The role of alternative investments in Brazilian portfolios

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Abstract This paper assesses the impact of alternative assets on the performance of Brazilian asset portfolios. Although alternative assets are largely studied throughout the world, that is not the case for Brazil as there are just a few studies on the topic. As the Brazilian capital markets are growing at a fast pace, the high correlated aspect of the market calls for measures to ensure balanced returns for the long run, therefore, the insights of the study may support investors during the process of asset allocation. In this study the alternative assets were divided into two categories: Brazilian alternative assets and international alternative assets. Performance measures were obtained from a portfolio comparison and through a Markowitz frontier analysis. The results show that adding alternative assets (Brazilian or international) to a portfolio usually generates higher returns with lower risks, leading to better risk adjusted results and an overall more balanced portfolio.

Keywords: Alternative investments; Portfolio analysis; Brazilian portfolios; Brazilian asset allocation.

JEL Code: G11, G12.

1. Introduction

The Brazilian capital markets pose a significant challenge to investors due to the high correlation among assets, hindering efforts to diversify portfolios and manage risk effectively. This phenomenon stems from the country's heavy reliance on a handful of major industries, such as commodities and financial services, which tend to move in tandem in response to macroeconomic conditions. With Brazil's capital markets experiencing rapid growth and an increasing demand for new asset classes, alternative investments emerge as a compelling option.

This study aims to explore the potential of alternative investments in diversifying Brazilian portfolios and mitigating overall risk. Specifically, it seeks to address the gap in the literature regarding the role of these assets within the

Brazilian context. By analyzing the impact of alternative investments on portfolio returns, correlation and volatility, the research seeks to provide insights into how these assets can enhance diversification and improve performance.

Employing a comprehensive analysis of historical data and risk-return profiles, the research delved into the role of alternative assets in the Brazilian investment landscape. Relying on an analysis of Markowitz frontiers and historical portfolio data, the methodology assessed diversification benefits and potential uncorrelated returns offered by these assets.

Our findings suggest that traditional asset classes alone may not adequately address the challenges and opportunities in the Brazilian landscape. Alternative assets show potential for diversification benefits and uncorrelated returns, particularly during market volatility. International alternatives outperformed national ones in risk-adjusted returns during the 2013-2023 period, yet incorporating Brazilian alternatives alongside international ones could enhance overall returns and improve risk profiles.

Contributing to existing literature, the study underscores the significance of alternative assets in navigating Brazil's unique investment landscape. It challenges traditional portfolio management approaches and expands discourse on diversification strategies, emphasizing the importance of considering both domestic and international alternatives in asset allocation.

Recognizing the potential benefits of alternative assets can provide more informed investment decisions, particularly for those with advanced financial knowledge. However, acknowledging study limitations, such as the constrained time frame of analysis, is crucial. Future research should aim to address these limitations by exploring alternative data sources and conducting more granular analyses, setting the stage for further investigations into the effectiveness of alternative investments within Brazilian portfolios.

2. Literature review

Fischer and Lind-Braucher (2009) published a study aiming to explore the role of alternative investments in optimal asset allocation, while also investigating the impact of adding alternative investments to traditional portfolios. The authors first provide a comprehensive literature review of portfolio optimization theory and the traditional asset allocation process. They argue that traditional portfolios that only invest in equities and bonds may not provide investors with sufficient diversification benefits and that alternative investments, such as hedge funds, private equity, and real estate, can potentially enhance performance.

The authors present their empirical investigation, which uses historical data from 1999 to 2009 to construct optimal portfolios with varying levels of

alternative investments. The study finds that adding alternative investments improves risk-adjusted returns and reduce volatility. Additionally, they performed an analysis to examine the impact of different types of alternative assets on performance. The analysis concluded that hedge funds and real estate investments provide the most significant diversification benefits, while private equity has a relatively small impact on portfolio performance.

Zhang (2021) examined the potential diversification benefits of including alternative investments in a portfolio. The study aims to answer the question of whether including these assets can help investors achieve better risk-adjusted returns and improved diversification. The methodology of the study involves comparing the performance and diversification benefits of portfolios that include alternative investments with those that do not. The author uses several alternative asset classes, including private equity, real estate and hedge funds, comparing them with a traditional portfolio consisting of only stocks and bonds. The study uses a variety of metrics to evaluate the performance and diversification benefits and show that alternative assets can provide investors with better diversification benefits, resulting in improved risk-adjusted returns.

Concerning digital assets, Demiralay and Bayraci (2021) investigated the potential diversification benefits of including cryptocurrencies in stock portfolios. The study highlights the fact that there is a growing interest in cryptocurrencies as an alternative investment and debate over their role in asset allocation. The authors argues that cryptocurrencies have unique characteristics that may provide diversification benefits to traditional asset classes, but their high volatility and lack of regulation also pose significant risks. They used data from 2015 to 2019 to examine the diversification benefits of including cryptocurrencies in stock portfolios, employing a conditional diversification benefits measure to account for the time-varying nature of the correlations between asset classes. Their analysis finds that including cryptocurrencies to stocks portfolios can provide diversification benefits.

Letho et al. (2022) examined the potential of cryptocurrencies to improve the risk-adjusted returns in emerging markets. The paper uses a variety of statistical methods, including mean-variance analysis, the Sharpe ratio, and the conditional value-at-risk, to compare the performance of South African traditional and alternative assets to cryptocurrencies. They find that cryptocurrencies can improve the risk-adjusted returns of portfolios in emerging markets. Portfolios that include cryptocurrencies have higher Sharpe ratios than those that do not. The paper also finds that cryptocurrencies can help to improve the efficiency frontier, meaning that including cryptocurrencies can achieve higher returns for a given level of risk.

This study has important implications for investors in emerging markets.

Investors who are seeking to improve the risk-adjusted returns of their portfolios may want to consider including cryptocurrencies during asset allocation. However, investors should also be aware of the risks associated with cryptocurrencies, such as their volatility and illiquidity.

Shahzad et al. (2022) compared the weak/strong hedging abilities of three alternative assets, namely bitcoin, gold and US VIX futures, against the downside movements in the stock market indexes of BRICS (Brazil, Russia, India, China and South Africa). The authors point out that the BRICS countries have acquired important roles in the world economy and their stock markets are active and useful for portfolio diversification. However, their stock markets are also highly sensitive to changes in global financial conditions and global risk sentiment, therefore, their study argues that it is important to investigate whether alternative assets, such as bitcoin, gold and US VIX futures, can hedge against downside risk in BRICS stock markets.

The authors find that bitcoin and gold are weak hedges against downside movements in BRICS stock indexes, suggesting that VIX futures generally offers larger diversification benefits, specifically for Brazil, Russia and South Africa.

Furthermore, their study underscores the dynamic nature of this hedging function, which varies across different alternative assets and diverse countries. Importantly, this protective role is most pronounced during periods of heightened volatility and market turbulence, also noting that bitcoin, gold and VIX futures offer appealing diversification benefits for investors in BRICS stock markets.

Aljinović et al. (2022) examines the impact of the COVID-19 pandemic on the risk and return of traditional and alternative investments. The paper uses a variety of risk measures, including standard deviation, Value at Risk (VaR), Conditional Value at Risk (CVaR), and Sharpe ratio, to compare the performance of different asset classes during the pandemic. They find that the COVID-19 pandemic had a significant impact on the risk of most of the assets analyzed. Crude oil, renewable energy sources, real estate, and stocks in general were the most heavily impacted, experiencing significant increases in risk. Commodities and gold were also affected, but to a lesser extent. Bonds, foreign exchange, and cryptocurrencies, on the other hand, experienced minimal or negligible changes in risk levels as a result of the crisis.

The impact of the crisis varied across different assets, but the overall order of assets based on their riskiness did not undergo significant changes compared to the pre-crisis period. However, the earning potential of certain assets underwent significant transformations. Specifically, commodities experienced

a remarkable shift, ascending in terms of earning potential during the crisis while it had a detrimental effect on the earning potentials of gold and bonds. Contrary to earlier studies, stocks emerged as the asset with the highest earning potential both prior to and amidst the crisis, despite carrying a moderate level of risk. Interestingly, renewable energy sources along with cryptocurrencies demonstrated their prowess as an alternative investment, securing one of the highest earnings potentials.

There are only a few papers in Brazil about the role of alternative investments. Flores et al. (2021) conducted an analysis regarding the use of alternative investments as a strategy implemented in Brazilian private pension funds. The study stands out in the Brazilian context, as it is one of the few papers that examines the impact of alternative assets on the performance of a portfolio that mainly includes regional assets. They find that portfolios with a higher allocation to alternative assets, specifically utilities, outperformed those with a lower allocation, supporting the argument that alternative investments can enhance portfolio performance.

In summary, this literature review has provided a comprehensive overview of the existing research on alternative investments in and out of Brazil. It is clear that while some studies have touched on various aspects of this topic, there remains a notable gap in the literature, especially in the context of the Brazilian financial market. By including the impacts of the COVID-19 pandemic on capital markets and encompassing a diverse range of alternative assets, including cryptocurrencies and private equity, it complements and extends the existing literature.

3. Data & methodology

This study encompasses a variety of asset categories, such as stock indexes, bonds, commodities, real estate, private equity, precious metals and cryptocurrencies. The assets were separated into three groups: Traditional Brazilian assets, Brazilian alternative investments and International alternative investments.

The traditional assets consist of:

- CDI ("Certificado de Depósito Interfinanceiro"): short-term interest rate benchmark in Brazil, generally used as a reference rate for many financial products, such as loans, bonds, and savings accounts, the CDI will be used as a risk-free proxy;

- IBOV ("Ibovespa"): the stock market index of the São Paulo stock exchange considered to be a proxy for the performance of the Brazilian stock markets;

- IDNS ("Índice do Setor Industrial"): stock market index that tracks the performance of industrial stocks listed on the Brazilian stock exchange;

- CONS ("Índice de Consumo"): stock market index that tracks the performance of cyclical and non-cyclical consumption companies;

- IFNC ("Índice Financeiro"): an index encompassing stocks of Brazilian companies in the financial sector.

The Brazilian alternative investments consist of:

- IFIX ("Índice de Fundos de Investimento Imobiliário"): a market index that tracks the performance of the Brazilian real estate investment trust (REIT) market, considered to be a proxy for the performance of the Brazilian real estate sector;

- UTIL ("Índice Utilidade Pública"): a stock market index that tracks the performance of Brazilian utilities companies (energy, gas, water and sanitation), used as proxy for infrastructure;

- BASC ("Índice de Materiais Básicos"): a stock market index that tracks the performance of Brazilian basic commodities companies.

The international alternative investments consist of:

- CRB ("Thomson Reuters/CoreCommodity CRB Index"): a commodity price index that tracks the prices of a basket of commodities, including energy, agricultural product and precious metals, serving as proxy for international prices of commodities;

- GOLD, collected from the spot prices of Gold in USD: used as a proxy for the precious metal, often used as a store of value;

- "IDPE (iShares Listed Private Equity UCITS"): as a proxy to international private equity investments;

- BTC, bitcoin used as a proxy to the cryptocurrencies market.

Daily closing prices were gathered for every asset within the time frame of June 1st, 2013, to June 1st, 2023. The data for the assets was sourced from Investing.com, except for the CDI, which was collected directly from the Brazilian Central Bank (BCB). Any workdays in which the price of one or more assets remained undisclosed were omitted from the final dataset. All dollar-denominated assets were converted to Brazilian Real using the PTAX,

the official exchange rate of the Brazilian Real against the US dollar, which is daily published by the Central Bank of Brazil (BCB).

Through the paper, the data will be presented and analyzed in different time frames: Ten years (June 1st, 2013 - June 1st, 2023), five years (June 1st, 2018 - June 1st, 2023), three years (June 1st, 2020 - June 1st, 2023) and one year (June 1st, 2022 - June 1st, 2023).

Further, an analysis of the Markowitz efficient frontier was conducted to provide a comparison of the overall performance between different strategies, offering insights into the risk-return trade-offs showcasing the benefits of including alternatives to a portfolio.

In addition, an analysis will derive from portfolios in which the weightings were established through an optimization process aimed at maximizing the Sharpe ratio. These portfolios underwent daily rebalancing to precisely gauge the benefits or drawbacks of adding alternative investments.

3.1   Descriptive statistics

Table 1 shows descriptive statistics for each asset class used in this study in different time horizons: 1 year (Panel A), 3 years (Panel B), 5 years (Panel C), and 10 years (Panel D). These statistics encompass the computation of key metrics such as the minimum daily return (Min), maximum daily return (Max), average daily return (μ), standard deviation (Std), skewness (Skew), and kurtosis (Kurt) for each asset class.

Panel A of Table 1 shows the results for the one-year period. Most assets classes (8 out of 12) presented positive average daily returns. GOLD had the highest performance (average of 0.05% per day), whereas BASC and CRB presented the lowest performance (-0.05% per day). As a highlight, Bitcoin showcases a single-day gain of 20.3%, counterbalanced by a single-day loss of −20.8%, underscoring the imperative need for investors to adopt a prudent and patient approach.

The three-year period (reported in Panel B) unfolds a trend towards normality across the spectrum of assets, characterized by most assets (11 out of 12) consistently achieving positive daily average returns. The average daily returns ranged from −0.04% (CONS) to 0.23% (BTC). As expected, CDI had the lowest standard deviation (0.02%) and bitcoin had the highest (4.32%).

The five-year period showcases the impact of the Covid-19 in capital markets, being evident when observing the maximum and minimum returns of the assets. The average daily returns ranged from 0.01% (CONS) to 0.24% (BTC), and the standard deviation from 0.02% (CDI) to 4.54% (BTC). This fluctuation is also evidenced by a pronounced increase in the kurtosis of the assets. In contrast with previous periods, all assets exhibited a significant rise

Table 1
Descriptive statistics

Panel A: One-year daily returns descriptive statistics

	IBOV	IFNC	INDS	CONS	BASC	UTIL	IFIX	CDI	PE	BTC	GOLD	CRB
μ (%)	0.01	0.04	−0.02	−0.04	−0.05	0.01	0.03	0.05	0.00	0.05	0.05	−0.05
Std (%)	1.36	1.68	1.20	1.82	1.70	1.39	0.33	0.01	2.01	3.78	1.30	1.29
Min (%)	−5.10	−6.40	−3.20	−6.70	−4.70	−5.10	−1.70	0.00	−4.80	−20.80	−3.00	−3.70
Max (%)	5.50	6.40	4.00	5.80	7.40	6.60	1.10	0.20	12.50	20.30	6.00	3.90
Kurt	1.30	1.55	0.40	0.82	1.52	2.86	3.44	42.74	5.39	8.01	2.25	0.24
Skew	0.06	−0.13	0.15	−0.13	0.52	0.18	−0.35	6.19	0.97	0.04	0.84	0.22

Panel B: Three-year daily returns descriptive statistics

	IBOV	IFNC	INDS	CONS	BASC	UTIL	IFIX	CDI	PE	BTC	GOLD	CRB
μ (%)	0.04	0.05	0.03	−0.04	0.08	0.04	0.02	0.03	0.01	0.23	0.02	0.10
Std (%)	1.34	1.69	1.27	1.62	1.71	1.35	0.35	0.02	1.67	4.32	1.36	1.41
Min (%)	−5.10	−6.40	−4.00	−6.70	−4.70	−5.10	−2.00	0.00	−4.90	−20.80	−7.50	−6.40
Max (%)	5.50	6.40	4.00	5.80	7.40	6.60	1.50	0.20	12.50	21.00	6.00	8.00
Kurt	0.51	0.55	0.06	0.78	0.53	1.02	3.53	1.25	4.09	3.17	2.05	1.84
Skew	−0.18	−0.06	−0.03	−0.11	0.25	0.13	−0.03	0.64	0.54	0.26	−0.07	0.12

Panel C: Five-year daily returns descriptive statistics

	IBOV	IFNC	INDS	CONS	BASC	UTIL	IFIX	CDI	PE	BTC	GOLD	CRB
μ (%)	0.05	0.05	0.04	0.01	0.06	0.08	0.03	0.03	0.03	0.24	0.07	0.06
Std (%)	1.72	1.99	1.61	1.88	1.97	1.66	0.65	0.02	1.71	4.54	1.35	1.42
Min (%)	−14.80	−13.30	−16.80	−16.20	−15.80	−13.60	−13.20	0.00	−12.90	−39.50	−7.50	−6.40
Max (%)	13.90	13.20	11.90	11.90	13.80	11.00	5.80	0.20	12.50	23.40	6.00	8.00
Kurt	15.65	6.99	22.51	12.44	9.69	10.24	161.24	3.34	7.71	7.16	1.93	2.59
Skew	−0.92	−0.22	−1.73	−1.04	−0.62	−0.73	−7.82	1.18	−0.15	−0.20	−0.08	0.14

Panel D: Ten-year daily returns descriptive statistics

	IBOV	IFNC	INDS	CONS	BASC	UTIL	IFIX	CDI	PE	BTC	GOLD	CRB
μ (%)	0.04	0.06	0.03	0.02	0.07	0.06	0.03	0.04	0.04	0.49	0.06	0.04
Std (%)	1.61	1.84	1.37	1.56	1.87	1.54	0.54	0.02	1.47	8.84	1.32	1.29
Min (%)	−14.80	−13.30	−16.80	−16.20	−15.80	−13.60	−13.20	0.00	−12.90	−57.60	−7.50	−6.40
Max (%)	13.90	13.20	11.90	11.90	13.80	11.00	5.80	0.20	12.50	338.30	6.30	8.00
Kurt	10.97	6.02	21.96	14.09	6.37	7.92	170.73	2.89	8.15	886.23	1.85	2.80
Skew	−0.57	−0.13	−1.41	−0.95	−0.31	−0.61	−7.18	0.71	−0.17	23.35	0.08	0.23

in their kurtosis, indicating a higher presence of outliers.

The ten-year period highlights the high returns of cryptocurrencies. Bitcoin exhibited a daily average return of 0.493%, being substantially higher than the second top-performing asset for the period (UTIL). The risk factor also manifests as anticipated, as the cryptocurrency attained a daily standard deviation of 8.84%.

3.2 Performance of assets

Table 2 shows various performance metrics for each asset class in different time horizons: 1 year (Panel A), 3 years (Panel B), 5 years (Panel C), and 10 years (Panel D). The indicators include total return, year-over-year return (YoY), annualized volatility and the Sharpe ratio.

Table 2
Performance of individual assets

Panel A: One-year performance of individual assets											
Metric	IBOV	IFNC	INDS	CONS	BASC	UTIL	IFIX	CDI	PE	BTC	GOLD	CRB
Tot. Ret. (%)	−0.70	7.50	−7.30	−13.70	−15.10	0.80	6.70	13.50	−4.00	−6.00	11.60	−13.00
Ann. Vol. (%)	21.54	26.74	19.09	28.93	26.95	22.05	5.30	0.17	31.88	60.06	20.63	20.42
Sharpe	−0.66	−0.22	−1.09	−0.94	−1.06	−0.58	−1.28		−0.55	−0.33	−0.09	−1.29

Panel B: Three-year performance of individual assets											
Metric	IBOV	IFNC	INDS	CONS	BASC	UTIL	IFIX	CDI	PE	BTC	GOLD	CRB
Tot. Ret. (%)	39.10	37.80	27.40	−23.90	87.00	42.60	16.40	25.50	3.30	167.80	4.10	95.10
Ret. YoY (%)	11.63	11.28	8.40	−8.72	23.20	12.55	5.19	7.86	1.08	38.87	1.36	24.96
Ann. Vol. (%)	21.30	26.80	20.20	25.70	27.20	21.50	5.50	0.30	26.50	68.50	21.60	22.40
Sharpe	0.37	0.27	0.05	−1.11	1.30	0.46	−0.95		−0.48	1.20	−0.57	1.80

Panel C: Five-year performance of individual assets											
Metric	IBOV	IFNC	INDS	CONS	BASC	UTIL	IFIX	CDI	PE	BTC	GOLD	CRB
Tot. Ret. (%)	33.40	25.40	26.00	−16.00	69.50	115.00	28.50	40.70	24.00	387.30	115.50	105.20
Ret. YoY (%)	5.94	4.63	4.72	−3.44	11.12	16.54	5.14	7.07	4.39	37.26	16.60	15.46
Ann. Vol. (%)	27.30	31.50	25.50	29.90	31.20	26.40	10.30	0.30	27.20	72.10	21.40	22.50
Sharpe	−0.12	−0.22	−0.26	−0.85	0.41	1.26	−0.53		−0.28	2.15	1.56	1.28

Panel D: Ten-year performance of individual assets											
Metric	IBOV	IFNC	INDS	CONS	BASC	UTIL	IFIX	CDI	PE	BTC	GOLD	CRB
Tot. Ret. (%)	105.00	165.80	67.80	23.50	234.10	218.80	94.90	136.90	111.10	52 345.00	230.70	135.70
Ret. YoY (%)	7.44	10.27	5.31	2.14	12.82	12.29	6.90	9.01	7.76	87.06	12.71	8.95
Ann. Vol. (%)	25.50	29.20	21.70	24.80	29.70	24.40	8.60	0.30	23.40	140.40	20.90	20.40
Sharpe	−0.40	0.31	−1.00	−1.45	1.04	1.06	−1.52		−0.35	117.61	1.42	−0.02

"Tot. Ret." = total return; "Ann. Vol." = annualized volatility; "Ret. YoY" = year-over-year return.

The total returns stand as the compounded gains of each individual asset. The year-over-year return represents the annualized total return. The volatility metric is derived from the annualized standard deviation of the assets returns. Finally, the Sharpe ratio quantifies the asset risk premium (that is, the difference between asset returns and risk-free returns) in relation to its inherent volatility. Risk-free for the Sharpe ratio was calculated using the CDI returns.

These performance metrics serve a dual purpose: firstly, enabling a comparison of asset performance across diverse temporal scopes; and secondly, facilitating the identification of assets that have not only delivered remarkable returns but have also exhibited low volatility.

The standout within the one-year returns rests upon the Brazilian risk-free rate ("CDI"). As a measure to mitigate the inflationary pressures from the lowered interest rates implemented to alleviate the effects of the COVID-19 pandemic, the Brazilian Central Bank (BCB), consistently elevated Brazil's basic interest rate to a peak of 13.75%. The high risk-free resulted in a negative Sharpe ratio for all of the assets observed.

For the 3-year window, the unusual surge in commodity prices, driven by

the COVID-19 pandemic's impact on worldwide supply chains, alongside the introduction of expansionary monetary measures and the ongoing Ukraine conflict, is directly mirrored in the CRB index. The CRB displays a Sharpe ratio of 1.80, attributing the highest return to risk among all the assets and a year-on-year return of 24.96%.

Spanning a five-year horizon, the results showcase a wide spectrum of returns within the Brazilian asset landscape. UTIL emerges with a cumulative return of 115%, representing a significant 16.54% year-on-year gain. In contrast, the IFNC index presents a subdued cumulative return of 25.4%, yielding a modest year-on-year return of 4.63%. Remarkably, Bitcoin garners attention for its substantial reduction in annualized volatility, plummeting from 140.4% over a ten-year period to 72.1% within this five-year window.

Panel D shows the results for 10-year window. Bitcoin and BASC present the highest returns (YoY of 87.1% and 12.8%, respectively). Notably, every asset demonstrates a consistent trend of positive year-over-year returns, underscoring their resilience. Furthermore, it is important to observe that the majority of assets exhibit annualized volatilities within the 20-30% range.

3.3   Correlation of assets

A correlation analysis was conducted to assess the relationships between different assets within a theoretical portfolio. The objective of this analysis is to discern the degree to which these assets move in tandem or exhibit divergent behavior over a specified period. This analytical approach holds significant importance, particularly when evaluating the classification as alternative investments.

The determination of whether assets can be categorized as alternative investments hinges on their potential to provide diversification benefits and mitigate risk. Correlation analysis serves as a fundamental tool to gauge the extent to which assets move in relation to one another. By quantifying the correlation coefficients, it is possible to infer whether certain assets display a lower correlation, and thus potentially offer enhanced diversification potential.

Furthermore, the assessment of correlations aids in uncovering underlying market trends and dynamics. Identifying assets with low or negative correlations is indicative of their potential to perform well during different market conditions, adding a layer of resilience to an investment strategy. Therefore, assets exhibiting high correlations may indicate a susceptibility to similar market influences, which could lead to increased volatility and decreased diversification benefits.

Figure 1 shows the correlation coefficients, prominently showcasing the interrelationships among the examined assets. The coefficients have been

Figure 1
Ten-year correlation of assets

	IBOV	IFNC	INDS	CONS	BASC	UTIL	IFIX	CDI	PE	BTC	GOLD	CRB
IFNC	0.92											
INDS	0.84	0.69										
CONS	0.85	0.77	0.86									
BASC	0.69	0.48	0.75	0.49								
UTIL	0.8	0.76	0.68	0.76	0.45							
IFIX	0.42	0.37	0.43	0.42	0.31	0.41						
CDI	-0.018	-0.0017	-0.036	-0.027	-0.031	-0.011	0.031					
PE	0.15	0.046	0.29	0.15	0.32	0.048	0.21	-0.0035				
BTC	0.025	-0.0057	0.066	0.035	0.067	-0.0038	0.03	0.0032	0.14			
GOLD	-0.35	-0.4	-0.22	-0.32	-0.11	-0.33	-0.1	0.0094	0.32	0.084		
CRB	-0.1	-0.22	-0.0016	-0.15	0.16	-0.2	0.029	-0.051	0.48	0.093	0.5	

derived through calculations using the daily returns of the ten-year window. The outcomes for different time frames (five years, three years, and one year) revealed negligible alterations in the coefficients, therefore, those results were omitted.

As expected, given the inherently "risk-free" nature of the CDI as an asset, the correlation with other assets is close to zero. The other traditional Brazilian assets are highly correlated among themselves, with correlation coefficients ranging from 0.69 (IFNC and INDS) to 0.92 (IBOV & INFC).

In contrast, the correlation of alternative Brazilian assets is significantly lower compared to the traditional counterparts. Within the lower bounds, BASC coefficient registers at 0.48 in its relationship with IFNC, while IFIX exhibits a coefficient of 0.37 relative to IFNC.

Shifting the focus to the relation between the international alternatives and traditional Brazilian assets, a majority of negative correlations with coefficients approximating zero becomes noticeable. Of particular significance is the prominence of CRB, notably in relation to INDS, showcasing a coefficient of −0.0016, indicating the highest diversification benefit for the sample.

4. Results and discussion

In this section, the outcomes of the analysis are presented, with a specific focus on the Markowitz frontier and portfolio analysis. Numerical results and interpretations are provided, shedding light on the practical implications and the relevance of the findings in different market conditions.

Figure 2
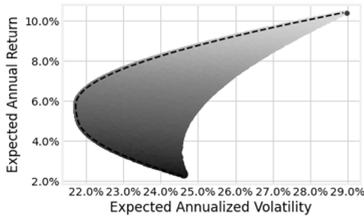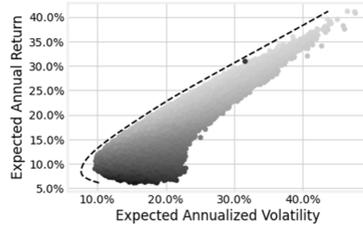**Brazilian traditional portfolio frontier**

Figure 3
"Complete" portfolio frontier

4.1 Markowitz frontiers

The Markowitz frontier is a crucial concept in modern portfolio theory (MPT) that plays a pivotal role in facilitating the comparison of two or more investment portfolios. MPT is a framework used by investors to optimize asset allocation in a way that balances risk and return. At its core, MPT acknowledges that investors are typically risk-averse, seeking to maximize returns while minimizing the associated risks.

The fundamental idea behind MPT is diversification. Diversification involves spreading investments across a variety of asset classes to reduce the overall risk. The key insight is that not all assets move in perfect harmony; some may perform well but others may do poorly. By combining assets with lower correlations, investors can potentially achieve a more favorable risk-return trade-off than by investing in individual assets.

The Markowitz frontier represents the set of results that an investor can obtain using a combination of assets. Each point on the Markowitz frontier represents a unique portfolio with a specific mix of assets. As the frontier graphically illustrates the relationship between risk and return, it facilitates the comparison between strategies.

Figures 2 and 3 show the Markowitz frontiers of two portfolios: the traditional assets portfolio, consisting of IBOV, IFNC, IDST, CONS and the "complete" portfolio, containing alternative investments. The "complete" portfolio consists of IBOV, IFNC, IDST, CONS, BASC, UTIL, IFIX, PE, BTC, GOLD, CRB. The frontiers were created using the daily returns of the ten-year window. As the CDI is a risk-free asset, it was omitted from the analysis.

As the "complete" portfolio has eleven assets, many simulations were necessary to produce the efficient frontier. Therefore, ten million simulations were randomly generated for both portfolios. Each point represents a random portfolio and its expected return and annualized volatility. The pointer indicates the highest Sharpe ratio.

The Markowitz analysis of the Brazilian traditional portfolio displays

Table 3
Ten-year performance of selected traditional and alternative assets

	Traditional BR		Alternative BR		Alternative INT	
Metric	IBOV	IFNC	BASC	UTIL	GOLD	CRB
Total Return	105.0%	165.8%	234.1%	218.8%	230.7%	135.7%
Return YoY	7.4%	10.3%	12.8%	12.3%	12.7%	9.0%
Annualized Vol.	25.5%	29.2%	29.7%	24.4%	20.9%	20.4%

meager year-on-year returns ranging from 2% to a maximum of roughly 10%. Those returns were accompanied by annualized volatility spanning from 21% to 29%. The "complete" portfolio displays average yearly returns ranging from 5% to a maximum of 40% while the annualized volatility falls in the spectrum of 10% to roughly 50%.

In the risk profile displayed by the Brazilian traditional portfolio (21% to 29% annualized volatility), the "complete" portfolio yields returns from 5% to 30%, indicating an overall superior risk-return ratio.

Bitcoin is an outlier for returns and volatility, consequently, the "complete" frontier contains a wider range for these metrics, rendering the process of drawing definitive conclusions challenging. Additionally, the "complete" portfolio comprises a significantly larger array of assets, potentiating diversification benefits. Therefore, it is challenging to specifically analyze the influence of alternative assets on the risk-return profile.

To address these challenges, two additional portfolios were defined for a comprehensive analysis. The allocation has been defined to maintain an identical amount of assets (four assets) and feature assets with comparable ten-year cumulative returns and a similar risk profile. The key differentiator between these portfolios lies in the intrinsic correlations among the assets.

The base portfolio contains two Brazilian traditional assets (IBOV, INFC) and two Brazilian alternatives (BASC and UTIL). The alternative portfolio contains two Brazilian traditional assets (IBOV, INFC) and two international alternatives (GOLD and CRB). Table 3 shows the summary of the returns and volatility and the correlation between the assets.

There were no constraints for asset allocation and five thousand portfolios were simulated. Figures 5 and 6 shows the Markowitz frontiers.

The mix containing Brazilian alternatives displays annualized returns ranging from 8% to around 13% with annualized volatilities lying between 22% to 28% while the mix encompassing international alternatives exhibit annualized returns in a similar interval of 8% to 13% accompanied by annualized volatilities spanning 12% to 22%.

Although the individual assets have similar returns and similar volatilities,

Figure 4
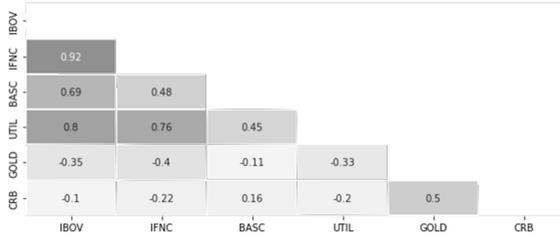**Ten-year correlation of selected traditional and alternative assets**

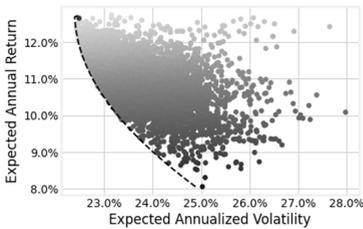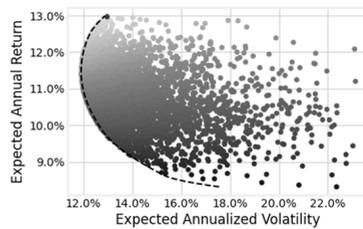**Figure 5**
BR traditional + BR alternatives

Figure 6
BR traditional + INT alternatives

the influence of the lower correlations becomes evident as the mix containing international alternatives displays similar expected returns while generally displaying significant lower volatility.

4.2 Portfolio analysis

In order to evaluate the role of alternative assets, five distinct portfolios were created and analyzed, each with its unique composition and objectives:

1. Brazilian Portfolio: this portfolio is composed exclusively of traditional Brazilian assets.
2. Brazilian Portfolio + Brazilian ALT Investments: in addition to traditional Brazilian assets, this portfolio incorporates Brazilian alternative investments.
3. Brazilian Portfolio + International ALT Investments: this portfolio combines Brazilian traditional assets with international alternative investments.
4. Brazilian Portfolio + International and Brazilian ALT Investments: this portfolio combines Brazilian traditional assets with Brazilian and international alternative investments.

Table 4
Portfolio asset allocation

Asset	Portfolio 1	Portfolio 2	Portfolio 3	Portfolio 4	Portfolio 5
CDI	20%	10%	10%	17%	5%
IBOV	10%	10%	10%	5%	5%
IFNC	50%	10%	10%	5%	5%
IDST	10%	10%	10%	5%	5%
CONS	10%	10%	10%	5%	5%
BASC	-	30%	-	5%	10%
UTIL	-	10%	-	8%	20%
IFIX	-	10%	-	5%	5%
PE	-	-	10%	5%	5%
GOLD	-	-	25%	30%	30%
CRB	-	-	10%	5%	5%
BTC	-	-	5%	5%	-

Note: Portfolio 1 - Brazilian traditional assets; Portfolio 2 - Brazilian traditional assets + Brazilian alternative investments; Portfolio 3 - Brazilian traditional assets + International alternative investments; Portfolio 4 - Brazilian traditional assets + Brazilian and International alternative investment; Portfolio 5 - Brazilian traditional assets + Brazilian and International alternative investments (Excluding Bitcoin).

5. Brazilian Portfolio + International and Brazilian ALT Investments (Excluding Bitcoin): this portfolio is similar to portfolio 4, excluding Bitcoin.

The weightings were allocated through a maximization for the Sharpe Ratio utilizing the ten-year window historical data. To ensure a realistic approach, the following exposure limits were set: Portfolios 1 to 3 had a maximum exposure limit of 50% per asset and a minimum exposure limit of 10% per asset, while Portfolios 4 and 5 operated with a maximum exposure limit of 30% and a minimum exposure limit of 5% per asset. Bitcoin, specifically, was subject to a fixed maximum allocation limit of 5%. Other portfolios with different weights were tested, but their results were equivalent to those in the study. Therefore, they were not reported due to space limitations. Table 4 reports the distribution of weightings of each portfolio.

Table 5 shows the 10-year performance of the selected portfolios. Examining the results, the inclusion of Brazilian alternative investments in the traditional portfolio yielded superior returns to the initial allocation, coupled with a modest reduction in volatility. Furthermore, the introduction of international alternative assets generated higher returns, accompanied by a significant decrease in volatility. Noteworthy is the fact that the portfolio encompassing both Brazilian and international alternatives outperformed the one comprising international alternatives, emphasizing the advantageous nature of incorporating Brazilian alternatives into the investment mix.

It is crucial to highlight that Portfolio 5 did not benefit from the expressive returns of Bitcoin within the ten-year time frame, therefore, serving as a better base for comparison with Portfolio 1 and 2. Portfolio 5 managed to

Table 5
Ten-year performance metrics of selected portfolios

Portfolio	Tot. Ret.	Ret. YoY	Ann. Vol.	Sharpe
Brazilian Portfolio	143.3%	9.3%	20.7%	0.014
Brazilian Portfolio + Brazilian ALT assets	168.5%	10.4%	18.8%	0.074
Brazilian Portfolio + International ALT assets	357.5%	16.4%	13.5%	0.550
Brazilian Portfolio + International & Brazilian ALT assets	402.5%	17.5%	12.1%	0.707
Brazilian Portfolio + International & Brazilian ALT assets (EX BTC)	223.1%	12.4%	11.7%	0.293

"Tot. Ret." = total return; "Ann. Vol." = annualized volatility; "Ret. YoY" = year-over-year return.

Table 6
Five-year performance metrics of selected portfolios

Portfolio	Tot. Ret.	Ret. YoY	Ann. Vol.	Sharpe
Brazilian Portfolio	42.2%	7.3%	22.8%	0.013
Brazilian Portfolio + Brazilian ALT assets	57.2%	9.5%	20.8%	0.119
Brazilian Portfolio + International ALT assets	84.6%	13.1%	13.7%	0.441
Brazilian Portfolio + International & Brazilian ALT assets	98.6%	14.7%	11.6%	0.666
Brazilian Portfolio + International & Brazilian ALT assets (EX BTC)	91.6%	13.9%	13.1%	0.527

"Tot. Ret." = total return; "Ann. Vol." = annualized volatility; "Ret. YoY" = year-over-year return.

deliver a superior return, lower volatility, and consequently, a more favorable Sharpe ratio compared to its Brazilian counterparts, indicating its potential for achieving a more balanced risk-return profile.

Table 6 shows the 5-year performance of the selected portfolios. Over the span of the five-year period, the influence of the COVID-19 pandemic becomes more evident, manifesting in heightened levels of volatility within the examples analyzed. Notably, four out of the five portfolios exhibited a significant increase in their annualized volatility during this period.

A highlight for the time frame is the superior performance of international assets during the pandemic. This is evident in the widening gap in returns between Portfolio 5 and Portfolios 1 and 2, all while maintaining a consistent risk profile. Similar to the ten-year window, in the five-year period, the addition of alternative assets progressively enhanced the performance and risk-return metrics for all of the portfolios.

Table 7 shows the 3-year performance of the selected portfolios. Over a three-year horizon, the samples exhibited closely matched returns, with the standout being the annualized volatilities. Notably, the portfolios incorporating alternative investments demonstrated better risk profiles as the alternative assets were systematically integrated.

Considering Portfolio 2, which exclusively comprises Brazilian traditional and alternative assets, despite delivering a year-over-year return comparable to that of the "complete" portfolio (Portfolio 4), it did so while bearing a

Table 7
Three-year performance metrics of selected portfolios

Portfolio	Tot. Ret.	Ret. YoY	Ann. Vol.	Sharpe
Brazilian Portfolio	20.5%	6.4%	22.8%	−0.064
Brazilian Portfolio + Brazilian ALT assets	30.4%	9.2%	20.0%	0.016
Brazilian Portfolio + International ALT assets	28.1%	8.6%	13.7%	0.056
Brazilian Portfolio + International & Brazilian ALT assets	30.8%	9.4%	11.7%	0.129
Brazilian Portfolio + International & Brazilian ALT assets (EX BTC)	25.7%	7.9%	10.1%	0.006

"Tot. Ret." = total return; "Ann. Vol." = annualized volatility; "Ret. YoY" = year-over-year return.

Table 8
One-year performance metrics of selected portfolios

Portfolio	Tot. Ret.	Ann. Vol.	Sharpe
Brazilian Portfolio	4.7%	19.0%	−0.628
Brazilian Portfolio + Brazilian ALT assets	−3.3%	16.2%	−0.900
Brazilian Portfolio + International ALT assets	3.0%	10.6%	−1.180
Brazilian Portfolio + International & Brazilian ALT assets	5.5%	9.0%	−1.296
Brazilian Portfolio + International & Brazilian ALT assets (EX BTC)	3.0%	9.6%	−1.303

"Tot. Ret." = total return; "Ann. Vol." = annualized volatility.

significantly higher risk. Specifically, Portfolio 2 exhibited an annualized volatility of 20.03%, in stark contrast to Portfolio 4's 11.72% annualized volatility.

Table 8 shows the 1-year performance of the selected portfolios. The negative Sharpe ratios throughout the portfolios is a highlight for the one-year window, as the Brazilian CDI yielded 13.5% in the time frame analyzed. Moreover, the trend of reduced volatility persists among portfolios featuring alternative investments, with the "complete" Portfolio emerging as the top performer in terms of returns while simultaneously upholding the lowest annualized volatility.

5. Conclusion

Through a comprehensive analysis of historical data and risk-return profiles, it becomes evident that traditional asset classes alone cannot fully address the unique challenges and opportunities presented in the Brazilian investment landscape. The Brazilian economy, marked by its inherent volatility and susceptibility to external shocks, may benefit from a diversified approach that incorporates alternative assets. As demonstrated by the comparison of the Markowitz frontiers and by analyzing the historical data of different portfolios, these assets may provide not only diversification benefits but also the potential for uncorrelated returns, acting as effective hedges against economic downturns and market turbulence.

Our results for selected portfolios during the 2013-2023 period show that international alternative assets outperformed their Brazilian counterparts when considering risk-adjusted returns. This superior performance can be attributed to the lower correlation between these two asset classes. However, it is worth highlighting that incorporating Brazilian alternatives into a portfolio already containing international alternatives may enhance returns and improve the overall risk profile, leading to more robust and stable outcomes.

In a world characterized by increasing uncertainty and market complexities, the inclusion of alternative assets in a Brazilian-focused portfolio may be considered by investors, especially for professionals with advanced financial knowledge. Investors seeking to achieve more balanced and resilient results should carefully consider the role of these assets in their investment strategy. By doing so, they may enhance risk-adjusted returns while mitigating downside risks, enabling them to navigate the dynamic Brazilian investment landscape with greater confidence.

While this study has provided insights into the role of alternative investments in a Brazilian portfolio, it is essential to acknowledge its limitations. One limitation lies in the time frame of the analysis. Due to the unavailability of daily returns spanning over a decade for most assets in the Brazilian market, our analysis was constrained by a shorter time frame. This limitation could potentially affect the comprehensiveness of our findings, as certain long-term trends and patterns may not have been fully captured. Future research in this area should aim to overcome this constraint by exploring alternative data sources or considering a broader range of assets to provide a more comprehensive understanding of the dynamics between alternative investments and the Brazilian market.

In conclusion, our research has provided a comprehensive overview of the broader landscape of alternative assets and their potential benefits, there is room for future investigations to delve deeper into this subject. Future studies could aim to conduct a more granular analysis, focusing on measuring the magnitude of the benefits that each individual alternative assets can generate within the Brazilian market context. Such detailed examinations may yield insights that can further enhance the effectiveness of alternative investments within portfolios, offering investors in Brazil a clearer and more tailored understanding.

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