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Does Bitcoin Add to Risk Diversification of Alternative Investment Fund Portfolio?

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Abstract

Venture capital investment and hedge fund investment are two asset classes of alternative investment fund portfolios. The purpose of this study was to determine whether the digital currency named bitcoin truly adds to diversification in an alternative investment fund portfolio. Vector auto regression was used to determine any unidirectional or bidirectional relationship between variables. The DCC-GARCH test was conducted to determine any conditional correlations that impact volatility transmission over a shorter and longer duration of time between variables. The results showed that there was no unidirectional or bidirectional relationship between bitcoin and FTSE venture capital index, as well as between bitcoin and the Barclays Hedge Fund Index. The DCC model showed no volatility transmission between bitcoin and the Barclays Hedge Fund Index, whereas volatility persists between bitcoin and the FTSE Venture Capital Index, connecting risk between the financial time series with only low correlations. These findings suggest that bitcoin could be used by investors, policy makers, and hedgers for diversification in alternative investment fund portfolios.

Keywords: bitcoin; venture capital; hedge fund; VAR; DCC-GARCH; diversification

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1. Introduction

The rise of bitcoin from niche curiosity to a major asset class has caused investors to reconsider their portfolio diversification (Brière et al., 2015). Although many studies reveal bitcoin often moves outside of stocks, bonds, and real estate, its role alongside alternative investments is yet unknown. While hedge funds seek absolute returns using leverage and derivatives (Kaplan & Schoar, 2005), Agarwal and Naik (2004) discuss how venture capital funds back early-stage businesses accepting high idiosyncratic risk.

Institutional investors give billions of dollars to hedge funds and venture capital funds for exponential returns, as well as for diversification. These institutional investors behave like funds, and they give capital to multiple hedge funds and venture capital funds. Now, as institutional investors have started investing in bitcoin, the question arises whether the addition of bitcoin to alternative investment fund portfolio adds to diversification or not. Using vector auto regression (VAR) and DCC-GARCH models for bitcoin, the FTSE Venture Capital Index, and the Barclays Hedge Fund Index, this paper investigates whether adding bitcoin really improves diversification in alternative investment portfolios.

1.1. Bitcoin as a Portfolio Diversifier

Earlier empirical studies suggest that when combined with conventional assets, bitcoin could improve portfolio efficiency. Adding bitcoin to portfolios dominated by stocks,

bonds, and real estate changed the efficient frontier upward and therefore lowered risk for a given expected return according to a study by Brière et al. (2015). Their study covered several market phases and confirmed that bitcoin's contemporaneous correlation with these assets stayed near to zero using rolling windows. This therefore highlighted both its diversification potential under calm and turbulent conditions alike. Building on this, Dyhrberg (2016) used a GARCH framework to compare bitcoin's hedging properties with those of gold and the U.S. dollar, exposing that bitcoin can act as both a safe haven during currency crises and a temporary hedge against equity market downturns. Dyhrberg discovered, by modelling volatility spillovers, that bitcoin reacted to shocks in equity markets more like a risk asset during bull runs but showed safe-haven characteristics during drawdowns, implying a dual role that conventional assets cannot entirely replicate.

More subsequent research made clear that the dynamics of bitcoin are far from fixed. Using rolling-window correlation methods, Kolte et al. (2022), demonstrated that bitcoin's relationship with major stock indices turned negative. Hence, this provides real safe-haven returns during significant equity drawdowns such as the 2018 bear market. Strong equity rallies, on the other hand, showed that correlations became positive, suggesting that bitcoin might sometimes act as a procyclical asset. This paper suggested that bitcoin could act as diversifier in alternative investment portfolio rather than a hedge against adverse market conditions where equity drawdown occurs.

Using DCC-GARCH models, Bouri et al. (2017a) verified these regime-dependent characteristics and showed how significantly global risk aversion measures, like the VIX, affect the hedge effectiveness of bitcoin. By revealing asymmetric responses to market shocks, extreme negative equity returns enhanced bitcoin's contemporaneous link to commodities and currencies while positive shocks tended to separate bitcoin from most asset classes. Yousaf and Ali (2020) further refined this view, and their results highlight the need for dynamic modelling techniques to capture the actual character of bitcoin's interactions with other assets and thus challenge the idea of a uniform diversification benefit.

More recent studies have focused a critical eye on the behavioral elements and market microstructure that might skew theoretical advantages. Pervasive price clustering across significant bitcoin exchanges was recorded by Urquhart (2017), suggesting that round-number biases and frictional effects add noise to recorded returns. Griffin and Shams (2020) cast doubt on the integrity of high-frequency return series by showing evidence that tether issuances were used deliberately to control bitcoin prices at pivotal market stress points. Particularly when world credit conditions tighten, Conlon and McGee (2020) found that liquidity conditions, proxied by bid–ask spreads on major pairs, play a central role in determining bitcoin's hedging performance. Taken together, these operational realities imply that any strong portfolio diversification study should include real-world trading frictions and structural vulnerabilities even if bitcoin presents a convincing theoretical diversification advantage.

1.2. Risk Dynamics of Venture Capital and Hedge Funds

With long lock-up times, concentrated equity stakes, and return distributions with clear skewness and fat tails, venture capital (VC) funds occupy a different part of the investment universe. Private equity, including VC, delivers consistent outperformance over public markets, according to Kaplan and Schoar (2005). They show correlations of almost zero with broad equity indices, therefore acting as a strong diversifier. Direct comparisons with liquid assets are complicated by Metrick and Yasuda's (2011) analysis of capital call and distribution timing, which shows that VC cash-flow patterns are naturally lumpy and dependent on vintage year dynamics. Harris et al.'s (2014) subsequent work using granular performance-attribution techniques to decouple manager skill from market timing found

that skillful selection explains most excess returns. None of these studies, meanwhile, take into account how digital assets might help to reduce cash-flow volatility or improve general VC portfolio efficiency.

By contrast, hedge funds cover a wide range of trading techniques, long/short equity, global macro, event-driven, and managed futures, each adding unique sources of systematic and individual risk. Persistent factor exposures across hedge fund strategies were found by Fung and Hsieh (2001), who also suggested that style-based indices can roughly replicate much of hedge fund performance. Agarwal and Naik (2004) calculated the relative diversification advantages hedge funds provide against conventional portfolios and found that a small hedge fund allocation greatly lowers total volatility in normal markets. They advised, however, that hedge funds' correlations with equities and credit markets can spike under extreme market stress, thus undermining diversification gains at exactly the most needed moment. By including dynamic factor models, Bollen and Whaley (2007) advanced this and demonstrated how macroeconomic regimes affect hedge fund exposures to equity, fixed income, and commodity factors. Building on this, Bartram et al. (2007) showed that the systematic risk of hedge funds, and hence their covariance with other assets, rises significantly during crisis times. This, therefore, challenges the conventional wisdom about static diversification. Though our knowledge of hedge fund risk drivers is great, we have not carried out any meaningful research on how an asset class as volatile and structurally unique as bitcoin might either complement or contradict these advanced approaches.

1.3. Motivation/Rationale in Including Hedge Fund, Venture Capital and Bitcoin in Alternative Investment Fund Portfolio

The motivation for including the Barclays Hedge Fund Index, the FTSE Venture Capital Index, and bitcoin in an alternative investment fund (AIF) portfolio lies in the complementary nature these asset classes have with respect to long-term diversification and performance. Hedge funds, venture capital, and bitcoin cover very different dimensions of alternative investments—hedge funds focus on risk-adjusted return and active management, venture capital focuses on innovation-driven growth, and bitcoin is an emergent digital asset class with asymmetric return potential (Brière et al., 2015). The arguments behind this three-pronged combination are based on the premise that they help to increase resilience and risk-adjusted performance and provide exposure to a range of sources of return, which eliminates the concentration risk posed by relying extensively on one particular alternative strategy (Kaplan & Schoar, 2005).

The addition of hedge funds, which are proxied in the Barclays Hedge Fund Index, is primarily guided by the fact that these funds can provide absolute returns via the application of flexible investment strategies that are relatively unrelated to the existence of traditional assets. Hedge funds take a long/short equity, global macro, event-driven, and relative value-based approach to generate alpha in different market cycles (Getmansky et al., 2015; Fung & Hsieh, 2001). The relevance of their position in an AIF portfolio is defensive in that they may assist in alleviating volatility and lowering downside risks and offer a chance of generating some returns regardless of whether or not the equity markets are experiencing a jolt. Indeed, the empirical evidence would flag a lower beta exposure to the equity markets by hedge funds as compared to mutual funds, and this would further cement the relevance of hedge funds as a stabilizer in diversified portfolios (Bartram et al., 2010). The Barclays Hedge Fund Index seeks to aggregate performance across strategies, thereby reducing the risks linked to the performance of a single manager or strategy, and its inclusion guarantees the portfolio can benefit from risk-managed absolute return strategies that provide an anchor for the portfolio in times of turbulent markets. In this sense, hedge funds are the "defensive engine" of the portfolio, mitigating against the risk exposures from other, more aggressive allocations.

By contrast, the FTSE Venture Capital Index reflects the risky and high-reward environment of early-stage entrepreneurial investment, offering exposure to structural growth that otherwise has little to do with broad macroeconomic cycles. Venture capital, by nature, is future-oriented, investing in innovation, technological disruption, and market transformation. Its inclusion in an AIF portfolio is driven by its potential for exponential returns as demonstrated by Kaplan and Schoar (2005) and Harris et al. (2014), who found that private equity and venture capital have historically outperformed public markets but with low correlation with traditional indices. Moreover, VC returns exhibit idiosyncratic patterns related to entrepreneurial ecosystems, industry breakthroughs, and the technological adoption cycle, making them an attractive diversifier (Metrick & Yasuda, 2011). While venture capital investments introduce liquidity and timing risks, they are vital, as they help ensure that the portfolio exposure includes innovation-derived allocation to growth taps that hedge funds or traditional equity indices cannot represent. Thus, the FTSE Venture Capital Index serves as the "growth catalyst" of the portfolio, which counterbalances the risk mitigation role played by hedge funds by providing outsized upside potential.

The third component, bitcoin, is a new frontier in alternative assets. It is added due to its innovative traits of a decentralized, scarce, and highly liquid digital asset with minimal correlation with other usual and alternative asset categories (Dyhrberg, 2016; Bouri et al., 2017a). Bitcoin's return distribution is characterized by extreme volatility and asymmetric upside potential, making it a candidate for improving the efficient frontier of portfolios (Brière et al., 2015). Studies show that not only has bitcoin acted as a diversifier, but it has also performed as a haven asset in some conditions, especially during equity market downturns (Alsulami & Raza, 2025). Moreover, with the growing demand for bitcoin among institutional investors and its standing as a hedge against inflation, its inclusion in AIF portfolios has become more rational (Alqaralleh et al., 2020). Importantly, the fact that bitcoin is digital in nature means that it can be traded globally and possesses high liquidity and accessibility as compared to other non-tangible alternative assets, making it a flexible complement to hedge funds and venture capital. Bitcoin, therefore, becomes the "asymmetric upside lever" of the portfolio, with potential for exceptional gain rise and inflation hedging, but at a cost of greater volatility.

Combining these three indices—hedge funds, venture capital, and bitcoin—constitutes a multidimensional portfolio that balances the defense, growth, and asymmetric potential of return. Hedge funds provide stability and downside protection by mitigating business risk, venture capital provides exposure to disruptive innovations and exponential growth over an extended period, and bitcoin provides an emerging asset with properties that are similar properties to those of digital gold and that can be both diversifying and portfolio-enhancing (Hasan et al., 2022). Collectively, this combination lessens systemic risk by diversifying exposures across asset classes that move in distinct ways based on the different drivers and time horizons (Urquhart, 2017). In addition, the tripartite inclusion reflects a futuristic approach to portfolio-building in times of economic uncertainty, where inflation is occurring alongside disruption by technology, permitting one to focus on the subject of gaining advantages in both the traditional and digital realms of finance.

1.4. Methodological Approaches to Dynamic Asset Relationships

Often based on either mean-variance models or stationary correlation coefficients, traditional portfolio studies only offer a glimpse of inter-asset linkages and mask the temporal propagation of shocks. Many researchers have used multivariate GARCH models to help with these flaws. Dyhrberg (2016) compared DCC-GARCH with univariate GARCH to show that DCC-GARCH more precisely follows the time-varying link between bitcoin and gold. Though these models still lack causal direction, Bouri et al. (2017b) similarly

used DCC-GARCH to track changes in bitcoin's hedge efficacy in response to global risk aversion measurements. Extreme co-movements between bitcoin and other assets intensify under joint market stress, according to copula-based approaches which have been used to identify tail dependencies. Copulas, however, failed to reveal the sequence in which shocks arise and lack a temporal component.

By modelling both contemporaneous and lagged relationships between variables, vector auto regression (VAR) provides a more complete framework. While using VAR-DCC-GARCH methods on bitcoin and major fiat currencies, and Yousaf and Ali (2020) found bidirectional causality during periods of extreme volatility. Extending VAR to a network of cryptocurrencies, Lahmiri and Bekiros (2019) mapped complex spillover effects between coins. VAR models essentially help to build impulse response functions (IRFs), which track the effect of a one-standard-deviation shock in one series on the future values of others over many horizons. In equity and fixed-income markets, IRFs have shown how macro announcements spread through asset returns. Using this tool on a mixed portfolio of bitcoin, venture capital, and hedge fund indices can expose not only whether bitcoin reduces volatility in alternative funds but also how long such effects last.

Testing for stationarity and co-integration among series helps to guarantee credible VAR estimation. While Johansen co-integration tests identify long-run equilibrium relationships informing the specification of vector-error-correction models (VECMs), augmented Dickey–Fuller tests guard against spurious regressions (Metrick & Yasuda, 2011). Ignoring these pre-tests runs the danger of biased estimates of both short- and long-run dynamics, a mistake hardly discussed in studies of static diversification. By means of rigorous pre-testing and model selection guided by information criteria (AIC, BIC), this study remedies that oversight and thus lays a strong basis for causality and IRF analysis.

1.5. Regulatory and Operational Considerations

Beyond statistical modelling, several real-world events influence the viability and strength of diversification plans including bitcoin. Daily return computations can be seriously disrupted by market microstructure including scattered liquidity across world exchanges. Price clustering around round numbers is widespread, according to Urquhart (2017), which introduces bias either exaggerating or understating correlation estimates. Griffin and Shams (2020) called attention to possible price manipulation by tether issuing, which erases trust in stated bitcoin values during times of crisis. Furthermore, custody options span self-managed wallets to institutional custodians, each with different counterparty and operational risks that are absent in controlled fund vehicles.

Regulatory uncertainty complicates portfolio inclusion choices even more. Different jurisdictions classify bitcoin: some view it as a commodity, others as a security. This results in different tax treatment, reporting rules, and investor eligibility guidelines. Significant announcements like China's 2021 mining and trading crackdown have set off sudden market disturbances that have momentarily raised equities' market correlations. This work uses event dummy variables for important regulatory milestones and performs sub-sample analyses around key dates to capture these episodic effects, thereby ensuring that diversification assessments reflect the whole range of market regimes and policy environments.

1.6. Identified Gaps and Study Contribution

The body of research to date firmly supports bitcoin's diversification benefits inside conventional portfolios and provides thorough understanding of venture capital and hedge fund risk drivers. Still, it noticeably leaves out any analysis of how bitcoin interacts with accepted alternative investment indices. The differences in liquidity horizons, cash-flow patterns, and risk exposures between venture capital and hedge fund indices suggest that

integration of bitcoin may yield diversification results different from those shown with stocks or bonds. Furthermore, most of the current research uses either static or correlation-based techniques that cannot detect temporal shock transmission or causal direction.

This paper closes that gap by aggregating bitcoin, the FTSE Venture Capital Index, and the Barclays Hedge Fund Index inside a single VAR framework, augmented by strict stationarity and co-integration testing. While impulse response functions will measure shock propagation speed across assets, Granger causality tests will expose the directionality of influence. Event dummies for important regulatory announcements guarantee practical relevance by capturing the actual volatility spikes sometimes overlooked by theoretical models. In the end, this study gives portfolio designers sophisticated, time-sensitive insights on whether bitcoin actually improves diversification—or unintentionally concentrates risk—in alternative asset portfolios, thereby supporting academic debate and the design of next-generation investment strategies.

1.7. Significance of the Study

This research helps academic studies and guides institutional investors. Academically, by emphasizing alternative investments, a field mainly neglected in bitcoin research, it increases the body of knowledge on bitcoin diversification (Katsiampa, 2017). Using VAR models reveals the changing causal interaction between digital assets and specialized fund indices, thereby addressing demand for more advanced econometric techniques in financial research (Conlon & McGee, 2020). Practically, the results will guide fund managers, institutional investors, and financial advisers weighing bitcoin allocations under alternative asset requirements. Whether it reduces portfolio volatility or improves returns, clear data on bitcoin's influence will enable design of strong investment plans using digital assets without sacrificing performance.

Understanding how bitcoin behaves alongside venture capital and hedge fund exposures will help asset managers organize multi-asset funds or customized portfolios (Brière et al., 2015; Dyhrberg, 2016). These observations also help authorities and legislators to grasp possible systemic hazards when volatile cryptocurrencies find less liquid investment platforms. In the end, this research provides stakeholders with the thorough, time-sensitive analysis required to make wise decisions about including bitcoin into alternative investment portfolios, thereby ensuring that such allocations really serve the objective of diversification rather than unintentionally increasing risk.

1.8. Research Problem

Good portfolio management is mostly dependent on diversification; it distributes risk among uncorrelated assets to generate smooth returns (Bouri et al., 2017b). Based on its price history, bitcoin seems to often act outside of conventional markets, which piques interest in its advantages for diversification among bonds, stocks, and real estate (Conlon et al., 2020). However, given their increasing importance in institutional portfolios, little attention has been paid to how bitcoin interacts with alternative investment funds, a major lapse given their influence.

Hedge funds and venture capital are quite different. Venture capital money carries great idiosyncratic and liquidity risk but invests in start-ups with the possibility for outsized returns (Bonini & Capizzi, 2019). Long/short positions, leverage, and derivatives, all of which hedge funds use, allow returns under different market conditions (Dyhrberg, 2016). These different strategies generate different volatility profiles and correlation patterns that might not reflect those found with conventional assets.

Most of the current studies depend on mean-variance models or stationary correlation coefficients, thereby only capturing a picture of relationships without disclosing their direction

of influence or change with time (Kaplan & Schoar, 2005). For portfolio managers to decide whether to include bitcoin in an alternative asset allocation, they need to know not just if bitcoin behaves differently but whether it leads or follows fund index movements, or both.

This study fills that gap by using VAR analysis to uncover both unidirectional and bidirectional causal links between bitcoin and each alternative fund index. Are changes in the price of bitcoin antecedents of changes in venture capital or hedge fund returns? Alternatively, do movements in these indices hint at the volatility of bitcoin? Knowing these dynamics is absolutely essential; without this knowledge, including bitcoin into other portfolios runs the danger of adding, rather than lowering, unexpected volatility (Urquhart, 2017; Griffin & Shams, 2020). Our studies directly address these issues and offer empirical clarity to investors negotiating an ever more complicated asset environment. The aim is to evaluate whether bitcoin provides real diversification advantages to portfolios including indices of venture capital and hedge funds. The paper worked on determining three objectives, including examination of dynamic interactions between bitcoin returns and the FTSE Venture Capital Index using a vector auto regression (VAR) framework. VAR analysis helps one to investigate causal links between bitcoin and the Barclays Hedge Fund Index and analyze changes in risk and return measures, thus aiding in comparison of the diversification effect of including bitcoin with venture capital and hedge fund portfolios.

The research questions that this paper worked on answering included whether bitcoin had a causal relationship with the FTSE Venture Capital Index and whether the movement of the index drove bitcoin's price. The paper also worked on determining the directionality of causality between bitcoin and the Barclays Hedge Fund. Moreover, the paper worked on determining the directionality of causality between the FTSE Venture capital Index and the Barclays Hedge Fund. The DCC GARCH model was used to determine volatility transmission and persistence so as to check diversification among bitcoin, FTSE Venture capital Index and the Barclays Hedge Fund.

This paper attempts to provide a deeper, time-sensitive knowledge of bitcoin's influence in alternative investment strategies by addressing these questions using a dynamic VAR framework instead of stationary correlation measures. The findings will direct portfolio building decisions and assist in deciding whether bitcoin is a real diversifier or causes unneeded risk.

2. Results

The unit root test was conducted to determine whether all the three series are stationary or non-stationary at level. Table 1 shows the results of unit root at level for three series, including the Barclays Hedge Fund Index (BHFI), bitcoin, and the FTSE Venture Capital Index (FTSE). For each of the BHFI, bitcoin, and the FTSE, results showed that the p-value was less than the critical value of 0.05, and thus, all three series are stationary at level.

The autocorrelation test was conducted to determine whether there was any autocorrelation at the selected lag. The AIC value was used to determine the autocorrelation at the selected lag. The AIC test showed that there was no autocorrelation at the selected lag (Table 2).

The stability test of the vector auto regression system was conducted, as it implies a stationary condition. The inverse root test was conducted to determine whether the VAR model is stable. Figure 1 shows the results of the inverse root test. All the inverse roots of the AR polynomial were less than the value of one and are contained in a circle. This showed that the VAR model was absolutely stable. As the VAR model was stable, the next step was to determine autocorrelation among residuals at a selected lag length. The results showed that all the values were between the two bounds of the standard deviations, and thus, there were no autocorrelations among residuals.

Table 1. Unit root test at level to check whether series are stationary or not at level.

		t-Statistic	Prob.
BHFI Unit Root test at Level		−11.673	0.0000
Test critical values:	1% level	−3.4782	
	5% level	−2.8824	
	10% level	−2.578	
Bitcoin Unit Root test at Level		−10.886	0.0000
Test critical values:	1% level	−3.4765	
	5% level	−2.8817	
	10% level	−2.5776	
FTSE Unit Root test at Level		−12.787	0.0000
Test critical values:	1% level	−3.4765	
	5% level	−2.8817	
	10% level	−2.5776	

Table 2. Autocorrelation analysis at selected lag length.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	437.6609	NA	0.000000214 *	−0.845054 *	−6.777868 *	−6.817757 *
1	440.6599	5.808954	0.0000002	−6.750549	−6.481807	−6.641362
2	443.7833	5.902649	0.0000003	−6.658005	−6.187707	−6.466929
3	446.5184	5.03937	0.0000003	−6.559345	−5.88749	−6.286378
4	451.1865	8.380516	0.0000003	−6.491126	−5.617714	−6.136269
5	456.0047	8.422425	0.0000003	−6.425271	−5.350303	−5.988524
6	461.8459	9.934674	0.0000003	−6.375527	−5.099002	−5.85689
7	465.2724	5.665769	0.0000004	−6.287754	−4.809673	−5.687227
8	477.4903	19.62558 *	0.0000004	−6.338429	−4.658791	−5.656013
9	480.7263	5.045158	0.0000004	−6.247658	−4.366464	−5.483352
10	482.4732	2.640959	0.0000004	−6.133436	−4.050685	−5.287239
11	488.6714	9.077759	0.0000005	−6.089314	−3.805006	−5.161227
12	492.093	4.849507	0.0000005	−6.001465	−3.515601	−4.991488

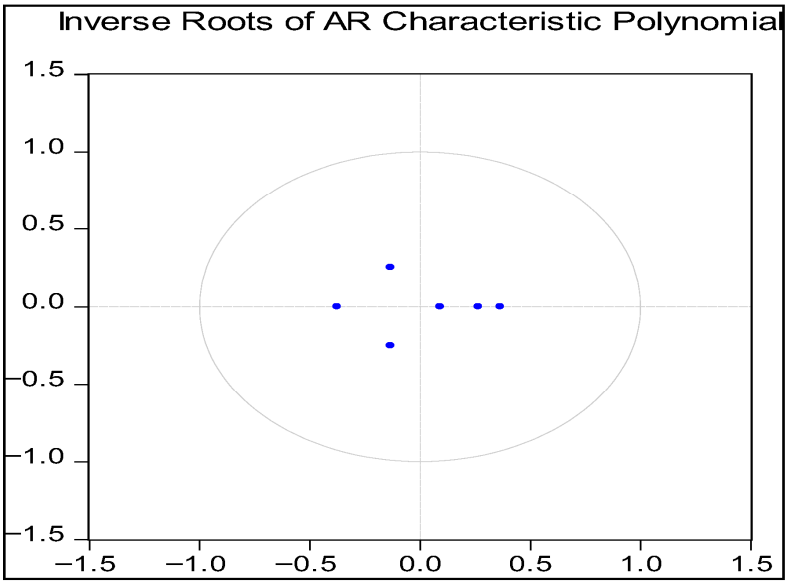


Figure 1. Inverse root test of stability of the characteristic AR polynomial for the VAR model of Barclays Hedge Fund Index (BHFI), bitcoin, and FTSE venture capital index.

An autocorrelation LM test was performed to determine any serial correlation among residuals at the selected lag length. As seen in Table 3, the *p*-values at the selected lag length

of value of one was far higher than the critical value of 0.05; therefore, we accepted the null hypothesis that there is no serial correlation at the selected lag length.

Table 3. Lagrange multiplier (LM) test for autocorrelation in residuals of the estimated VAR model.

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	4.013057	9	0.9106	0.443712	(9, 304.4)	0.9106

Further Granger causality tests were conducted to determine whether there was any unidirectional or bidirectional relationship among variables. Table 4 shows the results of the Granger causality test when the BHFI was the dependent variable. The results showed that *p*-values were far greater than the critical value of 0.05. Therefore, bitcoin and the FTSE do not have any causal effect on the BHFI.

Table 4. Granger causality test with BHFI as dependent variable.

Excluded	Chi-sq	df	Prob.
BITCOIN	2.186752	2	0.3351
FTSE	1.253402	2	0.5344
All	3.733508	4	0.4433

Table 5 shows the results of the Granger causality test when bitcoin was the dependent variable. The result show that *p*-values were far greater than the critical value of 0.05. Therefore, the BHFI and the FTSE do not have any causal effect on bitcoin.

Table 5. Granger causality test with bitcoin as dependent variable.

Excluded	Chi-sq	df	Prob.
BHFI	2.885266	2	0.2363
FTSE	1.03487	2	0.5960
All	3.227973	4	0.5204

Table 6 shows the results of the Granger causality test when the FTSE was the dependent variable. The result shows that *p*-values were far greater than the critical value of 0.05. Therefore, the BHFI and bitcoin do not have any causal effect on the FTSE.

Table 6. Granger causality test with FTSE as dependent variable.

Excluded	Chi-sq	df	Prob.
BHFI	0.558581	2	0.7563
BITCOIN	1.565607	2	0.4571
All	1.888155	4	0.7563

To further extend the analysis, heteroscedasticity tests were conducted so as to determine any time-varying volatility present among the variables. Table 7 shows the results of the DCC-GARCH model between bitcoin and the FTSE. Since the sum of the alpha and beta values was less than one, the stability condition for the DCC-GARCH model was satisfied. The alpha value of DCC-GARCH was statistically insignificant, which means that short-term correlation shocks have little to no impact. The beta value of DCC-GARCH was statistically significant, with a value of 0.912419, which means that past conditional correlations persist over time. The correlation structure was mainly driven by past correlations (β), which reflects that there was stable but time-varying correlation between bitcoin and the FTSE Venture Capital Index.

Table 7. DCC-GARCH model between bitcoin and FTSE Venture Capital Index.

DCC-GARCH	Variable	Coefficients	Std. Error	t Value	*p*-Value
Joint (bitcoin, FTSE)	α	0.00000	0.000007	0.004434	0.99646
	β	0.912419	0.249313	3.659738	0.00025

Figure 2 shows the dynamic conditional correlation between bitcoin and the FTSE Venture Capital Index. The correlation coefficient remained very low, at twenty-five percent. The VAR model showed that there was no unidirectional/bidirectional relationship between bitcoin and the FTSE, but the DCC-GARCH model showed time-varying volatility with very low correlation. This means that both financial time series could not predict the returns of the other series, and only risk was connected with very low correlation. Therefore, returns of both bitcoin and the FTSE are independent of each other even if risk was connected.

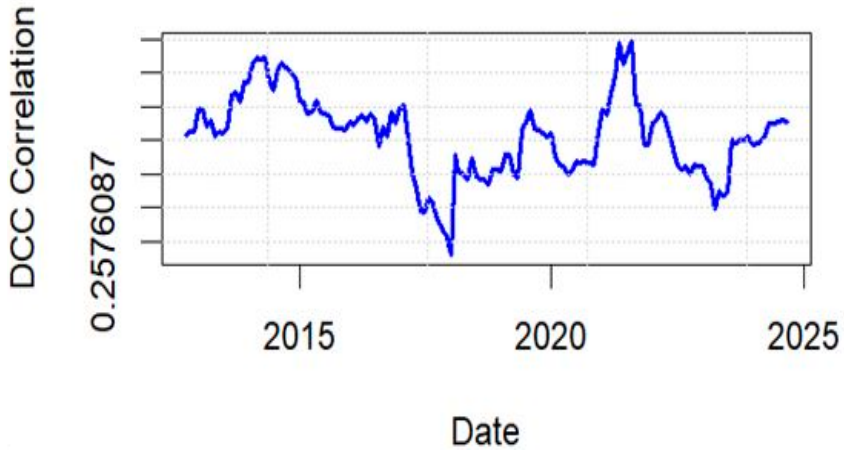


Figure 2. DCC GARCH between bitcoin and the FTSE Venture Capital Index.

Table 8 shows the results of the DCC-GARCH model between bitcoin and the FTSE. Since the sum of alpha and beta values was less than one, the stability condition for the DCC-GARCH model was satisfied. The alpha and beta values are statistically insignificant, as the *p*-value was higher than the critical value of 0.05. Thus, neither do immediate shocks influence volatility nor does volatility persist over time.

Table 8. DCC-GARCH model between bitcoin and Barclays Hedge Fund Index.

DCC-GARCH	Variable	Coefficients	Std. Error	t Value	*p*-Value
Joint (bitcoin, BHFI)	α	0.00000	0.000068	0.000007	0.999995
	β	0.915292	1.288949	0.710107	0.477638

3. Discussion

Bitcoin enhances the diversification of investment portfolios. Multiple scholars have proven these research findings through their work. Almeida and Gonçalves (2022) found that bitcoin acts as a perfect hedge asset and haven asset since it demonstrates a low correlation with other assets. The asset shows autonomy from stock, bond, and traditional kinds of investments. Another study by Alamsyah et al. (2024) indicated that unique market dynamics characterize bitcoin. Bitcoin's unique characteristics allow it to be leveraged to improve portfolio efficiency, as it aids in mitigating traditional investment risks. The study, therefore, advocates using bitcoins as a diversification mechanism. However, the studies fail to offer clinical insights into the relationship between bitcoin and alternative investment funds (AIFs).

3.1. Bitcoin Diversification of Alternative Investment Funds (AIFs)

This research has identified the independent relationship between bitcoin and AIFs such as the FTSE Venture Capital Index and Barclays Hedge Fund Index. Bitcoin does not move in their direction; hence, it would enhance stability during moments of economic downturn. However, only a few researchers substantiate this relationship. Arora et al. (2025) established that AIFs are risky investments that ought to be avoided but recommended integration of less risky cryptos into the portfolio to minimize risks. The findings of the paper confirm that the Venture Capital Index and Hedge Fund Index have no unidirectional/bidirectional relationship with bitcoin, and their results confirm the findings of Arora et.al. that bitcoin does add to diversification by reducing risk. Cao (2022) defined AIFs as distinct investments that rely on derivatives and commodities for returns. Including bitcoins, therefore, offers risk mitigation benefits, according to the research.

While they promised high returns, adding bitcoins allowed the investors to maintain high-level earnings even during moments of economic shifts. However, the research does not prove that bitcoins reduce portfolio risks. The research fails to examine the empirical relationship between crypto and AIFs well. This research seeks to fill this knowledge void by examining the relationship between bitcoin and AIFs such as the FTSE Venture Capital Index and Barclays Hedge Fund Index. The study has established no unidirectional or bidirectional relationship between bitcoin and the considered AIFs. Vector auto regression (VAR) has proven that bitcoin is an independent asset that does not follow venture capital and hedge fund movements. The independence earns bitcoin the ability to diversify AIFs.

3.2. Bitcoin Diversification Challenges

Although significant diversification benefits characterize bitcoin, it has challenges that make the investment more risky. These challenges are identified by Mittal et al. (2024), who define bitcoin as a risky asset that is unfavorable to investors and that will soon be out of the market. Syahputra (2023) substantiates these challenges and defines bitcoin as an investment that poses major risks to investors in pursuit of stable diversification benefits. Han et al. (2024) define bitcoin as a stock subject to volatility spillover effects; hence, its potential to diversify portfolios is compromised under certain market conditions.

3.3. Management Implications

The findings of this study, supported by other researchers, call for a change of strategy in diversifying investment portfolios. The studies established an independent relationship between bitcoin and AIFs and traditional equities and bonds. This implies that bitcoin is capable of diversifying investments. Managers must, therefore, always consider bitcoins in their AIF portfolio to achieve diversification benefits. However, they must exercise caution due to the volatile nature of bitcoins. It is also recommended that one note susceptibility to regulatory changes and utilize portfolio management practices that always yield the highest returns. Overall, carefully including and managing bitcoin assets in investment portfolios would offer diversification benefits.

3.4. AIF Diversification

Investors always seek diverse investment portfolios to ensure that they are free from adverse risks and can generate income during all periods. Investors carry this out by spreading investments across uncorrelated assets that respond to market changes differently. This research has established that bitcoin is one of the mechanisms utilized in diversifying alternative investment funds (AIFs). It also plays a significant role in diversifying investment portfolios made up of stocks, bonds, and real estate because it has proved to be high-income

generative during all periods of trade. The research is relevant because it explores the role played by bitcoin in diversifying AIFs such as venture capital and hedge funds.

3.5. VAR and DCC-GARCH Analysis Findings

Vector auto regression (VAR) analysis revealed that bitcoin is an independent investment. Movements or changes in venture capital and hedge funds do not affect bitcoin values. For these reasons, bitcoin can be considered a key diversifier of investment portfolios. VAR analysis established that bitcoin lacks a unidirectional or bidirectional relationship with other indices (Hairudin et al., 2022). Although all three were stationary at level and free from heteroscedasticity effects, bitcoin showcased zero or minute correlation. This implies that it is more resilient and unaffected by market changes than other portfolio components (Choithani et al., 2024). It can, therefore, be leveraged to solicit high-value returns during moments of economic downturns. It is, therefore, a potential diversifier for alternative investment portfolios (AIFs). The application of the DCC-GARCH model to compare bitcoin and the Barclays Hedge Fund Index showed that immediate shocks do not influence volatility nor does volatility persist over time. The application of the DCC-GARCH model to compare bitcoin and the FTSE Venture Capital Index showed that returns of both indices are independent of each other, with very low correlation of risk.

3.6. Investment Strategies Implications

The lack of a relationship between bitcoin and AIFs supports its investment application as a diversifier. The uncorrelated asset reduces portfolio risk; hence, an investor would never be prone to extreme declines in returns during moments of economic downturn (Khamis & Aassouli, 2023). Therefore, it is advisable to always consider bitcoin investment as a buffer against inconsistent market fluctuations that negatively affect the profitability of AIFs (Minto et al., 2021). Investors are therefore advised always to include bitcoin assets in their investment portfolios to achieve the most desired risk profile of investments. Including bitcoins enhances portfolio diversification beyond the traditional asset classes.

3.7. Traditional Diversification Strategies Comparison

In the past, investors diversified their portfolios by mixing equities and bonds, perceiving that the two have different risk profiles. Investors proposed having 60% of a portfolio in equities and 40% in bonds (Zaimovic et al., 2021). However, the independence of the two cannot be substantiated. They are usually correlated during economic downturns; hence, investments were still exposed and susceptible to reduced returns. Fortunately, adding bitcoin to the mix enhances independence. The asset is decentralized and offers stability benefits during economic downturns (Haq et al., 2021). Therefore, modern investors include bitcoin assets to minimize portfolio adversity during economic downturns. However, care must be taken when using bitcoins as portfolio diversifiers. The asset is usually characterized by high volatility and inherent risks such as susceptibility to regulatory changes.

3.8. Future Research Directions

While this research identifies the positive role of bitcoins in diversifying investment portfolios, there are still knowledge gaps that need to be filled through advanced research. It is important to define bitcoin as a cryptocurrency and hence consider the role played by other cryptocurrencies in diversifying portfolios (Rejeb et al., 2021). Currently, researchers focus only on bitcoin as the key crypto without seeking to know the influence of other crypto currencies in diversifying investments. Therefore, a more nuanced knowledge about the impacts of crypto currencies in diversifying investment risks and increasing potential returns ought to be established through advanced or integrated research. Research focusing on other major cryptocurrencies, like Ethereum, Solana, and XRP, can further enlighten

investors about the diversification potential of cryptocurrencies as part of an alternative investment fund portfolio.

It is well known that the performance of bitcoin is not constant or predictable. The asset is overwhelmingly influenced by existing economic and regulatory conditions. These findings are supported by Pv and Jackson (2023), who assert that bitcoin performance depends on macroeconomic conditions. However, the research does not reveal the dynamics of the relationship between bitcoin and external factors. The impact of periods and macroeconomic conditions on the ability of bitcoin to diversify portfolios needs to be explored further. Such exploration would enhance effective portfolio management, as investors can expect bitcoin to exhibit certain behaviors during specific economic times. The influence of these factors on bitcoin performance is known to be robust, but no research has proven that they affect the ability to diversify investments. Such a broader scope of analysis will be invaluable in establishing investment strategies that optimize alternative investment portfolios (AIFs).

4. Materials and Methods

The financial time series data was collected on the basis of monthly returns from October 2012 to September 2024 for the FTSE Venture Capital Index (Cambridge Associates, Boston, MA, USA), bitcoin, and the Barclays Hedge Fund Index. The stated period was used for the very reason that the FTSE Venture Capital Index provided data from October 2012 onwards. The hedge funds and venture capital companies strictly provide only monthly returns; thus, monthly data was obtained to analyze the relationship. This, in a way, contributes positively to analysis, as it reduces noise from bitcoin's drastic short-term volatility and provides more stable long-term dynamics. The collection of monthly data aligns with the investment horizons of institutional investors, as these institutions typically evaluate performance on a monthly basis. Consequently, monthly data offers a more consistent framework for analyzing the relationship between bitcoin, the Venture Capital Index, and the Hedge Fund Undex.

These time series have been chosen for their economic relevance and interactions in financial markets. Financial markets are inherently dynamic, and choosing a proper time frame may allow the capture of market fluctuations and volatility for an extensive period. According to Gajamannage et al. (2023), the inclusion of three different financial series increases the robustness of the present study by allowing comprehensive cross-market analysis.

4.1. Stationarity Test: Augmented Dickey–Fuller (ADF) Test

Before performing any econometric modeling, stationarity in the time series data has to be checked. Non-stationary data may result in spurious regression results. For this, the ADF test was performed to establish the stationarity of the financial time series at the level (Shrestha & Bhatta, 2018). ADF finds broad application in time series analysis, mainly due to its capability for detecting unit root presence that indicates stationarity or non-stationarity of the series (Guo, 2023). Checking for stationarity is of utmost importance in that a non-stationary series might lead to misleading statistical inference, which then questions the reliability of such a model.

$$\Delta Y_t = \alpha + \beta t + \gamma Y_{t-1} + \sum_{i=1}^{p} \delta_i \Delta Y_{t-i} + \epsilon_t$$

where:

- Y_t is the financial time series at time t,
- ΔY_t represents the first difference of Y_t

- α is a constant,
- βt represents the deterministic trend,
- γ is the coefficient testing for stationarity,
- δ_i accounts for the lagged differences,
- ϵ_t is the error term.

The null hypothesis of H_0: $\gamma = 0$ (unit root present) was tested against the alternative hypothesis of H_1: $\gamma < 0$ (stationary process). Since all three financial time series were found to be stationary at level, we proceeded to the next stage of analysis. This result infers that the financial series are not characterized by a stochastic trend, which implies that they are mean-reverting over time (Petrică et al., 2017). Consequently, the application of traditional econometric techniques will be reliably applicable without additional transformations using the VAR model (Akkaya, 2021).

4.2. Vector Auto Regression (VAR) Model

In order to investigate dynamic inter-relationships among financial time series, this study incorporated a vector auto regression model, VAR (Gajamannage et al., 2023). The VAR model encompasses unidirectional and bidirectional relationships among time series variables. Unlike single equation regression models, VAR assumes all variables to be endogenous, offering a flexible framework for modeling financial time series data (Warsono et al., 2020). In general, the impulse response functions and variance decompositions from the VAR model provide ways to trace how a shock to one variable moves through the system over time.

The general form of a VAR model of order p is provided by:

$$Y_t = c + \sum_{i=1}^{p} A_i Y_{t-i} + \epsilon_t$$

where:

- Y_t is a $k \times 1$ vector of endogenous variables,
- c is a $k \times 1$ vector of intercepts,
- A_i is a $k \times k$ matrix of autoregressive coefficients for lag i,
- ϵ_t is a $k \times 1$ vector of white noise error terms (Petrică et al., 2017).

The Granger causality tests under VAR estimated the direction of causality between the variables. In a case where variable X Granger-causes Y, past values of X add to the prediction of Y over and above what can be predicted by Y itself (Bose et al., 2017). This method is particularly useful in financial applications, where understanding lead–lag relationships can inform investment strategies and risk management. In addition, finding the causality structure helps in the building of correct forecasting models; it is important for policy decisions in financial markets.

4.3. DCC-GARCH Model

The DCC-GARCH model test was applied in this analysis to check for dynamic conditional correlation between bitcoin and the FTSE Venture Capital Index, as well as between bitcoin and the Barclays Hedge Fund Index. The DCC test basically evaluates how two financial time series are related to each other in terms of risk. The DCC model tracks down the change in relationship between two financial time series over the studied time period. The DCC-GARCH model helps investors in studying diversification strategies by providing ever-changing correlations over time. The first step in DCC-GARCH model is to determine whether model is stable, as the stability conditions help in determining that

correlations move smoothly, and in a controlled manner, over time. The stability condition is defined by following:

$$\alpha + \beta < 1$$

- α determines the impact of immediate shocks on volatility;
- β determines the persistence of volatility over time.
- If $\alpha + \beta > 1$, the model becomes unstable and explodes.

4.4. Justification for VAR and DCC Inclusion

While studying relationship between two financial time series, the two aspects needed to be analyzed. These aspects include return linkages and diversification potential. The return linkages helped in studying how one asset influences the other and diversification helped in understanding co-movements in volatility. These two aspects cannot be studied by using single model; thus, multiple models, including VAR and DCC-GARCH, are used to understand return linkages and volatility co-movement. The VAR DCC-GARCH model is highly useful when there are multiple financial time series that need to be studied for interdependence and volatility clustering.

5. Conclusions

There are many publications in the literature that support diversification in portfolio management using bitcoin with traditional assets like bonds, stocks, real estate, etc. There is little research that supports whether bitcoin adds to diversification in alternative investment fund portfolios. Alternative investment fund investment includes investing in either venture capital funds and/or hedge funds. Hedge funds derive the majority of their cash flows from investing in derivative investments/commodities, whereas venture capital funds derive the majority of their cash flows from investing in lucrative ideas/start-ups. So, both hedge funds and venture capital differ from each other in terms of the respective fundamentals of investment strategies and security selection. Both hedge funds and venture capital funds are very different from traditional assets in terms of risk and return profile. Cryptocurrency has emerged as an alternative asset class of its own, and bitcoin, being the most liquid cryptocurrency, has become the subject of research that answers this important question regarding diversification of alternative investment portfolios using bitcoin.

All three financial time series were stationary at level and were free of heteroscedasticity effects. The vector auto regression helped in determining whether the relationship between bitcoin and the FTSE Venture Capital Index, as well as between bitcoin and the Barclays Hedge Fund Index, was unidirectional or bidirectional. The results showed that there was neither a unidirectional nor bidirectional relationship between bitcoin and FTSE venture capital index, nor between bitcoin and the Barclays Hedge Fund Index. Also, the DCC model showed that there were no volatility shocks or persistence between bitcoin and the Barclays Hedge Fund Index. Moreover, the DCC model showed that there were no immediate shocks transmitted, but volatility did persist over time, with very low correlation between bitcoin and the FTSE Venture Capital Index. Therefore, as there was no unidirectional or bidirectional relationship between bitcoin and the FTSE Venture Capital Index, as well as between bitcoin and the Barclays Hedge Fund Index, bitcoin could be a perfect choice to diversify alternative investment portfolios. The vector auto regression (VAR) analysis proves that there is no unidirectional/bidirectional relationship between bitcoin and alternative investment funds such as the FTSE Venture Capital Index and Barclays Hedge Fund Index. Also, the DCC-GARCH model shows very weak correlation between bitcoin and alternative investment funds such as the FTSE Venture Capital Index and Barclays Hedge Fund Index. Lack of correlation implies that bitcoin is an independent asset that does not move with market tides. It would also offer diversification benefits to an

investment portfolio. The vector auto regression methodology helped in capturing temporal interdependencies and the influence of cryptocurrencies on venture capital and hedge fund returns, showing that correlations shift with market conditions, and these correlations do not remain fixed over time. This dynamic perspective broadens theoretical discourse by situating digital assets within a framework that accounts for spillovers, persistence, and structural changes—elements that static models are unable to accommodate. The VAR and DCC approach expands the discussion by placing digital assets in a framework that captures spillovers and structural shifts. However, investors must note the volatile nature of bitcoin and its susceptibility to strict regulations that increase compliance costs and thus reduce profit margins. These findings are supported by research. However, there is not enough evidence that bitcoins offer diversification benefits. This research seeks to fill this knowledge void and recommends the exploration of other crypto currencies that offer diversification benefits.

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