substitution is larger for Growth than for Value within each region. For each country–year–coin cell, the style differential is computed as (d_G-d_V) = $\triangle SR_{Growth}$ – $\triangle SR_{Value}$ and then pooled across BTC/ETH/BNB/XRP/SOL (n = 75 per region). Because there is no requirement that Growth must dominate Value a priori, the tests are two sided and the table reports 95% confidence intervals for the pooled mean.

Panel A (Test A; S2–S1) shows Growth's strongest advantage in Asia (*M* = 0.2165, very small p value, 95% CI [0.1453, 0.2876]); across countries, years, and coins, equity–crypto substitution raises Growth's Sharpe approximately 0.22 units above Value's. The Americas show a smaller supported advantage (*M* = 0.1444, 95% CI [0.0238, 0.2650]); Europe is positive but nonsignificant (*M* = 0.0678, 95% CI [-0.0117, 0.1473]).

Panel B (Test B; S4–S3) shows the same regional pattern at smaller magnitudes: Asia (*M* = 0.0861, 95% CI [0.0216, 0.1506]) and the Americas (*M* = 0.1122, 95% CI [0.0200, 0.2045]) favor Growth; Europe is nonsignificant (*M* = 0.0373; CI crosses zero).

Style dependence is regional: equity-only and equity–bond benchmarks favor Growth in Asia and the Americas; Europe appears style-neutral, although both styles may benefit, especially in Test

B. The smaller Test B gap, particularly in Asia, is economically coherent: reducing crypto from 50% to 33.33% in an equity–bond mix dampens style-specific volatility and comovement while Sharpe improvements remain broadly positive.

Table 4 tests improvement differences, not post-substitution Sharpe levels. Pooling correlated coins under common crypto return environments implies cross-market asymmetry, not 75 fully independent draws. Observed asymmetry consistently favors Growth.

Table 4 Growth–Value style differential in Sharpe improvements, pooled across cryptocurrencies

Panel A. Style differential for Test A (ΔSR(S2–S1): Growth – Value), pooled across coins					
Region	**n**	**Mean (G–V)**	**t-stat**	**p-value**	**95% CI**
Asia	75	0.2165***	6.0627	5.18e-08	[0.1453, 0.2876]
Europe	75	0.0678*	1.7003	0.0933	[−0.0117, 0.1473]
Americas	75	0.1444**	2.3851	0.0196	[0.0238, 0.2650]
Panel B. Style differential for Test B (ΔSR(S4–S3): Growth – Value), pooled across coins					
Region	**n**	**Mean (G–V)**	**t-stat**	**p-value**	**95% CI**
Asia	75	0.0861***	2.6615	0.0095	[0.0216, 0.1506]
Europe	75	0.0373	1.4199	0.1599	[−0.0151, 0.0897]
Americas	75	0.1122**	2.4239	0.0178	[0.0200, 0.2045]

Note: Within each region, (ΔSR_Growth – ΔSR_Value) is computed at the country–year–coin level and pooled across BTC/ETH/BNB/XRP/SOL (n = 75). p-values are two-sided; 95% confidence intervals are for the pooled mean. Significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Discussion

This study reframes cryptocurrency allocation as equity–crypto substitution, not marginal inclusion, and tests large-weight effects on risk-adjusted performance by Growth versus Value across Asia, Europe, and the Americas. Daily constant-mix effects are positive but vary by benchmark, coin, style, and region; interpretation uses risk-budgeting, factor-substitution, behavioral, and dynamic-rebalancing mechanisms.

Test A (S2–S1; 50% crypto) yields heterogeneous gains, especially for Value portfolios and BTC in some regions; Test B (S4–S3; 33.33% crypto within an equity–bond benchmark) yields uniform gains across regions, styles, and coins. At 50%, crypto dominates volatility, demanding offsetting excess return and equity–crypto rebalancing. Test B lowers this hurdle because bonds dampen volatility and the smaller sleeve reduces the denominator’s volatility cost. Under mean–variance and risk-budgeting principles, diversification depends on return, correlation, weight, and replaced-asset risk.

Substitution reduces regional market and style exposures while adding crypto-market, size, momentum, liquidity, network, and investor-attention exposures (Liu and Tsyvinski, 2021; Liu et al., 2022). Higher Sharpe ratios may reflect rewarded crypto-specific systematic risk rather than factor-neutral alpha; factor regressions must distinguish exposure changes from residual performance.

Coin-specific effects emerge in Test A: SOL—and often ETH and BNB—generates the strongest, most consistent gains; BTC is least consistent, especially for Value portfolios and the Americas. At large weights, Sharpe reflects sleeve return-to-risk profiles and daily weight restoration: weak performance or unfavorable equity co-movement limits gains, whereas stronger performance or rebalancing interactions raise them. Investor attention, momentum, and speculative demand may explain differences (Kogan et al., 2024; Liu and Tsyvinski, 2021), but rankings are sample-specific, not permanent.

Low correlation alone is insufficient. Constant-mix outcomes are path-dependent and include a rebalancing premium or penalty (Perold and Sharpe, 1988). Daily rebalancing sells crypto during persistent rallies, sacrificing buy-and-hold upside, and buys during declines, increasing exposure prematurely. With relative-return reversals, it buys weakness and sells strength. Thus, gains are gross-of-cost constant-mix outcomes, not universal buy-and-hold evidence; this matters especially when Test A's crypto sleeve dominates risk.

Test C finds Growth exceeding Value in Asia and the Americas, with style neutrality in Europe. Baseline volatility, trends, time-varying equity–crypto co-movement, and market, sector, profitability, investment, momentum, and value-factor exposures may alter crypto's marginal Sharpe effect. Shared risk-appetite, liquidity, narrative, and momentum sensitivities may raise Growth–crypto co-movement during risk-on and risk-off episodes. Stronger Growth results do not imply lower correlation; realized crypto returns and rebalancing apparently offset covariance costs. The Growth–Value gap narrows in Test B because lower crypto weight and bonds reduce style-specific volatility and co-movement effects.

Prior studies find modest crypto allocations improve risk-adjusted performance (Platanakis and Urquhart, 2020; Symitsi and Chalvatzis, 2019), but benefits are time-varying, allocation-dependent, and weaker during equity stress (Bouri et al., 2020; Conlon et al., 2020). Global crypto–equity–debt diversification is possible, but spillovers vary with financial conditions (Jayawardhana and Colombage, 2024; Ugolini et al., 2023). Higher average Sharpe ratios do not establish downside protection or universal safe-haven status. Thus, the results extend rather than contradict prior work.

The contributions comprise large-weight substitution, where mechanics and frictions matter; regional and style disaggregation; coin-level analysis; and linkage to daily constant-mix implementation, where assets and rebalancing jointly shape outcomes.

Nominal crypto weights may understate total risk. Investors should assess marginal and total risk, evaluate each coin against the policy benchmark, impose coin-specific limits, and stress-test drawdowns, higher equity–crypto correlations, and alternative rebalancing frequencies. Transaction costs, bid–ask spreads, market impact, custody, taxation, liquidity constraints, and turnover must be included before gross Sharpe gains are deemed implementable.

Policymakers, regulators, and product providers should disclose crypto's volatility and tail-risk contributions, claimed benchmark, rebalancing rule, and liquidity and cost assumptions. Coins' differing volatility, liquidity, behavior, and factor exposures preclude homogeneous treatment. These governance and disclosure implications neither assess systemic financial risk nor specify an optimal regulatory framework.

During 2021–2023, disciplined constant-mix substitution was associated with higher average Sharpe ratios across many region–style settings, most robustly within diversified equity–bond benchmarks rather than 50% direct equity replacement. The results do not establish a universal crypto safe haven, permanent coin rankings, or optimal experimental weights; they remain regime- and implementation-dependent.

Suggestions

Several extensions would strengthen realism and robustness without changing the substitution framing. Effects vary across benchmarks, cryptocurrencies, regions, and equity styles. Test B suggests smaller allocations in equity–bond portfolios may be more reliable than replacing 50% of equity, although the tested weights are not optimal.

Gross-of-cost daily constant-mix results assume low costs. Future research should estimate turnover, apply coin-specific costs of 5–50 basis points per trade, recalculate net Sharpe ratio improvements, and test weekly or monthly rebalancing. Persistence would reduce concerns about high-frequency "volatility harvesting."

Nonnormal, heteroskedastic returns require supplementing Sharpe ratios with maximum drawdown, conditional value at risk (expected shortfall), or Sortino ratios. Worse tail outcomes would qualify the conclusions; persistent downside-risk improvements would strengthen the diversification evidence.

Although assigning weekend returns from continuous cryptocurrency trading to the next business day is reasonable, synchronized timestamps could alter sequencing, covariance, turnover, and path-dependent Sharpe improvements.

Managers should assess total risk contributions, set coin-specific limits, use actual policy benchmarks, stress-test crashes and higher equity–cryptocurrency correlations, incorporate costs and turnover into rebalancing frequency, and report downside-risk metrics. These extensions would show whether substitution effects survive implementation assumptions, calendar conventions, and tail-risk evaluation, thereby strengthening external credibility.

References

Bariviera, A. F. (2017). The inefficiency of Bitcoin revisited: A dynamic approach. *Economics Letters*, *161*, 1–4. https://doi.org/10.1016/j.econlet.2017.09.013

Bodie, Z., Kane, A., & Marcus, A. J. (2021). *Investments* (12th ed.). McGraw-Hill Education.

Bouri, E., Molnár, P., Azzi, G., Roubaud, D., & Hagfors, L. I. (2017). On the hedge and safe haven properties of Bitcoin: Is it really more than a diversifier? *Finance Research Letters*, *20*, 192–198. https://doi.org/10.1016/j.frl.2016.09.025

Bouri, E., Shahzad, S. J. H., Roubaud, D., Kristoufek, L., & Lucey, B. M. (2020). Bitcoin, gold, and commodities as safe havens for stocks: New insight through wavelet analysis. *The Quarterly Review of Economics and Finance*, *77*, 156–164. https://doi.org/10.1016/j.qref.2020.03.004

Brière, M., Oosterlinck, K., & Szafarz, A. (2015). Virtual currency, tangible return: Portfolio diversification with Bitcoin. *Journal of Asset Management*, 16(6), 365–373. https://doi.org/10.1057/jam.2015.5

Campbell, J. Y., & Vuolteenaho, T. (2004). Bad beta, good beta. *American Economic Review*, 94(5), 1249–1275. https://doi.org/10.1257/0002828043052240

Carhart, M. M. (1997). On persistence in mutual fund performance. *The Journal of Finance*, 52(1), 57–82. https://doi.org/10.1111/j.1540-6261.1997.tb03808.x

CoinMarketCap. (2024, November 11). *Cryptocurrency historical data snapshot* [Data set]. https://coinmarketcap.com/historical/

Conlon, T., & McGee, R. (2020). Safe haven or risky hazard? Bitcoin during the COVID-19 bear market. *Finance Research Letters*, *35*, Article 101607. https://doi.org/10.1016/j.frl.2020.101607

Conlon, T., Corbet, S., & McGee, R. J. (2020). Are cryptocurrencies a safe haven for equity markets? An international perspective from the COVID-19 pandemic. *Research in International Business and Finance*, 54, Article 101248. https://doi.org/10.1016/j.ribaf.2020.101248

Diebold, F. X., & Yilmaz, K. (2012). Better to give than to receive: Predictive Directional measurement of volatility spillovers. *International Journal of Forecasting, 28*(1), 57–66. https://doi.org/10.1016/j.ijforecast.2011.02.006

Diebold, F. X., & Yilmaz, K. (2014). On the network topology of variance decompositions: Measuring the connectedness of financial firms. *Journal of Econometrics*, 182(1), 119–134. https://doi.org/10.1016/j.jeconom.2014.04.012

Dyhrberg, A. H. (2016). Bitcoin, gold and the dollar—A GARCH volatility analysis. *Finance Research Letters*, 16, 85–92. https://doi.org/10.1016/j.frl.2015.10.008

Engle, R. (2002). Dynamic conditional correlation: A simple class of multivariate generalized autoregressive conditional heteroskedasticity models. *Journal of Business & Economic Statistics*, *20*(3), 339–350. https://doi.org/10.1198/073500102288618487

Fama, E. F., & French, K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics*, *33*(1), 3–56. https://doi.org/10.1016/0304-405X(93)90023-5

Guesmi, K., Saadi, S., Abid, I., & Ftiti, Z. (2019). Portfolio diversification with virtual currency: Evidence from Bitcoin. *International Review of Financial Analysis, 63,* 431–437. https://doi.org/10.1016/j.irfa.2018.03.004

Jayawardhana, A., & Colombage, S. R. N. (2024). Portfolio diversification possibilities of cryptocurrency: Global evidence. *Applied Economics*, 56(47), 5618–5633. https://doi.org/10.1080/00036846.2023.2257928

Ji, Q., Bouri, E., Lau, C. K. M., & Roubaud, D. (2019). Dynamic connectedness and integration in cryptocurrency markets. *International Review of Financial Analysis*, *63,* 257–272. https://doi.org/10.1016/j.irfa.2018.12.002

Katsiampa, P. (2017). Volatility estimation for Bitcoin: A comparison of GARCH models. *Economics Letters*, *158*, 3–6. https://doi.org/10.1016/j.econlet.2017.06.023

Kogan, S., Makarov, I., Niessner, M., & Schoar, A. (2024). Are cryptos different? Evidence from retail trading. *Journal of Financial Economics*, *159,* Article 103897. https://doi.org/10.1016/j.jfineco.2024.103897

Lakonishok, J., Shleifer, A., & Vishny, R. W. (1994). Contrarian investment, extrapolation, and risk. *The Journal of Finance*, *49*(5), 1541–1578. https://doi.org/10.1111/j.1540-6261.1994.tb04772.x

Liu, Y., & Tsyvinski, A. (2021). Risks and returns of cryptocurrency. *The Review of Financial Studies*, *34*(6), 2689–2727. https://doi.org/10.1093/rfs/hhaa113

Liu, Y., Tsyvinski, A., & Wu, X. (2022). Common risk factors in cryptocurrency. *The Journal of Finance*, *77*(2), 1133–1177. https://doi.org/10.1111/jofi.13119

Lo, A. W. (2002). The statistics of Sharpe ratios. *Financial Analysts Journal*, 58(4), 36–52.

https://doi.org/10.2469/faj.v58.n4.2453

Markowitz, H. (1952). Portfolio selection. *The Journal of Finance, 7*(1), 77–91. https://doi.org/10.1111/j.1540-6261.1952.tb01525.x

Narayanan, A., Bonneau, J., Felten, E., Miller, A., & Goldfeder, S. (2016). Bitcoin and cryptocurrency technologies: A comprehensive introduction. Princeton University Press.

Novy-Marx, R. (2013). The other side of value: The gross profitability premium. *Journal of Financial Economics*, 108(1), 1–28. https://doi.org/10.1016/j.jfineco.2013.01.003

Pástor, Ľ., & Stambaugh, R. F. (2003). Liquidity risk and expected stock returns. *Journal of Political Economy*, 111(3), 642–685. https://doi.org/10.1086/374184

Patton, A. J. (2006). Modelling asymmetric exchange rate dependence. *International Economic Review*, 47(2), 527–556. https://doi.org/10.1111/j.1468-2354.2006.00387.x

Perold, A. F., & Sharpe, W. F. (1988). Dynamic strategies for asset allocation. *Financial Analysts Journal*, 44(1), 16–27. https://doi.org/10.2469/faj.v44.n1.16

Platanakis, E., & Urquhart, A. (2020). Should investors include Bitcoin in their portfolios? A portfolio theory approach. *The British Accounting Review*, 52(4), Article 100837. https://doi.org/10.1016/j.bar.2019.100837

Sharpe, W. F. (1966). Mutual fund performance. *The Journal of Business*, 39(1), 119–138. https://doi.org/10.1086/294846

Sharpe, W. F. (1994). The Sharpe ratio. *The Journal of Portfolio Management*, 21(1), 49–58. https://doi.org/10.3905/jpm.1994.409501

Symitsi, E., & Chalvatzis, K. J. (2019). The economic value of Bitcoin: A portfolio analysis of currencies, gold, oil and stocks. *Research in International Business and Finance*, 48, 97–110. https://doi.org/10.1016/j.ribaf.2018.12.001

Ugolini, A., Reboredo, J. C., & Mensi, W. (2023). Connectedness between DeFi, cryptocurrency, stock, and safe-haven assets. *Finance Research Letters*, 53, Article 103692. https://doi.org/10.1016/j.frl.2023.103692

Acknowledgement

Declaration of Generative AI and AI-Assisted Technologies. During the preparation of this manuscript, I used Grammarly solely for proofreading and language correction to improve the clarity and appropriateness of the academic language, including spelling, grammar, and punctuation. No generative AI functions were used to generate research ideas, analyses, results, interpretations, references, or substantive content. I reviewed all corrections and take full responsibility for the accuracy, integrity, and originality of the manuscript.