



## ADVANCED CRYPTOFINANCE

STRATEGIES AND RISK MEASURES FOR INVESTORS AND MANAGERS

A 2024 Collection of the Best Student Papers from the São Paulo School of Economics at Fundação Getulio Vargas (FGV EESP)







STRATEGIES AND RISK MEASURES FOR INVESTORS AND MANAGERS



#### **Preface**

In 2018, Ripple launched the University Blockchain Research Initiative (**UBRI**) to drive understanding, adoption, and innovation in financial technology - including blockchain and cryptocurrency.

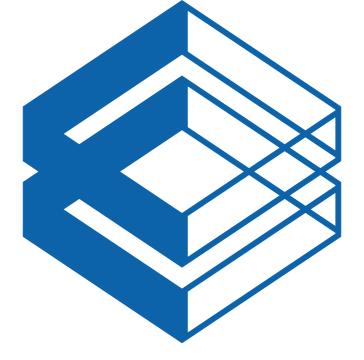
While we have an opportunity to lead global finance with digital assets, it is still early days and we are actively working to ensure that what we build today is scalable, sustainable, and built to last. This calls for greater collaboration between universities and industry partners to accelerate research and develop new talent.

By partnering with faculty and students from this leading global business school, FGV, we can create a more open, dynamic, and scalable fintech ecosystem to solve the challenges of tomorrow.

The bright young scholars featured in this e-book represent the best in groundbreaking thought leadership impacting Cryptofinance today. By combining a vision for the future, innovative technology, and global collaboration across communities, we can lead finance toward the digital shift together.

**Lauren Weymouth** 

Senior Director Partnerships, Ripple



#### Introduction



This e-book is dedicated to making complex research in cryptofinance accessible to professionals across industries. Our goal is to bridge the gap between academia and industry, sharing cutting-edge insights from student-led research with those shaping today's financial services landscape. Cryptofinance has rapidly evolved from a niche field into a crucial area of study, introducing technologies and approaches that challenge traditional models and offer transformative solutions for businesses and institutions. While it has recently gained traction in academia, many critical topics remain underexplored.

This publication is a product of FGV EESP's partnership with Ripple through the University Blockchain Research Initiative (UBRI). This collaboration has enabled FGV EESP to establish a comprehensive program in blockchain and cryptofinance, encompassing research, educational initiatives, and practical applications that address today's pressing financial challenges. With UBRI's support, FGV EESP students and faculty are advancing our understanding of cryptofinance, ensuring that findings are relevant and applicable to professionals outside academia.

We also invite you to explore the FinTech emphasis within <u>FGV EESP's Professional Master's and Doctorate Programs</u>, which offers a forward-looking curriculum covering blockchain-related and data science topics.

Accessibility is central to this e-book, where complex ideas are presented in a clear, approachable format. Inside, you'll find executive summaries of five research papers by FGV EESP students, each examining a distinct facet of cryptofinance. How do cryptocurrencies fit within traditional risk frameworks? Can Bitcoin serve as a reliable hedge against inflation? To what extent does corporate exposure to cryptocurrencies affect firm value? How does cryptocurrency salience influence retail investor behavior in the stock market? And finally, does

adding cryptoassets enhance portfolio performance? We hope industry professionals and enthusiasts alike find valuable takeaways and thought-provoking ideas within these pages.

We congratulate the students behind these five selected papers for their outstanding work and extend our gratitude to the faculty and partners who made this publication possible. We invite you to explore these findings with curiosity, hoping this collection provides a foundation for informed decision-making and inspires new ideas in this fast-evolving field.

#### **Prof. Jéfferson Colombo**

Head of FGV at the University Blockchain Research Initiative (UBRI) and Pedagogical Coordinator of the Professional Master and Doctorate Programmes (MPE/DPE).

### **Summary**

IS BITCOIN AN INFLATION HEDGE?

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# Is bitcoin an inflation hedge? Empirical evidence from CPI and PCE announcement surprises

Original Title: "Is Bitcoin an Inflation Hedge?".

- Student: Harold Rodriguez
   (Professional Master's in Finance and Economics, FGV EESP)
- Advisor: Professor Jéfferson Colombo, Ph.D.

#### Abstract of the original paper

Spot bitcoin ETFs have been recently approved in the U.S., increasing retail and institutional investors' attention to the crypto space. Still, empirical evidence on whether Bitcoin is an asset that protects investors against inflation is inconclusive. To contribute to this debate, we analyze the effect of inflation shocks on bitcoin returns through the estimation and inference of Vector Autoregressive Models (VARs). Unlike previous research on the topic, we identify inflation shocks as surprises in the US's CPI and Core PCE announcements: the difference between the announced inflation and the analysts' consensus. The results, based on monthly data between August 2010 and January 2023, indicate that bitcoin returns increase significantly after a positive inflationary shock, corroborating empirical evidence that Bitcoin can act as an inflation hedge. However, we observe that bitcoin's inflationary hedging property is sensitive to the price index - it only holds for CPI shocks - and to the period of analysis – the hedging property stems primarily from sample periods before the increasing institutional adoption of BTC ("early days"). Thus, the inflation-hedging property of Bitcoin is context-specific and is likely to be diminishing as adoption increases. This research contributes to the still under-explored strand of literature that analyzes the hedging and safe-haven properties of Bitcoin and benefits asset managers, investors, and monetary authorities.



This article has been accepted for publication in the *Journal of Economics and Business*.

Access the full version for discussion here:

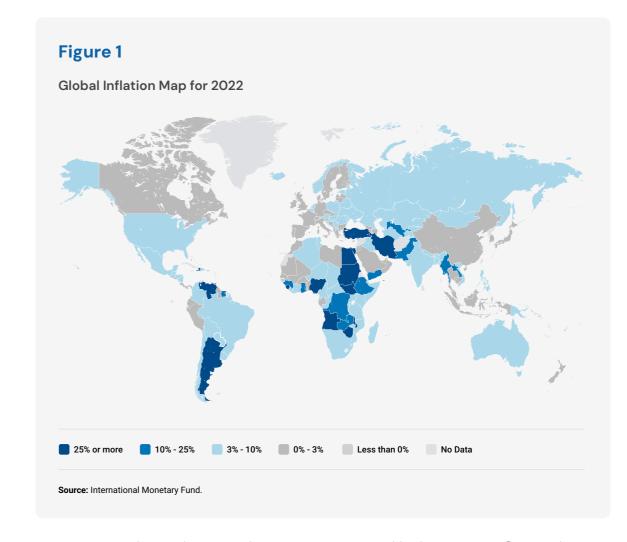
http://dx.doi.org/10.2139/ssrn.4763347



#### Context and study objective

Inflation represents a significant risk for investors, especially given the recent global increases in price levels, and is considered one of the biggest threats to businesses in the coming years.

In this context, investors must develop protective strategies by seeking assets that preserve value during periods of high inflation. This need has intensified due to widespread price increases across various regions, including developed economies that, for decades, maintained low interest rates and stable inflation.



In recent years, bitcoin has gained traction as a potential hedge against inflation. This view has gained support among investors, academics, and policymakers alike.

The proposition that bitcoin may serve as an inflation hedge is anchored in two key characteristics: its limited supply and decentralized network. These traits reinforce its scarcity and resilience, enabling bitcoin to potentially preserve value amid rising inflation. On the other hand, its

**FGV EESP** 





Therefore, the debate on bitcoin's effectiveness as an inflation hedge remains open, with recent studies showing no consensus and indicating that its role as an inflation hedge may vary depending on the methodology, analysis period, and specific economic conditions under study.

In this context, this paper seeks to estimate and analyze, using Vector Autoregression (VAR), the short-term effect of inflation shocks on bitcoin's price to determine whether it can be considered an inflation hedge. Specifically, it aims to assess the dynamic interrelationships between model variables using two tools provided by the methodology: impulse-response functions and forecast error variance decomposition.

This research thus contributes to the growing, yet still underexplored, debate on bitcoin's hedge properties against inflationary shocks and addresses remaining gaps in the literature.

#### Methodology and data

Inflation can be approximately measured through price indices which track changes in the cost of a specific basket of goods and services over time.

In Brazil, the most widely used indices are the IPCA, IPCA-15, and IGP-M. In the United States, whose inflation indices serve as the focus of this study, the most commonly referenced are:

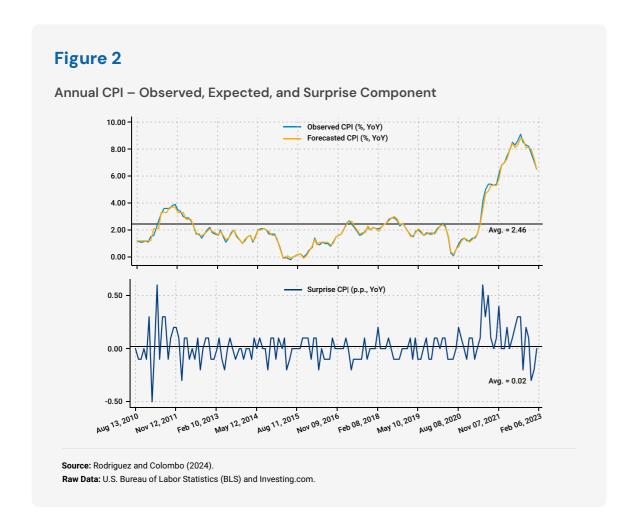
- **CPI (Consumer Price Index):** Measures variations in the prices of goods and services purchased by urban consumers. CPI reflects the impact of inflation on living costs.
- PCE (Personal Consumption Expenditures): Measures price changes in goods and services consumed by households, with a slightly different composition from the CPI. It is considered a broader measure and is closely monitored by the Federal Reserve in its monetary policy decisions.

Changes in these indices over time provide insight into whether prices are rising or falling and, consequently, how the purchasing power of money is affected. When prices increase unexpectedly and rapidly, as in periods of high inflation, investors seek to protect their portfolios by turning to assets that can maintain or increase in real value.

In financial markets, the dynamic between market expectations and actual inflation data is fundamental to understanding how the prices of financial assets, including bitcoin, respond to inflation shocks.

The reaction of financial assets to these inflation surprises depends on the economic context. In periods of heightened uncertainty, such as financial crises, deviations between expectations and actual data can trigger greater volatility.

Figure 2 below shows the historical series of annual inflation data measured by the CPI, the market's forecast for the index, and the surprise component from August 2010 to January 2023.





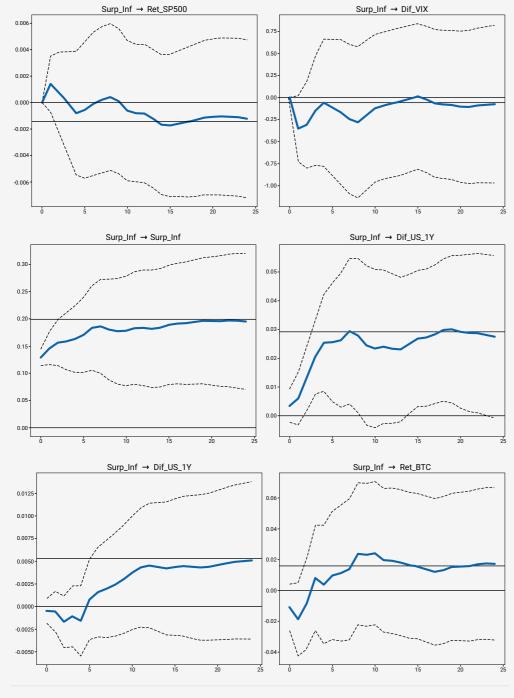
Understanding the relationship between inflation and the market is crucial for investors seeking protection against losses and volatility.

On average, the surprises are close to zero. However, beginning in mid-2021, with the monetary supply shock triggered by COVID-19, non-zero surprises became more frequent.

These inflation surprises are used in this study to evaluate how bitcoin returns react to them, considering movements and interrelations with all other variables in the system.

Figure 3 presents the cumulative responses of each asset to an inflation surprise shock following the release of monthly CPI data. For comparison, the assets, represented by their respective returns, include the S&P 500, gold, one-year U.S. Treasury bonds (US1y), and the VIX.

Figure 3
Impact of Inflation Shock on Different Assets



Source: Rodriguez and Colombo (2024).

Overall, it's possible to infer that an unexpected positive shock in the monthly CPI increases the returns of gold, bitcoin, and U.S. Treasury bonds, while it reduces returns for the S&P 500 and has no effect on the VIX.

#### Key findings

The test results using monthly CPI, which best captures inflation surprises (compared to annual CPI and PCE), suggest that bitcoin may initially be considered a useful asset for protecting against unexpected inflation shocks.

However, a more in-depth analysis, which segments the evaluation periods and considers both annual CPI and PCE, highlights several important factors to consider.

In its early years, the data indicates that bitcoin behaved as a decentralized asset with low correlation to traditional markets and common hedging assets. During this time, positive inflationary shocks, measured by unexpected increases in CPI and PCE, were associated with rises in bitcoin returns.

This suggests that, at that time, bitcoin could be viewed as an appealing alternative for those seeking to protect capital against purchasing power loss.

This correlation with inflation, however, did not remain constant. Beginning in 2020, when the COVID-19 pandemic impacted the global economy, bitcoin's behavior shifted. During this period of uncertainty, marked by expansionary monetary policies, bitcoin began to behave more similarly to risk assets like equities, as reflected in its increasing correlation with indices like the S&P 500.

Consequently, bitcoin's capacity to serve as an inflation hedge waned and the protection it provided in earlier periods became less evident. In contrast, gold, considered a classic inflation hedge, consistently demonstrated its protective properties throughout the analysis. With a longstanding reputation as a protective asset during economic instability, gold's resilience persisted during periods of elevated inflation. While bitcoin exhibited a higher correlation with equities during the pandemic's most turbulent years, gold maintained its protective qualities.

This contrast is visible in Figure 4, particularly in the time frame following the COVID-19 pandemic, when bitcoin began to show marginally diminishing returns in the months after an inflation surprise, whereas gold remained resilient as a store of value even during this period.

Other assets, such as real estate and U.S. Treasury bonds (US1y), also demonstrated resilience as hedging tools, though with varying degrees of effectiveness depending on portfolio structure and the evaluation period. In essence, diversification continues to be one of the best strategies for mitigating inflation impact on portfolios, especially when there is uncertainty surrounding the consistency of emerging assets like bitcoin.

The analysis of bitcoin's behavior over different historical periods suggests that its role as an inflation hedge may depend on factors such as the economic context and the level of institutional adoption.

In its early years, bitcoin proved to be an effective tool for protecting capital during inflationary increases. However, as it gained popularity and began being used as a store of value by large institutions, its behavior started to align more closely with that of risk assets, particularly following expansionary monetary policies implemented globally after the COVID-19 pandemic.



#### **Practical implications**

For portfolio managers and institutional investors, using bitcoin as an inflation hedge presents both opportunities and challenges. Its effectiveness as a protective asset against inflation depends on the chosen price index and the period analyzed.

Unlike traditional assets like gold and real estate, bitcoin is still in a maturing phase, meaning its reliability as a protective tool can vary significantly over time.

When considering bitcoin as part of a hedging strategy, it is essential to consider the current economic environment, the asset's volatility, and its correlation with other markets. Additionally, diversifying portfolios with assets that historically demonstrate greater consistency in protecting against inflation is crucial.

The data illustrating bitcoin's relationship with inflation indices over time, as well as comparisons with other hedge assets, are useful for visualizing these trends and emphasize the need for careful analysis before making allocation decisions.

While this study has revealed several empirical findings, it is important to highlight certain limitations that could influence the interpretation of bitcoin's effectiveness as an inflation hedge.

First, this is an extremely dynamic market, and the model used does not account for potential regulatory changes or the impact of new cryptocurrencies on bitcoin's price.

Second, the period analyzed includes bitcoin's early development years, meaning that critical factors like trading volume and liquidity may shift drastically in the future, impacting the conclusions presented here.

Furthermore, the methodology employed is based on a linear model, which may not fully capture nonlinear relationships or structural shifts among the variables analyzed.

Another critical point is that the analysis does not consider possible side effects of including bitcoin in a diversified portfolio, such as increased volatility and the presence of fat tails.

Finally, returns were calculated daily, which may result in the loss of relevant intraday information, potentially affecting the accuracy of the analysis.

Future studies should explore the feasibility of capturing these variations at high frequency for a more comprehensive analysis.

 Bitcoin as an inflation hedge presents opportunities and challenges for managers and institutional investors.

# Interested in this topic? Explore other academic publications related to this subject:

- Liu, J., & Valcarcel, V. J. (2024). Hedging inflation expectations in the cryptocurrency futures market. *Journal of Financial Stability*, 70, 101205.
   https://doi.org/10.1016/j.jfs.2023.101205
- Smales, L. A. (2024). Cryptocurrency as an alternative inflation hedge?.
   Accounting & Finance, 64(2), 1589-1611.
   https://doi.org/10.1111/acfi.13193
- Sakurai, Y., & Kurosaki, T. (2023). Have cryptocurrencies become an inflation hedge after the reopening of the US economy?. Research in International Business and Finance, 65, 101915.
   <a href="https://doi.org/10.1016/j.ribaf.2023.101915">https://doi.org/10.1016/j.ribaf.2023.101915</a>
- Wen, F., Tong, X., & Ren, X. (2022). Gold or Bitcoin, which is the safe haven during the COVID-19 pandemic?. *International Review of Financial Analysis*, 81, 102121. https://doi.org/10.1016/j.irfa.2022.102121
- Choi, S., & Shin, J. (2022). Bitcoin: An inflation hedge but not a safe haven. Finance Research Letters, 46, 102379.
   https://doi.org/10.1016/j.frl.2021.102379
- Conlon, T., Corbet, S., & McGee, R. J. (2021). Inflation and cryptocurrencies revisited: A time-scale analysis. *Economics Letters*, 206, 109996.
   <a href="https://doi.org/10.1016/j.econlet.2021.109996">https://doi.org/10.1016/j.econlet.2021.109996</a>
- Pyo, S., & Lee, J. (2020). Do FOMC and macroeconomic announcements affect Bitcoin prices?. Finance Research Letters, 37, 101386.
   https://doi.org/10.1016/j.frl.2019.101386



## Including cryptoassets in a diversified portfolio: a detailed analysis of the brazilian case

Original Title: "The impact of cryptocurrencies on the performance of multi-asset portfolios: Evidence from Brazil".

- Student: Oswaldo Donatelli Neto (Professional Master's in Finance and Economics, FGV EESP)
- Advisor: Professor Jéfferson Colombo, Ph.D.

#### Abstract of the original paper

This paper assesses the impact of adding cryptocurrencies to well-diversified portfolios, from a Brazilian investor's perspective. Based on otherwise-identical portfolios composed of equities (IBOV), fixed income (IMAG), real estate (IFIX), commodities (GOLD), and foreign equity (IVVB11), we evaluate the changes in risk-adjusted returns by including cryptocurrencies under eight allocation strategies, both in- and out-ofsample. Results indicate that including cryptoassets increases the Sharpe, Sortino, and Omega indices for all analyzed strategies. Among the diversification categories, "Crypto Basket" and "Altcoins" outperformed "Bitcoin" (on average), indicating potential benefits from the diversified crypto investment. The results are robust to different estimation windows and rebalancing frequencies.



This article has been accepted for publication in the Revista Brasileira de Finanças (2021). Access the full version for discussion here:

https://periodicos.fgv.br/rbfin/article/ view/84354/80496



#### Context and study objective

Cryptoassets have been established as a new asset class in global financial markets. With over 10,000 digital currencies being traded, assets like bitcoin and altcoins have attracted the attention of both retail and institutional investors.

This trend has developed in the context of diversification and a low-interest-rate environment, encouraging the search for riskier assets.

The global decline in interest rates has led institutional investors to adjust their portfolios, seeking higher-risk assets to offset the low-interest environment. Although cryptoassets remain a relatively new topic for studies in Brazil, their impact on diversified portfolios has sparked interest.

Despite the growing body of literature on the role of cryptoassets in portfolios of traditional and alternative assets, most studies examine this topic from the perspective of investors in the U.S., Europe, or China. Thus, there is a lack of empirical studies addressing the inclusion of cryptoassets in the portfolios of investors in developing countries.

This study, therefore, seeks to fill this gap by evaluating the performance of a wide range of asset allocation strategies, with and without cryptoassets, from the perspective of a Brazilian investor.

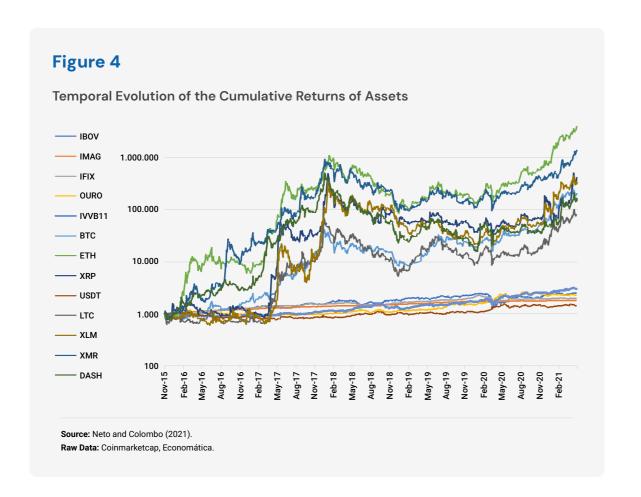
#### Methodology and data

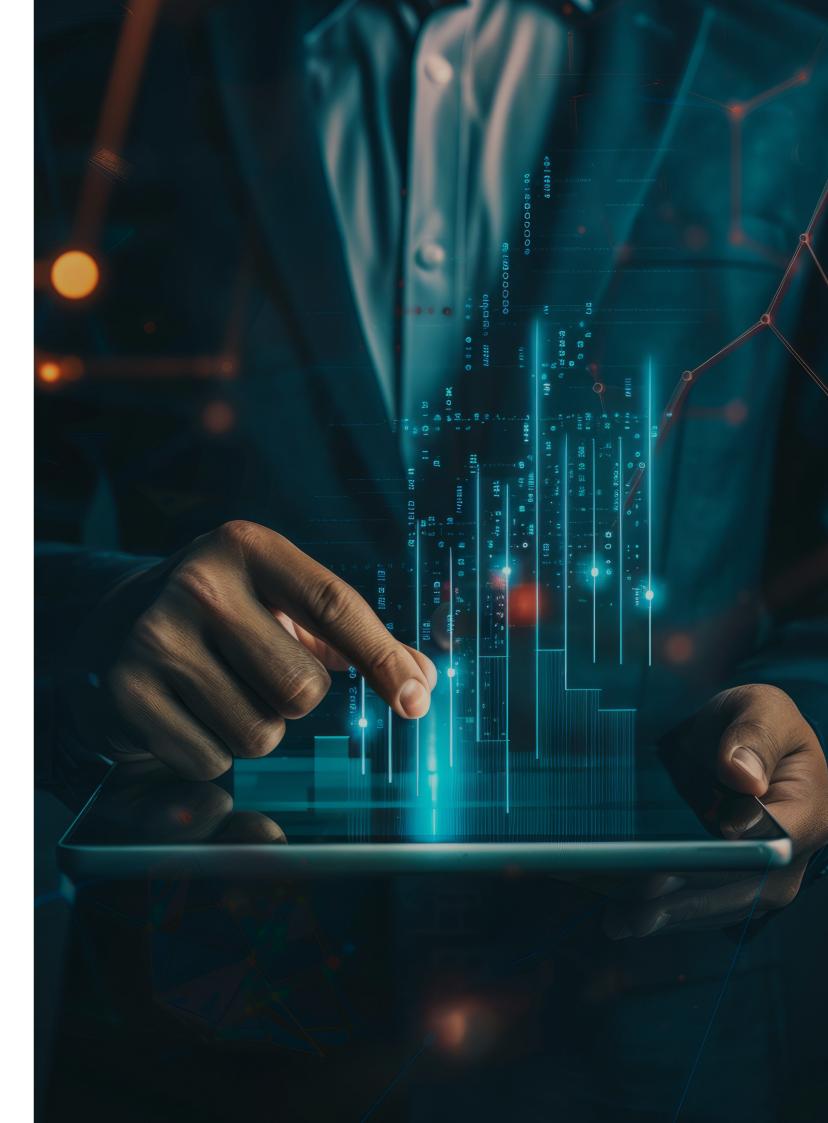
In particular, the performance results of the base portfolio are evaluated against four other portfolios containing cryptoassets, using investment strategies that balance risk and return in the composition of portfolio assets.

The base portfolio includes investments in equities, represented by the Ibovespa index; fixed income, represented by the IMA-Geral index (ANBIMA); real estate, represented by the real estate fund index IFIX; commodities, represented by gold; and international investments, represented by the ETF IVVB11, which replicates the S&P500 index in Brazilian reais and is traded in the Brazilian stock exchange.

To assess not only the role of bitcoin in the portfolio but also the potential diversification benefits of digital assets, the study includes eight additional cryptoassets, divided into the following categories: Altcoin (ETH, LTC, XRP, BCHM, XLM, XMR), Bitcoin (BTC), and Stablecoin (USDT).

The price data for the assets used in this study are daily from November 1, 2015, to April 30, 2021.





Assigning weights to each asset in a portfolio is one of the most critical steps in constructing an investment portfolio. By assigning weights, the investor determines how much of their capital will be allocated to each asset, balancing potential returns and risks.

This process is especially significant when considering volatile investments such as cryptoassets, which can substantially impact the risk-return profile of a portfolio. Several approaches can be employed to define these weights, ranging from simpler methods to techniques that account for market expectations.

- 1. Equal Weighting (EQL): This is a straightforward and accessible method. Each asset receives the same weight in the portfolio, regardless of its risk level or expected return. For instance, in a portfolio with five assets, each would receive a 20% allocation. The simplicity and ease of implementation make equal weighting a common starting point for many investors.
- 2. Strategic Risk Profiles (STW): This strategy adjusts asset proportions according to the investor's risk profile, which can be conservative, moderate, or aggressive. In this approach, a conservative profile allocates 80% of the portfolio to fixed income, with the remaining balance distributed among riskier assets. The addition of cryptoassets ranges from 1% (conservative profile) to 4% (aggressive profile).

- 3. Risk Parity Models (RP): This method distributes risk, rather than capital, across assets. This means that more volatile instruments, such as cryptoassets, will receive a smaller weight, while more stable assets are assigned proportionally higher weights. Risk parity helps to balance portfolio volatility, particularly when including assets with significantly different price fluctuations.
- 4. Minimum Variance (MinVar): For investors seeking to minimize volatility, the minimum variance strategy is an appealing option. This approach aims to identify the combination of assets that results in the lowest possible risk, considering their correlations. It allows investors to reduce exposure to market fluctuations, which can be particularly valuable in portfolios with highly volatile cryptoassets.
- 5. Mean-Variance Models (MaxMV): Originating from modern portfolio theory, this technique seeks to maximize expected returns for a given level of risk. Here, the investor adjusts weights based on the mean return and variance of each asset. This approach is highly flexible and can be tailored to specific risk profiles, making it one of the most popular choices for diversified portfolios.
- 6. Black-Litterman Model: This method is used to incorporate market expectations into the portfolio. The Black-Litterman model allows for weight adjustments based on predicted returns for certain assets, integrating a market outlook into future prices. This model is particularly

appealing to investors who monitor financial market trends and wish to align their portfolios with these forecasts.

Each of these approaches has its advantages and limitations. The choice of which method to adopt will depend on the investor's goals, risk tolerance, and the characteristics of the assets within the portfolio.

In the case of cryptoassets, methods that consider high volatility and significant price swings are especially beneficial, as they help mitigate the impact of abrupt market movements on the portfolio.

The following table illustrates the calculations and parameters required for each model discussed in this study, ranking them from least to most complex.

Asset Allocation Strategies and	l Portfolio Optimization Fur	nctions	
asset allocation strategy	função de otimização/ ponderação de portfólio	restrições da função de otimização	parâmetros necessári
ponderação igualitária (EQL)	$\omega_i = 1/n$	não há	
pesos estratégicos: perfil de risco conservador (STWcon), moderado (STW) e agressivo (STWagr)	$\omega_i = \omega_{STWi}$	não há	
inverso da variância (RPvar)	$\omega_i = rac{1/\sigma_i^2}{\sum_{i=1}^n 1/\sigma_i^2}$	não há	variâno
inverso da volatilidade (RPvol)	$\omega_i = \frac{1/\sigma_i}{\sum_{j=1}^{n-1} 1/\sigma_j}$	não há	volatilida
retorno/risco (RRT)	$\omega_i = \frac{r_i/\sigma_i^2}{\sum_{j=1}^n r_i/\sigma_i^2}$	não há	retorno e variâno
mínima variância (minVAR)	$\min \sigma_p^2 = \min \Omega^T \Sigma \Omega$	$\sum_{i=1}^{n} \omega_i = 1$ $\omega_i \ge 0$ $i = 1, \dots, n$	matriz de variância covariânc
utilidade média-variância: perfil de risco conservador (maxMVcon), moderado (maxMV) e agressivo (maxMVagr)	$\max_{r_p} - \frac{\delta}{2} \sigma_p^2 = \max_{r} \Omega^T R - \frac{\delta}{2} \Omega^T \Sigma \Omega$	$\sum_{i=1}^{n} \omega_i = 1$ $\omega_i \ge 0$ $i = 1, \dots, n$	retorno, matriz variância e covariânce e coeficiente aversão risco $\delta =$ (conservador), $\delta =$ (moderado) e $\delta =$ (agressiv
utilidade média-variância Black-Litterman. Perfil de risco conservador (maxMVBLcon), moderado (maxMVBL) e agressivo (maxMVBLagr). Benchmarks: STWcon, STW e STWagr	$\begin{split} & \overline{\max \Omega^T R_{BL} - \frac{5}{2} \Omega^T \Sigma_{BL} \Omega} \\ & R_{BL} = \left[ (\tau \Sigma)^{-1} + P^T \Omega^{-1} P \right]^{-1} \times \left[ (\tau \Sigma)^{-1} \Pi + P^T \Omega^{-1} Q \right] \\ & \Sigma_{BL} = \Sigma + \left[ (\tau \Sigma)^{-1} + P^T \Omega^{-1} P \right]^{-1} \\ & \Pi = \delta \Sigma \varphi \\ & \Omega = P(\Sigma/c) P^T \end{split}$	$\sum_{i=1}^{n} \omega_i = 1$ $\omega_i \ge 0$ $i = 1, \dots, n$	retorno, matriz variância e covariância e perfil $\delta$ = (conservador), $\delta$ = (moderado), $\delta$ = (agressive

Once the issues related to asset allocation are addressed, it becomes possible to evaluate how the different models affect portfolio performance.

To compare portfolios that include cryptoassets with those that do not, several indicators widely used in financial markets were analyzed to measure risk-adjusted returns.

The primary one is the **Sharpe Ratio**, which

Another important measure is the **Sortino** Ratio, a variation of the Sharpe Ratio that considers only the volatility of returns below the minimum expected return level for the investor. Thus, the Sortino Ratio focuses on downside risk, which can be useful for better understanding the potential for losses.

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Finally, the Omega Ratio can also be used, which measures the relationship between returns above and below the desired minimum return.

The advantage of the Omega Ratio is that it accounts for the asymmetry of returnsconsidering the frequency and impact of significant upward and downward fluctuations, which is highly relevant in volatile markets such as cryptoassets.

To evaluate the asset's expected returns and define an optimized allocation strategy, two approaches to return estimation were utilized: in-sample and out-of-sample. These approaches help to understand how cryptoassets can impact the diversification and performance of a multi-asset portfolio.

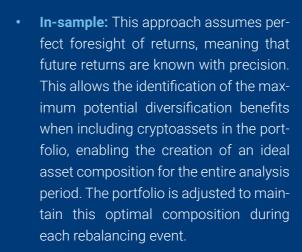


Figure 5

Out-of-sample: This approach more accurately reflects the real-world conditions faced by institutional and retail investors, using past data as a reference for predictions. Here, a historical rolling window is applied to project the expected return and variance of the assets. During each rebalancing event, the portfolio is adjusted based on recent historical returns, better representing actual market conditions.

The optimal allocation of assets is determined on the first business day of each month when rebalancing occurs. Thus, the total invested capital is redistributed according to the asset weights calculated for that period, dynamically maximizing the potential for risk-adjusted returns.

To ensure greater reliability of the results, the portfolio analysis uses different historical data periods to calculate asset returns.

In addition to the standard 6-month period, windows of 1, 3, and 12 months were also tested. This adjustment allows the assessment of how the choice of data period influences portfolio performance.

 $W_{op,3}$ 

 $W_{op,4}$ 

 $W_{op,n-1}$ 

Rebalancing Period

Visual representation of the out-of-sample analysis method

Rebalancing Analysis Window:

Return and Covariance Matrix Calculation (Rolling Window)

Source: Neto and Colombo (2021).





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Lastly, various portfolio rebalancing frequencies were explored, ranging from weekly, and quarterly, to semi-annual intervals, with monthly being the default frequency.

This approach allows for observing how different adjustment intervals in portfolio composition can impact final returns, helping identify the optimal frequency to balance transaction costs and potential returns.

To analyze the effect of including cryptoassets in the portfolio, the performance of five portfolios was compared:

- I. Base Portfolio, which includes the assets IBOV, IMAG, IFIX, GOLD, and IVVB11;
- **II. CriptoBasket Portfolio**, which includes the base portfolio assets and the crypto index, composed of the simple average of the eight analyzed cryptoassets;
- III. Bitcoin Portfolio, which includes the base portfolio assets and bitcoin;
- IV. Altcoin Portfolio, which consists of the base portfolio assets and alternative cryptoassets;
- V. Stablecoin Portfolio, which contains the base portfolio assets and fiat-backed stablecoins

#### Key findings

The results obtained for the reference scenario indicate that portfolios including cryptoassets outperformed the base portfolio regarding the Sharpe ratio across all tested models.

A sensitivity test, which considers 12 months for historical data analysis, shows similar results, as indicated in the table on the following page:



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Table 2
Sensitivity Analysis with a 12-Month Periodicity

				Portfólio		
modelo	métrica	base	Cripto Basket	Bitcoin	Altcoin	Stablecoin
	retorno (%)	17,36	39,97	38,55	46,58	16,78
EQL	volatilidade (%)	9,77	18,17	17,60	21,69	8,16
	Sharpe	1,16	1,87	1,85	1,87	1,31
	retorno (%)	11,25	12,70	12,56	13,18	11,18
STWcon	volatilidade (%)	4,42	4,57	4,57	4,65	4,34
	Sharpe	1,17	1,45**	1,42**	1,53**	1,18
	retorno (%)	14,34	17,93	17,59	19,12	14,17
STW	volatilidade (%)	6,74	7,31	7,26	7,61	6,48
	Sharpe	1,23	1,62**	1,59**	1,71**	1,25
	retorno (%)	17,36	23,02	22,51	24,88	17,08
STWagr	volatilidade (%)	9,77	10,75	10,67	11,26	9,34
	Sharpe	1,16	1,58**	1,54**	1,67**	1,18
	retorno (%)	10,66	11,16	11,10	11,11	10,69
Rpvar	volatilidade (%)	4,19	4,19	4,19	4,19	3,92
	Sharpe	1,10	1,22***	1,20***	1,20***	1,18
	retorno (%)	13,04	17,88	17,44	18,27	13,03
Rpvol	volatilidade (%)	5,73	6,33	6,26	6,44	5,02
	Sharpe	1,22	1,87***	1,82***	1,90***	1,39
	retorno (%)	13,58	40,96	38,95	47,29	13,14
RRT	volatilidade (%)	9,83	21,11	20,11	25,11	8,92
	Sharpe	0,76	1,65*	1,64*	1,64	0,79
	retorno (%)	10,74	11,12	11,00	11,07	10,56
minVAR	volatilidade (%)	3,68	3,68	3,68	3,68	3,34
	Sharpe	1,27	1,38***	1,34**	1,36***	1,35
	retorno (%)	13,97	47,42	34,74	50,99	13,82
maxMVcon	volatilidade (%)	13,94	28,12	23,27	29,61	13,38
	Sharpe	0,57	1,47*	1,23	1,52*	0,58
	retorno (%)	15,99	70,65	52,93	77,12	15,36
maxMV	volatilidade (%)	16,50	47,04	38,93	48,80	16,01
	Sharpe	0,60	1,37	1,20	1,46	0,58
	retorno (%)	13,76	88,87	80,74	102,99	12,64
maxMVagr	volatilidade (%)	18,68	59,84	61,78	70,51	18,70
	Sharpe	0,41	1,38	1,21	1,37	0,35
	retorno (%)	8,47	14,25	12,26	15,10	8,77
maxMVBLcon	volatilidade (%)	9,90	10,86	10,69	11,09	9,62
	Sharpe	0,24	0,75**	0,58**	0,82**	0,28

Source: Neto and Colombo (2021).

Moreover, among the options for including cryptoassets in the portfolio, the "Stablecoin" alternative performed the worst, while cryptoasset portfolios (ranging from CriptoBasket to Altcoins) demonstrated the best performance.

In addition to the Sharpe ratio, the results are robust across other performance indices, with the Omega ratio showing the greatest improvement from adding cryptoassets to the portfolio.

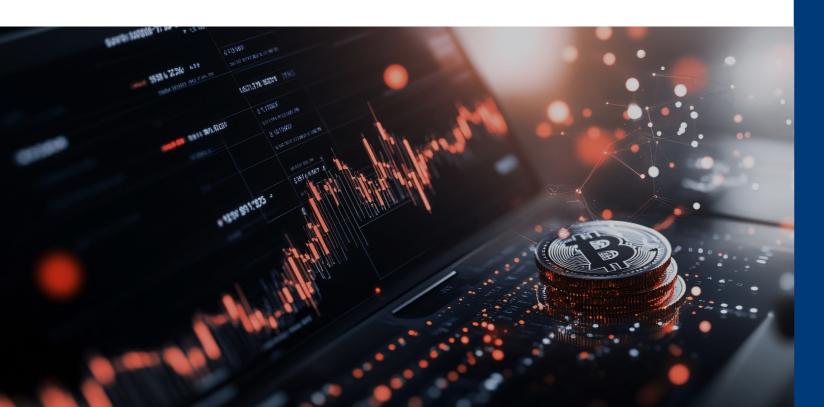
When the historical data analysis window periods and portfolio rebalancing frequencies are changed, the overall results remain consistent, further reinforcing the robustness of the findings presented here.

#### **Practical implications**

The empirical evidence obtained in this study highlights the potential for diversification benefits arising from the addition of cryptoassets into investment portfolios.

The findings for Brazil align with evidence from the U.S., Europe, and China. However, it is important to note that the analysis focuses on a specific period with unique market conditions. During this time, cryptoassets experienced high average returns, a trend that may not persist over longer horizons.

In summary, the results emphasize the potential of cryptoassets as an asset class capable of enhancing risk-adjusted returns in Brazilian portfolios, though their volatile nature necessitates well-structured diversification strategies..



#### Interested in the topic? Check out other academic publications related to this subject:

- Han, W., Newton, D., Platanakis, E., Wu, H., & Xiao, L. (2024). The diversification benefits of cryptocurrency factor portfolios: Are they there?. Review of Quantitative Finance and Accounting, 1-50.
   https://doi.org/10.1007/s11156-024-01260-w
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# The relation between cryptoassets market salience and retail investors' activity at B3

Original Title: "Distracted by crypto".

- Student: Matheus Brito (PhD in Business Economics at FGV EESP)
- Advisor: Professor Jéfferson Colombo, Ph.D.

#### Abstract of the original paper

How have retail equity investors responded to the surge in cryptocurrencies? Analyzing detailed data on all Brazilian investors from 2012 to 2018, we find that retail equity trading decreases during periods when cryptocurrencies are attention-grabbing. The economic impact ranges from 5.1% to 7.9% and is more pronounced among younger investors and those in blockchain-related professions. Net trading flow analysis reveals no significant inflows or outflows, supporting a distraction-based interpretation. Validation with U.S. retail trading data confirms these results. As cryptocurrencies become mainstream from 2019 to 2022, we observe a diminishing distraction effect, consistent with individuals perceiving them as a conventional asset.



Access the full version for discussion here:

https://papers.ssrn.com/sol3/papers.
cfm?abstract\_id=5018192



#### Context and study objective

Since its creation in 2009, bitcoin has evolved from obscure beginnings to being traded on major stock exchanges through ETFs and futures contracts. Enthusiasts highlight its hedging potential and advocate for its inclusion in diversified portfolios, arguing that cryptoassets constitute a new investment class in their own right.

At the same time, regulators and academics warn that they are speculative assets prone to bubbles. But how has individual trading behavior responded to the rapid rise of cryptocurrencies in the investment landscape?

This study examines how attention-grabbing events in the cryptocurrency market impact retail investor behavior in the stock market. Using a rich dataset from Brazil's Securities and Exchange Commission (CVM), the researchers analyzed the daily trading activity of all retail investors on the Brazilian stock exchange from 2012 to 2018.

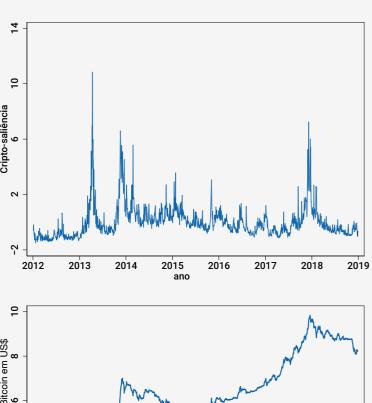
This dataset captures every stock transaction, offering a detailed view of trading patterns across different demographic profiles, including age and profession. By observing this group over time, the study reveals how fluctuations in the digital asset market, particularly involving bitcoin, divert retail investors' attention away from traditional stocks.

#### Methodology and data

To identify when cryptoassets capture public interest, the "crypto-salience" indicator was developed. It is a composite measure that reflects bitcoin's popularity. Its time series, along with bitcoin's price chart, can be observed in Figure 6 below:

Figure 6

Crypto-salience and the prices of bitcoin



2012 2013 2014 2015 2016 2017 2018 2019 ano

Source: Brito, Chague and Colombo (2024).



This indicator combines three metrics:

- 1. Daily mentions of bitcoin on major Reddit subforums;
- 2. bitcoin price fluctuations; and
- 3. Trading activity on major exchanges.

These variables represent moments when cryptoassets are most likely to capture public attention, potentially driving changes in investor behavior.

The measure was designed to identify periods when Bitcoin, the most recognized cryptoasset in the market, becomes an especially engaging topic for the public, influencing investment decisions across other asset classes.

#### **Key Findings**

It was found that retail investors' stock trading activity in Brazil decreased by 5.1% to 7.9% on days when bitcoin is in the spotlight, suggesting that investor attention shifts from stocks to digital assets. This effect, referred to as the "distraction phenomenon," implies that retail investors, constrained by time and attention, may be captivated by the appeal of the cryptocurrency market, temporarily sidelining their stock trading activities.

These overall results are presented in Table 3, which includes regressions with various explanatory and dependent variables (log of the number of retail investors, log of the trading volume by retail investors, and the ratio of retail investors' traded volume to total traded volume)..



Table 3

Crypto-salience and retail crypto trading

	$\log(\text{number})$		$\log(\text{volume})$		fraction	
	(1)	(2)	(3)	(4)	(5)	(6)
Crypto-salience	-0.081***	-0.070***	-0.068***	-0.053***	-0.722***	-0.710***
	(-4.85)	(-5.49)	(-4.20)	(-5.06)	(-5.27)	(-5.32)
Market returns		0.014***		0.011***		0.164***
		(5.01)		(4.67)		(4.83)
Market volume		0.512***		0.717***		
		(18.59)		(25.64)		
Market volatility		-0.077***		-0.048***		-0.950***
		(-5.18)		(-3.98)		(-5.72)
Calendar controls	yes	yes	yes	yes	yes	yes
Adjusted R-squared	0.46	0.69	0.37	0.75	0.22	0.27
Observations	1727	1727	1727	1727	1727	1727

Source: Brito, Chague and Colombo (2024).

Notably, this decline in activity occurs without significant capital shifts from stocks to cryptocurrencies, supporting the hypothesis that the effect is primarily a matter of attention rather than financial reallocation.

A more detailed analysis of the data further reveals that this distraction effect varies based on age and profession. The impact is especially pronounced among younger investors, who may be more receptive to cryptoassets, and professionals in technology-related fields, such as engineers and system analysts. These groups are more likely to engage in online discussions about cryptocurrencies and track price fluctuations, making them more susceptible to crypto-driven distractions.

This demographic insight is a key finding, illustrating that specific groups of investors are more affected by the rise of digital assets in terms of where they focus their trading efforts.

To validate these findings, the study applied the same crypto-salience measure to retail trading data in the United States, revealing a similar but slightly smaller decline in stock market activity among U.S. retail investors. This cross-country comparison reinforces the distraction interpretation, suggesting that the shift in focus toward cryptocurrencies during high-attention periods affects retail investors across different markets. Social media mentions and trading intensity emerges as the most significant factors driving this attention shift.

Interestingly, an extension of the dataset from 2019 to 2022 reveals a reversal of this effect starting in 2020. As cryptocurrencies have gained mainstream appeal, with products such as cryptocurrency ETFs emerging in Brazil and other countries, retail investors appear to view digital assets more as conventional investments.

This shift aligns with the growing integration of cryptocurrencies into the financial system, where they are incorporated into traditional investment portfolios rather than being seen solely as speculative alternatives.

#### **Practical implications**

For industry professionals, these findings highlight the importance of understanding the dynamic role that shifts in attention play in retail investment behavior.

Financial advisors and market analysts can benefit from monitoring cryptocurrency market sentiment, particularly among younger or tech-savvy clients, to anticipate changes in stock trading activity.

Additionally, the growing integration of cryptocurrencies into traditional portfolios marks a new phase in the evolution of digital assets, demonstrating that retail investors are beginning to treat them as part of a diversified investment strategy rather than merely a temporary and high-risk venture.



#### Interested in the topic? Check out other academic publications related to this subject:

- Kogan, S., Makarov, I., Niessner, M., & Schoar, A. (2024). Are cryptos different? evidence from retail trading. *Journal of Financial Economics*, 159, 103897. <a href="https://doi.org/10.1016/j.jfineco.2024.103897">https://doi.org/10.1016/j.jfineco.2024.103897</a>
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- Barber, B. M., & Odean, T. (2008). All that glitters: The effect of attention and news on the buying behavior of individual and institutional investors. The review of financial studies, 21(2), 785-818.
   <a href="https://doi.org/10.1093/rfs/hhm079">https://doi.org/10.1093/rfs/hhm079</a>

## Exposure to cryptoassets by publicly listed companies and its effects on stock prices

Original Title: "Store of value or speculative investment? Market reaction to corporate announcements of cryptocurrency acquisition".

- Student: André Dias Gimenes (Professional Master's in Finance and Economics at FGV EESP)
- Advisor: Professor Jéfferson Colombo, Ph.D.

#### Abstract of the original paper

In this study, we analyze the stock market reaction to 35 events associated with 32 publicly traded companies from six countries that have announced cryptocurrency acquisitions, selling, or acceptance as a means of payment. Our analysis focuses on traditional firms whose core business is unrelated to blockchain or cryptocurrency. We find that the aggregate market reaction around these events is slightly positive but statistically insignificant for most event windows. However, when we perform heterogeneity analyses, we observe significant differences in market reaction between events with high (larger CARs) and low cryptocurrency exposure (lower CARs). Multivariate regressions show that the level of exposure to cryptocurrency ("skin in the game") is a critical factor underlying abnormal returns around the event. Further analyses reveal that economically meaningful acquisitions of BTC or ETH (relative to firm's total assets) drive the observed effect. Our findings have important implications for managers, investors, and analysts as they shed light on the relationship between cryptocurrency adoption and firm value.



This article has been accepted for publication in the Financial Innovation (2023). Access the full version for discussion here:

https://link.springer.com/ article/10.1186/s40854-023-00539-6



#### Context and study objective

The rise of disruptive technologies has often led to corporate value creation and wealth generation. Recently, the adoption of cryptocurrencies and other digital assets by institutional investors has brought the crypto sector closer to traditional markets.

However, companies have only recently started investing in crypto assets to manage excess cash and increase exposure to digital assets.

The net present value of these corporate decisions is uncertain ex-ante; while they may act as a hedge against inflationary risks and offer higher returns on excess cash compared to traditional flat currencies, they are also more volatile and subject to regulatory and cybersecurity risks.

Corporate investments in crypto assets have become a recent trend in various countries, particularly since Tesla announced in early 2021 that it had invested \$1.5 billion in bitcoin (BTC) as part of a new excess cash management policy.

#### Figure 7

Headline on Tesla's \$1.5 Billion Bitcoin Purchase



Home News US Election Sport Business Innovation Culture Arts Travel Earth Video Live

#### Elon Musk's Tesla buys \$1.5bn of Bitcoin causing currency to spike

8 February 2021

Fonte: Portal BBC.

"In January 2021, we updated our investment policy to provide us with more flexibility to further diversify and maximize returns on our cash that is not required to maintain adequate operational liquidity. As part of this policy, we may invest a portion of such cash in certain specified alternative reserve assets. Thereafter, we invested an aggregate \$1.5 billion in bitcoin under this policy."

Tesla, Inc. (2021) Form 10-K, Part II, Item 7, management's discussion and analysis of financial condition and results of operations.

While there is extensive empirical evidence on cryptocurrency adoption by retail and institutional investors, research examining the effects of such adoption from the perspective of corporate investors remains scarce. The primary reason is that corporate investment in cryptoassets is a relatively new phenomenon.

Despite the potential motivations, the adoption of cryptoassets by corporations is of practical importance, and there is a gap in academic research that needs to be addressed.

To explore this, an event study analysis was conducted to examine the market response of publicly traded companies to cryptoassets-related announcements. The dataset includes 35 events associated with 32 listed companies across major stock exchanges, such as New York, London, Toronto, Oslo, Hong Kong, Tokyo, and São Paulo, covering the period from 2014 to 2022.

The corporate cryptoassets announcements were classified into three categories: acquisition/investment, sale/divestment, and acceptance as means of payment. The empirical approach involved estimating abnormal returns around each event using the market model.

Additionally, the analysis investigated potential heterogeneity in market reactions based on different levels of cryptoassets exposure. Events were categorized into low, medium, or high exposure based on the USD value of BTC or ETH acquisition/divestment relative to the firm's total assets. A qualitative assessment of news content for indirect crypto investments (e.g., the acquisition of a crypto company) and acceptance as a means of payment (intention vs. effective acceptance) was also conducted.

This research contributes to a deeper understanding of the role of cryptocurrencies for corporations, helping managers, analysts, and investors comprehend the implications of cryptocurrency-related corporate announcements.

#### Methodology and data

To analyze the impact of cryptocurrency acquisition announcements, an event study methodology was applied.

This technique is widely used to measure the market's reaction to specific events, allowing for the observation of changes in stock prices across different time windows before and after the announcement. The goal is to capture both the immediate and potentially persistent effects of cryptocurrency acquisitions on the market value of firms.

In this study, market reactions were analyzed over short- and medium-term windows, covering days and months following the announcement. The methodology accounted for factors such as the company's prior stock performance, market volatility, and investment patterns

The selection of companies was rigorous, including only those whose core business was not directly related to cryptoassets. This ensured that the observed impact was genuinely attributable to the cryptoasset acquisition and not to a pre-existing affinity with the sector.

A critical aspect often overlooked is the level of exposure the announcing company has to cryptoassets. Treating all corporate investments in cryptoassets equally, regardless of size, may obscure genuine market reactions to cryptocurrency-related corporate announcements.

As illustrated in Figure 9 below, which highlights publicly traded companies with the largest bitcoin holdings as of December 2022, there is significant variability in exposure to the cryptocurrency among these firms.

On the left side of the figure, the amount invested is shown in millions of dollars, while the right side displays the ratio of the investment's value to each company's market capitalization.

Publicly Traded Companies and Major Bitcoin Holdings

Investment (USD Million)

Investment / Market Capitalization (%)

Galaxy Digital Holdings
Golobal
Hut 8 Minig
Nexon
Bit digital Inc
Riot Blockchain Inc
Aker ASA
Argo Blockchain Inc
Aker ASA
Argo Blockchain PLC
Source: Gimenes, Dias and Yousaf (2023).
Raw data: Cryptotreasuries.org and Bloomberg (December 2022).

MicroStrategy, the company with the largest BTC position, also exhibits the most substantial investment in relative terms. In contrast, despite being the second-largest company regarding announced cryptocurrency investments, Tesla's investment is relatively low compared to its market value.

As indicated in the table below, within the category of direct cryptocurrency acquisition (BTC or ETH), the ratio between the USD volume of cryptocurrency acquisitions and the total assets of the company ranges from 0.0% to 27.3%.

Table 4

Degree of Cryptoassets Exposure from Different Publicly Traded Companies

Company	Announcement date	Degree of cryptocurrency exposure	Crypto acquisition (USD million)	Assets (USD Million)	Ratio (%)
MicroStrategy Incorporated	11/Aug./2020	High	250	917	27.3
NEXON Co., Ltd	27/Apr./2021	High	100	862	11.6
The Brooker Group Public Company	11/May/2021	High	7	82	8.0
Ruffer_Out	07/Jun./2021	High	1,840	27,300	6.7
Phunware, Inc	06/Apr./2021	High	2	32	4.7
Tesla, Inc	08/Feb./2021	Medium	1,500	52,148	2.9
Ruffer Investment Company Limited	15/Dec./2020	Medium	744	27,300	2.7
Tesla_Out	20/Jul./2022	Medium	936	52,148	1.8
Block, Inc	08/Oct./2020	Medium	50	4551	1.1
Meitu, Inc	08/Mar./2021	Medium	40	4507	0.9
Aker ASA	08/Mar./2021	Low	50	6779	0.7
Townsquare Media, Inc	10/May/2022	Low	5	726	0.7
Metromile, Inc	11/Aug./2021	Low	1	202	0.5
MercadoLibre, Inc	05/May/2021	Low	8	6526	0.1
Globant S.A	24/May/2021	Low	1	1289	0.0

Source: Gimenes, Dias and Yousaf (2023).

We utilized this market-based measure of a company's cryptocurrency exposure to categorize events into three groups: high, medium, and low exposure.

Based on a sensitivity analysis, high-exposure events were further segmented into three categories: substantial direct acquisitions of bitcoin or ether, pioneering acceptance of

#### Key findings

Overall, the results of the analysis indicate that the market reaction to announcements of cryptoassets acquisitions by traditional companies tends to be mildly positive but, in many cases, lacks statistical significance.

This finding suggests that, on average, the market maintains a cautious stance toward such acquisitions, possibly due to the volatility associated with cryptoassets and uncertainty about their long-term impact.

However, when analyzing the firm's degree of exposure to cryptoassets the results reveal that the level of exposure plays a crucial role in understanding how the stock market reacts. Specifically, positive impacts on stock performance are concentrated among companies with higher exposure to cryptoassets (High Exposure – blue bars in Figure 10).

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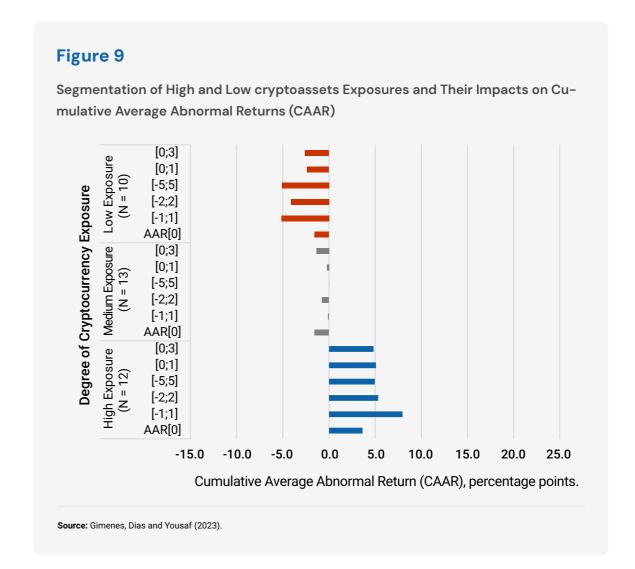
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Conversely, events involving low exposure, such as cryptoassets acquisitions with relatively small relevance compared to the size of the company, resulting in average negative abnormal returns (Low Exposure – red bars). Each bar corresponds to a computation window for these returns (e.g., [0;3] indicates that the analysis evaluates the cumulative average abnormal return from the event day to the third business day following the event).



This analysis suggests that what truly drives value and market confidence are substantial investments in cryptoassets The findings also indicate that when investments in cryptoassets are more modest or symbolic, market reactions tend to be neutral or even adverse.

These results underscore that the market values significant financial commitments—often referred to as "skin in the game"—when reacting to announcements of cryptoassets acquisitions.

The study further suggests that while adopting cryptoassets as part of a company's balance sheet can be an intriguing diversification strategy, it is not without risks and may not be suitable for every company.

In the context of traditional companies, the market appears to reward those taking a more significant stance on cryptocurrencies but remains skeptical of timid or partial adoption.

It is important to note that this study was conducted during a specific period and that the cryptoassets market is subject to significant changes due to evolving regulations and technological innovations.

Factors such as the price volatility of cryptoassets the lack of regulation in many countries, and the emergence of new technologies may shift the market's perception of these assets. Additionally, future research could explore the impact of repeated cryptoassets acquisitions, examining whether the market reacts differently when a company incorporates cryptoassets into its balance sheet multiple times.

#### Practical implications

The results provide valuable insights for managers and institutional investors considering the inclusion of cryptoassets in their portfolios.

Companies that incorporate cryptoassets into their balance sheets may signal to the market an innovative stance and a willingness to explore new forms of asset diversification. However, this decision must be carefully weighed, as market responses depend on the context and the scale of the investment.

For investors, these findings emphasize the importance of analyzing the sector and the company profile before considering the purchase of shares in companies that have added cryptoassets to their reserves.

Market reactions tend to be more favorable in industries where the inclusion of cryptoassets is seen as a natural extension of business activities (such as the technology sector). In other sectors, observing market responses and the long-term performance of these assets within the company's financial structure may be prudent.

Substantial investments in cryptoassets build confidence in the market, while modest contributions may elicit neutral or adverse responses.

# Interested in the topic? Check out other academic publications related

## publications related to this subject:

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### Tail risk in the cryptoassets market: an innovative approac an innovative approach

Original Title: "Estimation risk in conditional expectiles".

- Student: Víctor Henriques (Ph.D. in Business Economics at FGV EESP)
- Advisor: Professor Marcelo Fernandes, Ph.D.

#### Abstract of the original paper

We establish the consistency and asymptotic normality of a two-step estimator of conditional expectiles in the context of location-scale models. We first estimate the parameters of the conditional mean and variance by quasi-maximum likelihood and then compute the unconditional expectile of the innovations using the empirical quantiles of the standardized residuals. We show how replacing true innovations with standardized residuals affects the asymptotic variance of the expectile estimator. In addition, we also obtain asymptotic-valid bootstrap-based confidence intervals. Finally, our empirical analysis reveals that conditional expectiles are excelent alternatives to assess tail risk in cryptomarkets, relative to traditional quantile-based risk measures, such as value at risk and expected shortfall.



This article is currently under development. The Ph.D. theses can be accessed here: https://repositorio.fgv.br/items/c87f668f-1134-4f83-b09b-07cc5060041a



#### Context and study objective

The cryptoassets market is known for its pronounced volatility and the frequent occurrence of extreme events that challenge investors and portfolio managers. Sudden price swings can lead to significant gains or losses over very short periods.

In high-risk, high-uncertainty environments like crypto, understanding so-called "tail risks"—rare events with substantial impacts—becomes an essential tool for investment management.

Historically, risk metrics such as Value at Risk (VaR) and Expected Shortfall (ES) have been used to assess these tail risks, following recommendations from the Basel Committee on Banking Supervision. While VaR provides insight into potential loss risk within a specific confidence interval, and ES reflects the expected loss beyond the VaR threshold, both are essential tools but have limitations, often failing to adequately capture the intensity of extreme events.

In markets like crypto, characterized by extreme fluctuations and frequent tail events, VaR typically underestimates while ES overestimates the true risk exposure, as they focus on isolated points within the return distribution.

To address these limitations, this study explores risk measures based on expectiles, which combine the probability of extreme events with their potential intensity. Unlike VaR and ES, expectiles provide a broader view of the impact of large fluctuations, making them a more suitable approach for highly volatile crypto markets.

This research develops a methodology for the estimation and inference of conditional expectiles tailored to the crypto market, offering a new perspective on tail risk management and providing practical insights for investors and portfolio managers.

#### Methodology and data

Quantiles are cutoff points that divide a data distribution into uniform intervals of relative frequency or probability.

For instance, percentiles, a specific type of quantile, split the distribution into 100 equal parts. Therefore, the 90th percentile represents the value below which 90% of the data falls.

In the financial market, quantiles are frequently used to assess investment returns in terms of their relative position, such as determining whether a specific asset return is in the upper, median, or lower range of a historical series.

This approach helps provide a general understanding of value distribution but has its limitations: quantiles focus on the position of each value without accounting for the intensity or impact of extreme fluctuations.

Value at Risk (VaR), one of the most widely used risk metrics, exemplifies these limitations. It focuses on the loss percentile within a confidence interval without considering the shape of the return distribution in the tails.

In the context of cryptoassets, this shortcoming is particularly problematic, as VaR fails to adequately capture the diversification gains these assets can offer.

In volatile markets, where the correlation between traditional assets and cryptoassets may be low, diversification benefits are critical to optimizing a portfolio's risk-return balance. VaR's inability to capture this dynamic can lead investors to underestimate the role of crypto assets in reducing overall portfolio risk.

This is precisely where the concept of expectiles stands out: a measure that extends the idea of quantiles by incorporating not only the relative position of values but also the magnitude of extreme events (such as abrupt price changes). Expectiles weigh the values in a distribution based on both frequency and intensity, providing a more detailed view of tail risks—those rare and intense events that often represent large variations and can have disproportionate impacts.



This more detailed analysis is particularly useful in the crypto market, where extreme events are common, and high volatility can result in significant value fluctuations over short periods.

With conditional expectiles, the analysis becomes even more precise because they adjust to the most recent market conditions. Unlike a fixed value, conditional expectiles are adaptive, responding to current volatility. In highly volatile markets, such as crypto, this is essential.

This specificity makes conditional expectiles a better choice for the crypto market, where high volatility and the frequency of extreme events demand continuous adaptive analysis.

Moreover, estimating conditional ES is extremely challenging because it relies solely on the extreme quantiles, which rarely occur. In contrast, conditional expectiles incorporate all conditional quantiles, making them less sensitive to the rarest and hardest-to-estimate extreme events.

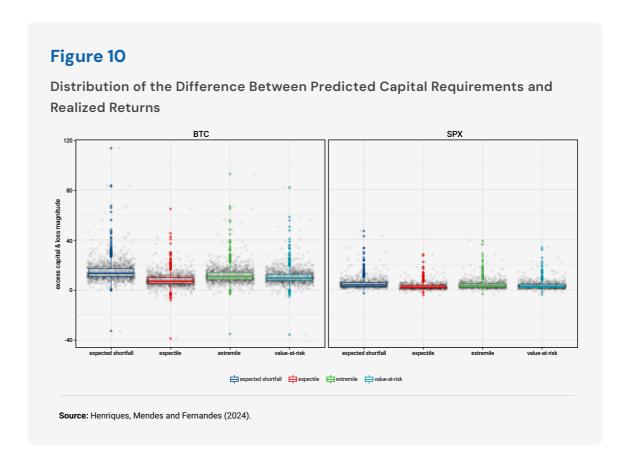
#### Key findings

The results show that conditional expectiles stand out for capturing tail events with greater precision than traditional methodologies. Unlike VaR and ES, conditional expectiles provide a more detailed view of the potential impact of abrupt price fluctuations by being closely tied to the ratio between expected gain and expected loss. This approach allows for more effective forecasting of capital requirements and potential safety margins necessary for investors in high-risk assets.

When applying this analysis to the crypto market, it is observed that extreme fluctuations in these assets are not only frequent but also intense. This underscores the relevance of conditional expectiles as a tool that not only identifies risks but also enables quick adaptation to unexpected events, which can be essential for mitigating losses.

The figure below compares the capital requirements recommended by different risk measures against actual losses.

This chart illustrates the difference between the recommended capital for each measure and the actual market losses, providing insight into whether the reserved capital was excessive or insufficient to cover the market's real fluctuations.



The results indicate that the Expected Shortfall (ES) is the most conservative measure, recommending higher capital reserves to provide robust protection in extreme risk scenarios. However, this excessive conservatism often leads to capital requirements significantly exceeding realized losses.

In contrast, conditional expectiles suggest lower capital requirements, enabling more efficient capital use in highly volatile markets like cryptoassets. Despite a higher frequency of exceptions — where the reserved capital is insufficient to cover significant losses — overall, the capital requirement aligns more closely with realized losses.

By combining the strengths of each measure, VaR, ES, and conditional expectiles offer complementary tools for risk management.

#### **Practical implications**

The adoption of conditional expectiles brings valuable practical implications for managers and investors. In a highly volatile market like cryptoassets, understanding tail risk enables better preparation for crisis scenarios, where a price drop could have widespread repercussions.

Portfolio managers aiming to allocate capital more securely can leverage this tool to calculate more precise cash reserves while avoiding excessive exposures.

For investors, using conditional expectiles helps prevent unpleasant surprises during periods of extreme price fluctuations. Instead of merely reacting to such variations, well-informed investors can adopt a more proactive strategy, adjusting their allocations based on the intensity and likelihood of extreme events.

Looking ahead, this methodology paves the way for broader studies on its application in other sectors and on how different market conditions might influence reserves and portfolio planning.

Conditional expectations help managers anticipate crises and adjust strategies in volatile markets.



## Interested in the topic? Check out other academic

## publications related to this subject:

- Abdullah, M., Sarker, P. K., Abakah, E. J. A., Tiwari, A. K., & Rehman, M. Z. (2024). Tail risk intersection between tech-tokens and tech-stocks. *Global Finance Journal*, 61, 100989.
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#### Conclusion

As we conclude this e-book, we hope the ideas and discoveries shared within these pages have offered relevant perspectives on the constantly evolving field of cryptofinance. Each executive summary encapsulates research that connects theoretical advancements with practical applications, serving as a testament to the potential of blockchain technologies and digital assets to transform financial systems globally.

In compiling these works, our goal was to create a resource that is not only educational but also market-relevant. The diversity of topics covered reflects the interdisciplinary nature of the field, encompassing elements of technology, economics, regulation, and data analysis. By presenting these studies in an accessible format, we hope to empower professionals from various sectors to engage with these concepts and apply them within their organizations and roles.

This e-book would not have been possible without the collaborative efforts of students, faculty, and industry partners who contributed to the research and its dissemination. In particular, the support from Ripple, through the University Blockchain Research Initiative (UBRI), was instrumental in fostering a robust academic environment that supports innovation and the relevance of blockchain research and its use cases at FGV.

We appreciate your engagement with this collection. We encourage you to explore the full articles and stay connected with the ongoing advancements in the field of cryptofinance — a field that promises to remain dynamic and transformative in the coming years. We look forward to your continued interest and involvement in the developments that lie ahead.

#### **Prof. Jéfferson Colombo**

Head of FGV at the University Blockchain Research Initiative (UBRI) and Pedagogical Coordinator of the Professional Master and Doctorate Programmes (MPE/DPE).

# **About** FGV EESP

The <u>São Paulo School of Economics at Fundação Getulio Vargas</u> (FGV EESP) is a center of excellence dedicated to the generation and dissemination of economic knowledge. Its mission is to foster a learning environment and public debate aligned with national interests, contributing to the education of an intellectual and leadership elite for Brazil.

An institution guided by ethics and social responsibility, FGV EESP aims to influence the development of the national agenda, emphasizing sustainable economic growth with equity.

To fulfill its mission, FGV EESP ensures intellectual freedom and promotes pluralism among its members, continuously recruiting talent to uphold excellence and drive ongoing improvement.

**FGV EESP** operates on principles of market competitiveness. Internally, cooperation and total quality are prioritized, combined with a relentless pursuit of innovation and refinement in educational management.

The São Paulo School of Economics began its undergraduate program in 2004. Before this, Fundação Getulio Vargas in São Paulo primarily focused on undergraduate programs in private and public administration.

Since the 1980s, FGV has already offered postgraduate programs in economics at FGV EAESP. Expanding its scope, FGV established the São Paulo School of Economics, offering undergraduate, academic, and professional postgraduate, continuing education, and specialized economics courses.

By creating the São Paulo School of Economics, FGV sought to establish a center of excellence in teaching and research, contributing to the country's economic and social development and strengthening its national identity.

## **About BlockTrends**

**BlockTrends is an innovative edtech** dedicated to simplifying the world of Web3 and cryptocurrencies across Brazil.

With over 27,000 students trained, BlockTrends proudly stands as a benchmark for learning about crypto, blockchain, and new technologies in a clear and straightforward way. It has achieved significant milestones, including offering the largest course ever hosted on the Brazilian stock exchange (B3) and launching the country's first postgraduate program in blockchain development, setting the standard for quality education in this sector.

BlockTrends also developed, in partnership with Ancord, the first cryptocurrency certification for the Brazilian financial and capital markets, **the CCA Program**.

Since 2020, BlockTrends has been a guiding light for those seeking clarity and simplicity in understanding digital assets. It offers a comprehensive educational ecosystem with practical courses on crypto, curated learning paths, weekly reports, daily analyses, an exclusive community for subscribers, and much more.

With over 150 hours of Web3-focused content, BlockTrends aims to reach even more professionals, enthusiasts, and curious learners looking to deepen their knowledge in this market.

In addition, **BlockTrends operates a news portal on cryptoassets** reaching over a million people every month. This portal serves as a go-to destination for the latest news, trends, and insights in the crypto space.

BlockTrends is here to demystify the world of digital assets and block-chain technology. Whether you're an enthusiast, investor, or simply curious, BlockTrends ensures you stay well-informed and prepared for the digital future.

#### **Credits**

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Jéfferson Colombo / FGV EESP

#### **Guest Panel for Work Selection**

Alexandre Ludolf, Gladstone Arantes Jr. and João Marco Braga da Cunha

#### **Production**

**BlockTrends** 

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#### **Editorial Coordination**

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#### **Bibliographic Review**

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#### **Development and Hyperlinks**

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#### Review

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