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Diversification and the Efficient Market Hypothesis in Investments

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Abstract

The growth in the number of individual investors in B3, rising from 700,000 to 6.2 million between 2018 and 2022, has increased the demand for knowledge about effective financial strategies. In this context, diversification, a key concept in financial theory, stands out as a fundamental strategy for mitigating risks and ensuring more stable returns. This study examines the impact of diversification and the Efficient Market Hypothesis (EMH) on equity investments in Brazil using data from "Google Finance". Random portfolios were constructed and evaluated over different time horizons (2, 5, and 10 years), comparing them to the Ibovespa and Ifix indices. The results indicate that increasing the number of assets in a portfolio reduces risk without compromising expected returns, demonstrating the effectiveness of diversification in optimizing the risk-return trade-off. This finding suggests that investors who choose not to diversify their portfolios are exposed to non-compensated market risks, reinforcing the importance of diversification as a strategy to maximize return potential while minimizing associated risks.

Keywords: diversification, efficient markets, equity investments

1. Introduction

In recent years, the Brazilian financial market has undergone a substantial transformation, driven by a significant increase in the number of individual investors on the B3. From 2018 to 2022, the population under discussion increased from 700,000 to 5 million, reaching 6.2 million in June 2023 (B3, 2023). This expansion can be attributed to a shift in the profile and preferences of investors, leading to an increased demand for knowledge on financial principles, investment strategies, and risk management.

Diversification, a foundational principle in financial theory, seeks to mitigate exposure to specific risks by allocating resources across a diverse array of assets, thereby ensuring more stable returns over time. The seminal work Modern Portfolio Theory (MPT), proposed by Markowitz (1952), established diversification as an essential strategy for mitigating market fluctuations. This theory posits that combining assets with inverse correlations can balance risk and return. Vaughan (1997) offers a complementary perspective, emphasizing that risk management is an inherent aspect of human behavior, necessitating adaptation in the face of adversity.

Iquiapaza, Amaral, and Bressan (2009) emphasize the 1950s as a pivotal era in the transformation of financial decision-making, underscoring the consolidation of diversification as a foundational principle. Assaf Neto (2011) further reinforces this perspective, asserting that effective risk management necessitates the selection of assets exhibiting greater divergence in profitability, thereby reducing exposure to unsystematic risk.

While classical economic theory emphasizes the significance of diversification, the field of behavioral finance has revealed that cognitive biases influence investment decisions, thereby challenging the conventional assumptions of the aforementioned theory. In their seminal work, Kanapickienė et al. (2024) explore the paradigm shift from classical to behavioral finance, unveiling the mechanisms that enable investors to discern systematic errors such as loss aversion and overconfidence. Zhang (2024) has offered a critique of MPT, highlighting its limitations, including the assumption of efficient markets and the difficulty in accurately estimating future returns. This critique has led to the suggestion of incorporating behavioral factors into portfolio optimization.

The phenomenon of international diversification is also influenced by psychological factors. In their study, Matei and Buz (2023) examined "home bias," defined as the tendency of investors to allocate their resources primarily to the domestic market, thereby diminishing portfolio globalization. Ceolin and Mazzoni (2024) explore a range of theoretical

approaches to finance, contending that the Austrian perspective, by incorporating the subjectivity of agents, offers a more robust explanation for pricing and market movements. Alghifari et al. (2023) have raised concerns regarding the applicability of MPT in the present context, proposing that behavioral theory can serve as a complementary framework to asset allocation. Spulbar and Minea's (2020) critique is reinforced by the observation that traditional financial theories are deficient in their omission of behavioral factors, thereby impeding their capacity to adequately elucidate market fluctuations and investor behavior.

The Efficient Market Hypothesis (EMH), as postulated by Fama (1970, 1991), asserts that asset prices are a reflection of all available information, thereby rendering the attainment of above-average returns unlikely without the assumption of additional risks. Notwithstanding the controversies surrounding the topic, Strong (2007) underscores the enduring pertinence of this hypothesis within the domain of finance. Siegel (2015) conducted an analysis of the U.S. stock market and observed that diversified stock portfolios tend to outperform fixed-income investments over time. This observation underscores the importance of diversification in optimizing the risk-return relationship.

However, identifying assets with negative correlation remains a formidable challenge in the financial market, given the prevalence of positive correlations between assets (Lekovic, 2018). Furthermore, although diversification has been extensively studied in developed financial markets, a comprehensive empirical analysis of its effectiveness for individual investors in the Brazilian context of B3 remains to be conducted. The relationship between diversification, risk, and return in Brazil has not been sufficiently explored, particularly when considering benchmark indices such as Ibovespa and Ifix. Furthermore, there is a paucity of research investigating the impact of diversification over different time horizons, which limits understanding of its applicability in the Brazilian context.

In light of this scenario, the objective of the present study is to analyze the relevance of asset diversification in the risk-return relationship in the Brazilian equity market. The present study aims to empirically investigate the possibility of risk reduction, coupled with positive returns. To this end, a series of randomized portfolios with varying degrees of diversification were constructed and evaluated over a period of two, five, and ten years, from 2014 to 2023. The analysis encompasses the primary assets traded by individual investors on B3—namely, stocks and real estate investment funds—utilizing the average of the Ibovespa and Ifix indices as a reference point.

This research makes a significant contribution by empirically testing the effectiveness of diversification in the Brazilian equity market. To this end, the study examines random portfolios of stocks and real estate investment funds over different periods. The research analyzes the relationship between systematic and unsystematic risk, providing relevant information for individual investors. The study contributes to the existing body of literature on finance in Brazil by offering insights that support investors' decision-making processes. It demonstrates the potential for reducing risks without compromising returns, emphasizing the importance of diversification as a strategy in long-term investment management.

The structure of the paper is as follows: it is divided into five sections. The subsequent section delineates the theoretical framework on investment management, with an emphasis on Modern Portfolio Theory and the Efficient Market Hypothesis. The third section is devoted to a review of the extant literature on portfolio selection and management techniques. The fourth section delineates the methodology, addressing the analysis of diversification and the EMH in Brazil, using financial data and simple random sampling. The fifth section presents the results, and finally, the last section offers the concluding remarks.

2. Modern Portfolio Theory and the Efficient Market Hypothesis: Foundations, Criticisms, and Practical Implications

The field of investment management is predicated on a series of theories that aspire to optimize asset portfolios by achieving a balance between risk and return. According to the precepts of Modern Portfolio Theory (MPT), as developed by Markowitz (1952), the importance of diversification in reducing risk without significantly compromising the expected return is paramount. Markowitz's seminal work challenged the prevailing notion of concentrating investments in higher-return assets. He demonstrated that allocating capital to assets with imperfect correlations results in a more efficient balance between risk and return. The author delineates two stages in the process of portfolio selection: the initial stage encompasses the establishment of fundamental principles concerning asset performance, while the subsequent stage involves the selection of a portfolio based on these principles. MPT is predicated on the assessment of the correlations between asset returns, with diversification constituting a central strategy to mitigate the overall risk of the portfolio (Markowitz, 1952).

Although diversification has been shown to minimize variance, Markowitz suggests that it does not eliminate risk entirely. It is therefore essential for the investor to find a balance between expected return and variance (a measure of risk), considering their own risk profile. He posits that the selection of an optimal portfolio is contingent upon the investor's risk tolerance, thereby facilitating the maximization of return while concomitantly minimizing risk. However,

it is imperative to note that it is inherently impossible to attain both the highest return and the lowest risk; as such, it is not feasible to achieve both simultaneously (Markowitz, 1952).

The Efficient Market Hypothesis (EMH), as proposed by Fama (1970), posits that asset prices are efficiently influenced by all available information, thereby reducing the likelihood of investors consistently outperforming the market average. This theory extends the foundations of Portfolio Theory by classifying market efficiency into three levels: weak, where prices reflect only past information; semi-strong, when publicly available data is also considered; and strong, which assumes that private information is incorporated into asset prices.

Fama's (1970) classification system is predicated on three distinct sets of information. In its weakest manifestation, market efficiency is constrained to the extent that price predictability is based solely on historical data. In the semi-strong form, the analysis's focal point is on whether prices adjust with alacrity to publicly accessible information, such as financial statements and corporate announcements. The strong form of the study investigates whether certain investors have exclusive access to insider information that influences asset pricing, thereby questioning the existence of informational asymmetries in the market.

According to Fama, the price fluctuation process can be conceptualized as a "random walk," in which fluctuations are inherently unpredictable and instantaneously reflect all available information. This finding indicates that the use of past or public information for price prediction is futile, as such data has already been reflected in market prices. The theory posits that investors are rational, making decisions based on complete and objective information. According to the EMH, this undermines strategies for market outperformance (Fama, 1970).

Nonetheless, the EMH has been the subject of critique, predominantly from the domain of behavioral finance, which posits that investors do not consistently act in a rational manner. Emotions and cognitive biases have been demonstrated to exert a significant influence on financial decision-making, giving rise to market inefficiencies and anomalies, including momentum reversals and trends (Kanapickiene et al., 2024). However, these factors have been shown to be inadequate in explaining phenomena such as speculative bubbles (Kahneman; Tversky, 1979). This viewpoint is reinforced by Matei and Buz (2023), who demonstrate how psychological biases affect international diversification, causing investors to adopt suboptimal strategies, such as home bias.

Consequently, there is an increasing necessity to reevaluate the underlying principles of conventional finance. Alghifari et al. (2023) call into question the continued relevance of MPT in the context of significant advancements in behavioral finance and the increasing market volatility. In contrast, Spulbar and Minea (2020) underscore the limitations of contemporary financial theories and advocate for the adoption of more flexible approaches to comprehending market complexity. In this context, Cui (2024) emphasizes the impact of investor expectations and how heuristics and emotional factors shape investment strategies. Alternatively, Leković (2019) proposes the Behavioral Portfolio Theory and the Behavioral Asset Pricing Model, which seek to more accurately capture the irrationality of investors and market dynamics.

Furthermore, the EMH operates under the assumption of informational efficiency, a premise that does not align with the observed reality. Financial markets exhibit anomalies, such as the January effect, which challenge the notion of efficiency. The January effect is a phenomenon in which stocks, especially those with lower market capitalization, tend to show abnormally high returns in January. This behavior stands in opposition to the notion that asset prices effectively reflect all available information, as it suggests a predictable pattern that investor could exploit to achieve above-average returns. Empirical evidence for this anomaly is provided by studies such as Keim (1983) and Haug and Hirschey (2006). However, its persistence has decreased over time, possibly due to increased market sophistication and better understanding of the anomaly.

A further critique of the EMH asserts that it operates under the assumption that all investors have equal access to information. However, in practice, some investors possess insider information or superior data interpretation skills, thereby generating asymmetries within the market. Empirical evidence has demonstrated that investors can achieve superior returns, particularly in less liquid markets or with less-traded assets (Malkiel, 2003).

Conversely, Behavioral Portfolio Theory (BPT) and the Behavioral Asset Pricing Model (BAPM) have been advanced as alternatives to Modern Portfolio Theory, incorporating psychological factors in portfolio construction and asset pricing. These models endeavor to provide a more realistic representation of investor behavior and market dynamics (Leković, 2018).

The advent of these behavioral models underscores the mounting cognizance of the constraints imposed by conventional financial theories and the imperative for more adaptable investment strategies (Zhang, 2024; Leković, 2018). Despite the critiques leveled against it, scholars such as Malkiel (2003) concede the EMH's limitations yet contend that it serves as a foundational framework for market analysis, aiding in the comprehension of how information is reflected in asset prices. While the EMH does not provide a comprehensive explanation for all anomalies, it remains a

foundational concept in modern finance.

Consequently, Modern Portfolio Theory and the Efficient Market Hypothesis provide the theoretical foundations for investment management, despite facing substantial criticism. Behavioral finance offers an alternative explanation for the deviations observed in markets, providing a more realistic view of investor behavior and financial market functioning.

Concerning the Brazilian stock market, it has been observed that it manifests institutional and microstructural characteristics that have the potential to influence the outcomes of efficiency tests. The Brazilian stock market is characterized by the following factors: high sector concentration driven by a few large-cap stocks in the Ibovespa; heterogeneity in liquidity and free-float between equities and REIT-like funds (FIIs); a significant participation of retail investors during bullish and bearish cycles; and regulatory and macroeconomic events that produce discrete shocks.

The aforementioned factors have the potential to engender information asymmetries, transaction costs, and arbitrage frictions, which can impede the rate at which information is integrated into pricing structures. Consequently, when assessing EMH in Brazil, it is advisable to acknowledge that its efficiency may fluctuate based on various factors, including segment, time horizon, and market conditions. These fluctuations may result in short-term deviations, which, over time, tend to dissipate.

In conclusion, while behavioral finance offers a compelling critique of MPT, it is important to note its own limitations. Critics contend that behavioral finance may overemphasize biases and neglect the role of rational decision-making and external economic factors. Furthermore, the absence of a unifying theoretical framework within the domain of behavioral finance may impede its consistent implementation across diverse market contexts (Ceolin; Mazzoni, 2024). Notwithstanding the aforementioned challenges, the integration of behavioral insights into financial models persists in offering valuable perspectives on investor behavior and market dynamics.

3. Method

The methodology employed in this study encompasses the collection and selection of the assets analyzed, which are structured in two main stages. Initially, the data sources utilized to obtain information about stocks and Real Estate Investment Funds (FIIs) are described, ensuring the consistency and reliability of the data. The subsequent section details the asset selection process, which is carried out using the Simple Random Sampling (SRS) technique without replacement. This ensures impartiality in the composition of the portfolios. The subsequent presentation of the inclusion and exclusion criteria for assets ensures that only those with a complete data history are considered in the analysis.

3.1 Data Collection and Analysis Procedures for Assessing Diversification and Market Efficiency

Given the scope delineated for this investigation, which endeavors to undertake an empirical examination of the ramifications of diversification and the theoretical underpinnings of the Efficient Market Hypothesis (EMH) within the context of equity investments in Brazil, data from the Google Finance platform were utilized for stocks, while information pertaining to the nominal return of real estate investment funds was extracted from the Investidor10 portal, where data had previously been consolidated.

Utilizing a descriptive approach, complemented by the utilization of Excel software, a systematic comparison was conducted between return and risk. The latter was typically measured by the standard deviation of returns, as outlined by Markowitz (1952). The results were then compared to a market benchmark index, conceived in this case as the weighted average between the Ibovespa and Ifix.

Thus, the study was grounded in five key metrics for the comparative evaluation of the portfolios analyzed: return, standard deviation, mean, median, and skewness, as per Equation 1:

$$Med_X = \frac{\sum_{i=1}^{n} x_i}{n} \tag{1}$$

where “i” denotes the specific asset subscript and “n” represents the number of assets in the portfolio, ranging from 2, 5, 10, 20, to 30 assets.

The median is a fundamental statistical parameter that is instrumental in identifying the central tendency of data. It is distinguished by its resistance to influences from extreme values, thereby allowing for a more accurate representation of the return distribution. Skewness provides a detailed analysis of the configuration of the return distribution concerning its symmetry. This analysis allows for the identification of whether there is greater concentration around the mean or if there is a skew toward positive or negative values. Collectively, these metrics play a crucial role in characterizing the risk and return profile of investments, providing an expanded and more grounded perspective for strategic decision-making.

In regard to the nature of this study, its approach is explanatory, aiming to clarify, though without the intention of establishing definitive proof, a potential cause-and-effect relationship. In this regard, Granger (1969) posits that the mere observation of correlation is insufficient to establish a causal relationship. Consequently, the establishment of a causal relationship necessitates the integration of robust and coherent theoretical frameworks.

With regard to diversification, Kouyoumdjian (2010) observes that the performance of disparate allocation strategies does not exhibit a significant discrepancy from that observed in simple diversification. Consequently, the latter was adopted as the central methodology in this study. Furthermore, Michaud (1989) underscores the practical limitations of more sophisticated allocation models, largely attributable to investors' perception that the tangible benefits derived from these models do not justify the effort required for their implementation.

In accordance with this perspective, Black and Litterman (1991) emphasize that the complexity inherent in theoretical models, in conjunction with the incompatibility between investors' intuitive weightings and the weights derived from asset allocation methodologies, constitutes one of the primary impediments to the implementation of these models. In this context, it is proposed that adopting a simplified diversification approach may not only be more feasible but also more efficient in the practical financial market.

Consequently, the present study adopted the simplified diversification strategy, in which assets are weighted uniformly, assigning each one a weight equivalent to 1/n of the total portfolio, where "n" is the total number of assets in the portfolio. The analysis was conducted in three distinct time windows: short term (2 years – 2022-2023), medium term (5 years – 2019-2023), and long term (10 years – 2014-2023). The choice of time windows was motivated by the desire to capture different market dynamics. According to Fama and French (1988), profits exhibit positive autocorrelation for periods of up to one year; however, this correlation dissipates over longer time horizons. This phenomenon occurs because, with the emergence of a new innovation, a significant interval is required for its impact on asset prices to be fully assimilated. During this period of adjustment, investors who are more rapid in their adoption of the innovation tend to gain a competitive advantage over those who are slower to incorporate it.

For each of the periods analyzed, 100 hypothetical portfolios were generated, distributed across five levels of diversification. These levels corresponded to portfolios consisting of 2, 5, 10, 20, and 30 assets, which totalled 20 portfolios for each level. In order to maximize the randomness of the selection and mitigate potential biases resulting from the choice of a single sample, the procedure was replicated three times for each time window. This generated three distinct samples for each analyzed period (see Figure 1). The data were then examined in an aggregated manner for each of the periods, allowing for a comprehensive evaluation of the effects of diversification over time.

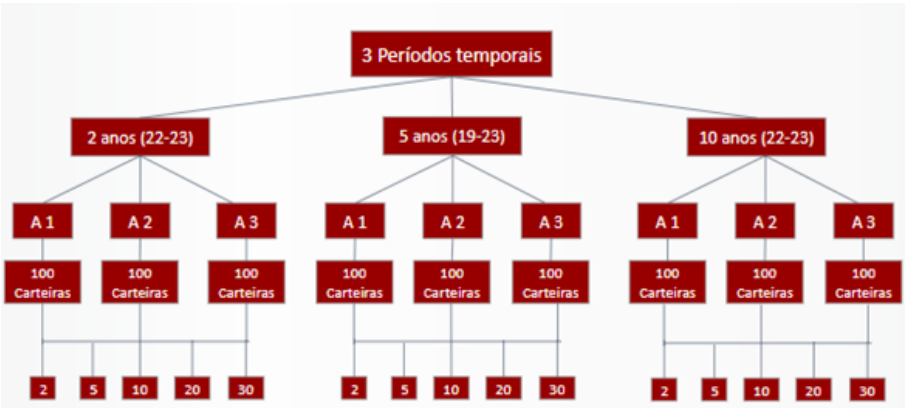

Figure 1. Illustrative flowchart of the employed methodology.

Source: Own elaboration based on research data.

The decision to pursue diversification was informed by a thorough analysis of the investment patterns exhibited by Brazilian investors. The B3 report (2023) indicates that, in the same year, approximately 37% of individual investors possessed only one asset, 11% had two assets, 7% had three, 5% had four, and 39% had five or more assets in their portfolios.

3.2 Asset Selection

The asset selection process involved the implementation of the Simple Random Sampling (SRS) technique without replacement, thereby ensuring that each asset was selected on an individual and random basis, without the application of any stratification or subdivision into stages. This approach ensured that each unit possessed an equal probability of being selected, as elucidated by Bolfarine and Bussab (2005).

At the conclusion of the specified period in 2023, the Bovespa index comprised eighty-seven stocks, which were numbered in alphabetical order. In a similar manner, the IFIX, the benchmark index for Real Estate Investment Funds (FIIs), comprised one hundred and eight assets, which were also organized in alphabetical sequence. The random selection was conducted using the "RANDBETWEEN" function in MS Excel, ensuring the impartiality of the process. In instances where repetitions occurred, a new number was selected to avoid redundancies.

Consequently, the composition of the resulting portfolio did not necessarily include both types of assets (stocks and FIIs), as the selection criterion prioritized maximizing randomness. This approach is consistent with the fundamental theoretical framework of this study, the Efficient Market Hypothesis (EMH).

It is imperative to acknowledge that not all assets were accompanied by a comprehensive and sufficient historical dataset for the specified periods under analysis. Consequently, subjects failing to meet this criterion were excluded from the corresponding sample, thereby ensuring the robustness and coherence of the analysis conducted.

4. Results

As previously stated, the data analysis was conducted across three distinct time intervals, encompassing three individual samples per period, in addition to an aggregated sample. The results obtained in this section will be presented in tabular and graphical formats to facilitate clearer visualization and a more profound comprehension. In addition, the findings will be organized into a segmented structure, with each time interval being addressed individually.

4.1 2-Year Time Horizon (2022-2023)

The data analysis yielded an inverse proportional correlation between the number of assets in the portfolio and the associated risk level, measured by standard deviation. This relationship is evident in both individual samples and the aggregated sample, thereby highlighting that increased diversification tends to mitigate portfolio volatility. This dynamic is supported by the graphical representation in Chart 1, which illustrates the reduction in risk as the number of assets increases.

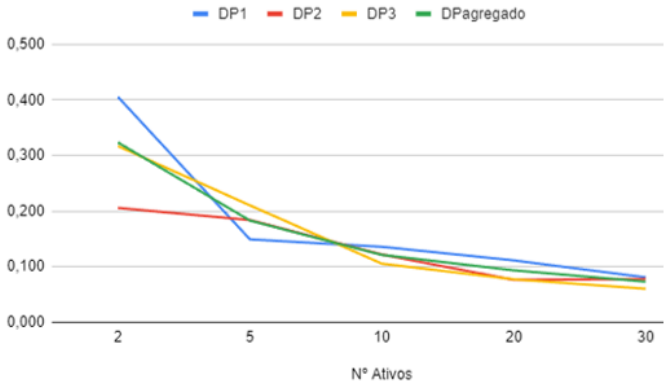

Chart 1. Variation in Standard Deviations from 2022 to 2023

Source: Own elaboration based on research data.

Table 1 presents the relationship between the number of assets in a portfolio and the corresponding volatility, measured by standard deviation. The data highlight the effect of diversification in reducing risk.

Table 1. Descriptive Statistics of the Three Aggregated Samples for the Period 2022-2023

Number of Assets	Average Returns	Standard Deviation	Skewness	Median
2	18.47%	0.323	0.643	20.06%
5	18.06%	0.183	0.445	17.03%
10	13.07%	0.121	-0.008	12.36%
20	17.47%	0.094	0.915	15.91%
30	16.24%	0.073	-0.363	17.10%
Ibov-Ifix Average	24.50%	-	-	-

Source: Own elaboration, based on research data.

In absolute terms, as demonstrated in Table 1 for the aggregated sample, a portfolio composed of only two assets exhibits a standard deviation of 32.3% around the mean. Conversely, a portfolio exhibiting high diversification, with 30 assets, demonstrates a substantially diminished standard deviation of 7.3%. This result indicates that dispersion relative to the mean is approximately 4.2 times smaller in the diversified portfolio, demonstrating the benefits of diversification

in risk mitigation.

A decline in average returns is observed in the short-term horizon as portfolio diversification increases, a phenomenon that is particularly evident in the aggregated sample. This phenomenon suggests that diversification functions as a mechanism for mitigating volatility, although it concomitantly results in a compression of average returns. This phenomenon can be attributed to the dilution of specific risks associated with individual assets, thereby enhancing portfolio stability and mitigating extreme positive fluctuations. In a less diversified portfolio, these fluctuations could potentially amplify the average returns.

Another salient aspect pertains to the negative skewness observed in more diversified portfolios, particularly those comprising 30 assets. This tendency is further accentuated in medium- and long-term analyses. As posited by Artes (2014), a comprehensive understanding of skewness is paramount in financial analysis. Distributions exhibiting strong positive skewness tend to concentrate most values below the mean, while those with negative skewness exert the inverse effect.

Consequently, in the context of an investment portfolio, lower skewness values are preferable, as they indicate more predictable and consistent returns, thereby facilitating risk assessment. Furthermore, reducing skewness enables the more efficient application of traditional statistical models, such as the Markowitz Model, which assumes normal return distributions. This contributes to a more robust portfolio management strategy that is less susceptible to extreme events.

The analysis of skewness in return distributions is fundamental to understanding asset behavior within a portfolio. As illustrated in Figure 2, this phenomenon is distinguished by the presence of positive skewness (right) and negative skewness (left).

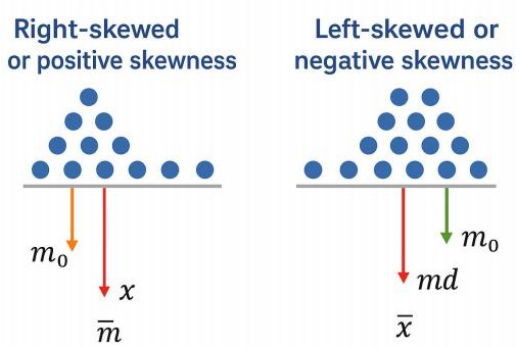

Figure 2. Graphical Representation of Positive and Negative Skewness

Source: Own elaboration, adapted from statistical literature.

In positive skewness (right-skewed) distributions, the majority of values are concentrated to the left of the mean, with an extensive right tail. This phenomenon is indicative of the presence of extreme positive returns. Conversely, negative skewness (left-skewed) distributions demonstrate an antithetical pattern, characterized by values that are concentrated to the right of the mean and a protracted left tail. This reflects the predominance of extreme negative returns.

4.1 5-Year Time Horizon (2019-2023)

In the empirical analysis conducted over the five-year period in question, the same pattern observed in shorter periods is recurrent. An inverse relationship is identified between the number of assets in the portfolio and the magnitude of standard deviations, thereby highlighting the fundamental role of diversification in reducing volatility. This phenomenon is vividly illustrated in Chart 2.

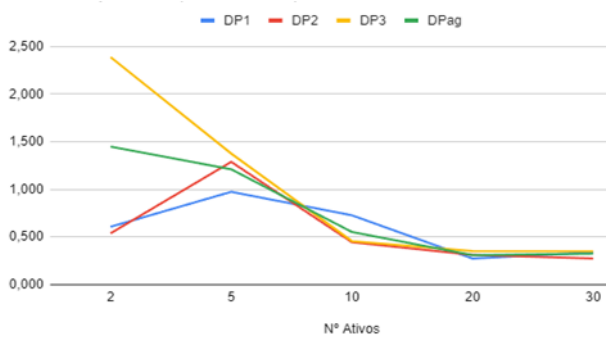

Chart 2. Variation of Standard Deviations from 2019 to 2023

Source: Own elaboration, based on research data.

The following table (Table 2) illustrates the relationship between the number of assets and the observed skewness. Additionally, it has been observed that skewness tends to decrease as the number of assets increases, with this correlation being more pronounced compared to the previous two-year period.

Table 2. Descriptive Statistics of the Three Aggregated Samples for the Period 2019-2023

Number of Assets	Average Returns	Standard Deviation	Skewness	Median
2	45.96%	1.449	6.335	23.38%
5	66.41%	1.211	2.801	32.11%
10	53.25%	0.553	2.606	37.90%
20	42.33%	0.310	2.200	36.93%
30	53.62%	0.325	0.842	41.97%
Média Ibov-Ifix	46.03%	-	-	-

Source: Own elaboration, based on research data.

Furthermore, in this particular context, the mean returns of portfolios exhibited a greater degree of alignment with the market average, in contrast to the preceding period. This trend is clearly illustrated in Chart 3.

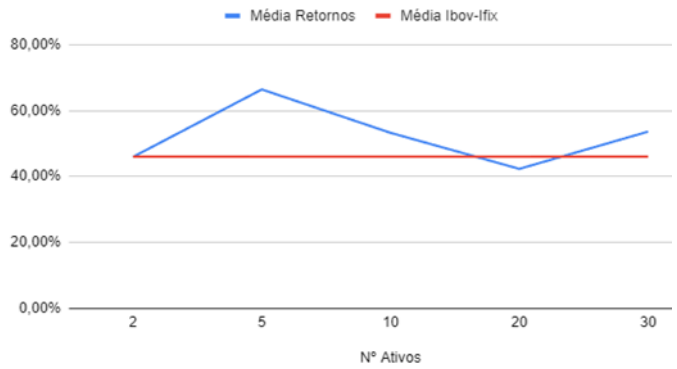

Chart 3. Comparative Analysis of Aggregate Return Averages Relative to the Ibov-Ifix Average (2019-2023)

Source: Own elaboration, based on research data.

This finding corroborates the conclusions of Fama and French (1988), who postulated that, in the short-term time horizon, profits may exhibit positive autocorrelation, indicating that past returns may have some influence on future returns within this interval. However, this autocorrelation tendency dissipates as the analysis period extends. This phenomenon suggests that, although inefficiencies and predictable return patterns may emerge in the short term, such anomalies do not persist over time.

4.2 Ten-Year Time Horizon (2022-2023)

In the empirical data covering the longer ten-year period, the inverse correlation between diversification and risk becomes even more evident, revealing a more clearly defined trend, as illustrated in Chart 4.

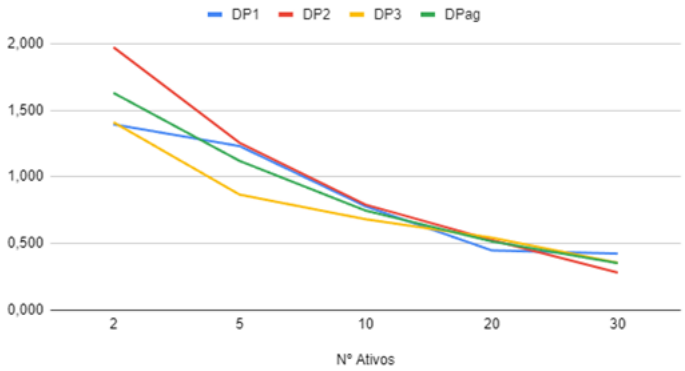

Chart 4. Variation in Standard Deviations from 2014 to 2023

Source: Own elaboration, based on research data.

Moreover, the analysis in Table 3 underscores the continuity of the pattern observed in previous periods. The findings reveal an inverse correlation between the number of assets and the standard deviation, as previously illustrated, as well as in skewness. Furthermore, a direct relationship is observed between the degree of diversification and the median of the aggregated data.

Table 3. Descriptive Statistics of the Three Aggregated Samples (2014-2023)

Number of Assets	Average Returns	Standard Deviation	Skewness	Median
2	137.73%	1.630	2.165	91.39%
5	130.86%	1.120	1.703	101.35%
10	149.16%	0.747	0.757	138.64%
20	142.94%	0.516	0.488	132.91%
30	140.94%	0.353	0.088	142.75%
Ibov-Ifix Average	149.19%	-	-	-

Source: Own elaboration, based on research data.

Upon examination of the median, it is evident that there is a tendency for its value to rise in proportion to the augmentation of the number of assets comprising the sample. The median value for two assets is 91.39%, while for 30 assets, it increases to 142.75%. This increase indicates that diversification is associated with a higher probability of achieving not only higher returns but also more stable returns. As more assets are incorporated, the typical return exhibits a tendency to be both higher and more predictable. This phenomenon can be attributed to the diversification process, which serves to mitigate extreme variations and promote more consistent performance.

Furthermore, a decline in return skewness is evident as the number of assets increases. For a sample of two assets, skewness is notably positive (2.165), indicating that the return distribution exhibits a long right tail. As the number of assets increases, the skewness value decreases progressively, reaching 0.088 with 30 assets. This decline in skewness indicates that, with increased diversification, the return distribution becomes more symmetrical and less biased toward one extreme. This behavior demonstrates that diversification helps balance returns, bringing them closer to a normal distribution and reducing the impact of extreme risks.

Similar to the five-year period, the average return of portfolios in this period tends to align with the market average, as illustrated in Chart 5.

Chart 5. Comparative Analysis of Aggregated Returns vs. Ibov-Ifix Average (2014-2023)

Source: Own elaboration, based on research data.

As illustrated in Chart 5, initial portfolios comprising 2 to 5 assets demonstrate unstable average returns, exhibiting fluctuations in both upward and downward directions. However, as the number of assets exceeds 10, the average portfolio return exhibits a tendency to stabilize, indicating a shift towards convergence with the Ibov-Ifix return. This alignment is further intensified from 20 assets onwards, with the blue line increasingly aligning with the red line.

This dynamic suggests that the diversification provided by a larger number of assets contributes to stabilizing returns, bringing them closer to the market average. The lower variability indicates that diversification can mitigate the risks inherent to individual assets, diluting the impact of potential losses and optimizing the potential for gains.

As illustrated in Chart 6, a comparison is presented of the total return of different portfolios from 2014 to 2023, considering two diversification approaches: portfolios with two assets (blue line) and portfolios with 30 assets (red line). The green line signifies the Ibov-Ifix Index average, which is utilized as a benchmark for performance analysis.

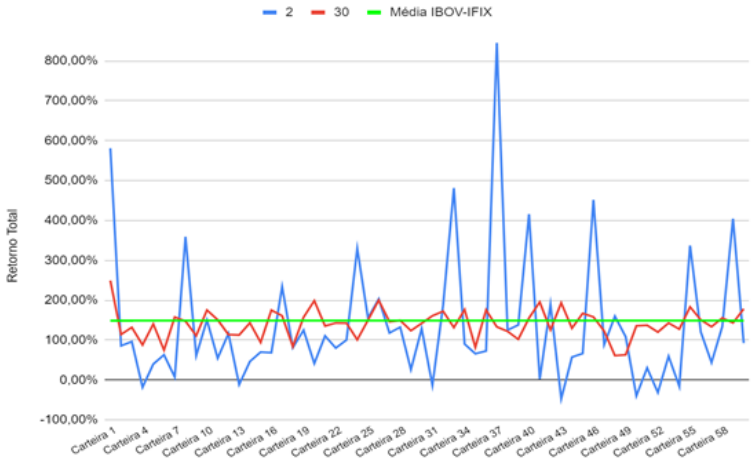

Chart 6. Comparative Analysis of the Aggregated Sample (2014-2023): Diversification of 2 vs. 30 Assets

Source: Own elaboration, based on research data.

The vertical axis of this representation indicates total returns, which are expressed as percentages and range from negative values to over 700%. This range underscores the high degree of volatility exhibited by certain portfolios. The horizontal axis denotes the numbering of the analyzed portfolios.

The findings suggest that portfolios comprising only two assets demonstrate heightened variability, characterized by pronounced peaks in returns and precipitous declines. In contrast, portfolios with 30 assets exhibit greater stability, exhibiting more moderate fluctuations and an average performance that approaches the benchmark. This analysis underscores the efficacy of diversification in mitigating risk and stabilizing returns over the examined period.

5. Final Considerations

The objective of this research was to explore the relevance of diversification and its impact on the interaction between risk and return in equity investments within the Brazilian market. The central question guiding the study was whether an individual investor could mitigate risk without compromising returns in practice.

An inversely proportional relationship was observed between the number of assets and portfolio risk, evidenced by the reduction in standard deviation as the portfolio became more diversified, without a corresponding decrease in the expected average return. This finding demonstrates that investors who choose not to diversify their portfolios are exposed to risks that are not compensated by the market. This reinforces diversification as an effective strategy to optimize the risk-return relationship.

This pattern remained consistent across various time horizons and became even more pronounced as the analysis period was extended, aligning with both financial theory and the Efficient Market Hypothesis (EMH). The EMH suggests that, in the long run, the market tends to correct anomalies.

Consequently, Brazilian investors appear to exhibit a deficiency in the optimal level of diversification. The data indicate a high degree of concentration in particular assets. As previously mentioned, 48% of individual investors, according to the B3 report (2023), hold two or fewer assets in their portfolios. This concentration leaves them vulnerable to uncompensated risks and reduces the effectiveness of their investment strategies.

In this context, the present analysis contributes to clarifying the issue raised by Chague, De-Losso, and Giovannetti

(2018) regarding the reasons why Brazilian individual investors who invest in stocks achieve, on average, annual returns eight percentage points below the Ibovespa. This scenario indicates that the absence of diversification may be a substantial contributing factor to this underperformance, underscoring a pivotal opportunity to enhance portfolio management through the implementation of more diversified strategies.

It is imperative to underscore that, while the mean return and standard deviation are pivotal metrics for evaluating the efficacy of diversification in long-term equity investments, additional complementary metrics, such as the median and skewness, should also be taken into account, as they substantiate the findings obtained.

As previously discussed, the median functioned as a robust measure of central tendency, effectively mitigating the influence of extreme values and outliers. Skewness is a measure of the distribution of returns, providing insights into the presence and extent of tails. These tails can impact the probability of extreme events. The integration of these measures served to strengthen the hypothesis, thereby providing a more comprehensive and detailed analysis of the effectiveness of diversification.

In summary, this study utilizes empirical evidence to demonstrate that diversification is a fundamental strategy for optimizing the risk-return relationship in equity investments within the Brazilian market. The analysis demonstrated that diversification not only mitigates risk without compromising expected returns but also aligns with financial theory and the Efficient Market Hypothesis. The observed pattern, characterized by a reduction in standard deviation and the maintenance of average returns, underscores the significance of diversification in mitigating uncompensated risks and enhancing portfolio performance. The finding that Brazilian investors frequently exhibit excessive concentration in a few assets underscores the urgent need for more diversified strategies.

Consequently, this study makes a significant contribution to the academic advancement of understanding the effectiveness of diversification. Moreover, it offers a valuable practical perspective for investors seeking to refine their strategies and achieve more consistent returns aligned with the average performance of the Brazilian equity market.

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Authors' contributions

Dr. Rafael Abreu Campos and the graduate Bernardo were responsible for the study design and data collection.

Ms. Let ícia drafted the manuscript, and Dr. Fabr ício de Assis Campos Vieira conducted the final revision.

All authors read and approved the final version of the manuscript.

The authors contributed equally to the development of this study.

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Data sharing statement

No additional data are available.

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