REVISTA AMBIENTE CONTÁBIL
Universidade Federal do Rio Grande do Norte
ISSN 2176-9036
Vol. 14, n. 2, Jul./Dez., 2022
Websites: http://www.periodicos.ufrn.br/ambiente
http://www.atena.org.br/revista/ojs-2.2.3-06/index.php/Ambiente
Article received on 19.07.2021. Peer-reviewed on: 22.09.2021. Rewritten on: 23.10.2021. Evaluated by the double blind review system

DOI: 10.21680/2176-9036.2022v14n2ID29387

Historical VaR as a stock fund diversification assessment tool

VaR histórico como herramienta de evaluación de la diversificación de fondos de renta variable

VaR histórico como ferramenta de avaliação da diversificação de fundo de ações

Authors

Victor Amancio de Oliveira
MBA in Finance from FEA-RP/USP and Internal Auditor of Market Risk at Banco Santander. FEA-RP/USP - Av. Bandeirantes, 3900 - Vila Monte Alegre, Ribeirão Preto - SP, 14040-905. Identifiers (ID):
ORCID: https://orcid.org/0000-0001-9321-3037
Lattes: http://lattes.cnpq.br/2612207236882674
E-mail: victor-amancio@hotmail.com

Rafael Moreira Antônio
PhD in Controllership and Accounting from FEA-RP/USP and Coordinator of Matrix Projects of Multimarket Funds at DTVM of Caixa Econômica Federal. FGV EAESP - Rua Itapeva, 474 - 8º andar - Bela Vista, São Paulo, SP - Brasil. 01332-000. Identifiers (ID):
ORCID: https://orcid.org/0000-0003-1116-808X
Google Citations: https://scholar.google.com.br/citations?user=ABm63yUAAAAJ&hl=pt-BR
Lattes: http://lattes.cnpq.br/4657039708780181
E-mail: rafael.antonio@fgv.br

Rafael Confetti Gatsios
PhD in Finance from FEA-RP/USP and Professor of the Accounting Department at FEA-RP/USP. FEA-RP/USP - Av. Bandeirantes, 3900 - Vila Monte Alegre, Ribeirão Preto - SP, 14040-905. Identifiers (ID):
ORCID: https://orcid.org/0000-0003-4364-7157
Lattes: http://lattes.cnpq.br/5432465387302084
E-mail: rafaelgatsios@hotmail.com

Abstract

Purpose: The aim of this study is to assess the potential maximum loss in more concentrated investment portfolios and more diversified portfolios using the VaR calculation as a tool for controlling and managing market risk. For this, the study proposes to answer the following research question: "Do more diversified equity funds present less risk?"

Methodology: The historical simulation model was applied, considering seven portfolios of equity investment funds (FIAs) and 493 daily returns, under the 95% confidence level.

Results: The results indicated that the maximum expected loss is higher in more concentrated portfolios. Therefore, the diversification strategy helped to reduce risk and is an important instrument to be considered in a stock portfolio.

Contributions of the Study: The main contribution of the study is to provide subsidies for investors and asset managers, while providing a simulation and practical application of VaR in the analysis of portfolio diversification in equity investment funds.

Keywords: VaR; Equity Funds, Capital Markets.

Resumen

Objetivo: El objetivo de este estudio es evaluar la pérdida máxima potencial en carteras de inversión más concentradas y carteras más diversificadas utilizando el cálculo del VaR como herramienta de control y gestión del riesgo de mercado. Para ello, el estudio propuso dar respuesta a la siguiente pregunta de investigación: "¿Los fondos de renta variable más diversificados presentan menos riesgo?"

Metodología: Se aplicó el modelo de simulación histórica, considerando siete carteras de fondos de inversión de capital (FIA) y 493 rentabilidades diarias, por debajo del nivel de confianza del 95%.

Resultados: Los resultados indicaron que la pérdida máxima esperada es mayor en carteras más concentradas. Por lo tanto, la estrategia de diversificación ayudó a reducir el riesgo y es un instrumento importante a considerar en una cartera de acciones.

Contribuciones del Estudio: La principal contribución del estudio es otorgar subsidios a inversores y gestores de activos, al tiempo que proporciona una simulación y aplicación práctica del VaR en el análisis de la diversificación de carteras en fondos de inversión de renta variable.

Palabras clave: VaR; Fondos de Renta Variable, Mercados de Capitales.

Resumo

Objetivo: O objetivo do presente estudo é avaliar a potencial perda máxima em carteiras de investimentos mais concentradas e carteiras mais diversificadas utilizando como ferramenta para o controle e gerenciamento do risco de mercado, o cálculo do VaR. Para isso, o estudo se propôs a responder a seguinte questão de pesquisa: “Os fundos de ações mais diversificados apresentam menor risco?”.

Metodologia: O modelo de simulação histórica foi aplicado, considerando sete carteiras de fundos de investimentos em ações (FIAs) e 493 retornos diários, sob o nível de confiança de 95%.

Resultados: Os resultados indicaram que a perda máxima esperada é superior em carteiras mais concentradas. Portanto, a estratégia de diversificação auxiliou na redução do risco e é um instrumento importante a ser considerado em um portfólio de ações.

Contribuições do Estudo: A contribuição central do estudo é a de fornecer subsídios para investidores e gestores de recursos ao passo em que traz uma simulação e uma aplicação prática do VaR na análise da diversificação das carteiras dos fundos de investimentos em ações.

Palavras-chave: VaR; Fundos de Ações, Mercado de Capitais.

1 Introduction

The Brazilian Association of Financial and Capital Market Entities (ANBIMA) announced in August 2021 that the net worth of Brazilian investment funds is around BRL 6.8 trillion and this number was BRL 1.64 trillion in December 2000, which represents a growth of 415% over this period. As for the equity investment funds (FIAs) in August 2021 they had a total of BRL 675 billion in net worth and a growth of 646% since December 2000. These numbers show and give the dimension of the size of the investment fund industry in the country and address the relevance of this research.

Given the importance of this industry, it is essential to quantify the risks in the stock market and in equity investment funds, as well as to assess whether the gains earned will not be offset by potential losses due to market volatility. This is where this study comes in; that is, it presents a practical application of the VaR model to assess whether diversification in equity mutual fund portfolios is a factor capable of reducing investment risks. Thus, this study uses VaR from the historical simulation model, whose approach is based on the assumption that historical returns correspond to a representative sample of the future to assess the diversification of FIAs. The analyses carried out in this study covered mono share funds, sector funds, funds indexed to Ibovespa and free equity funds, and this is the first Brazilian study to perform this type of analysis.

Based on this, the purpose of this study is to assess the potential maximum expected loss in more concentrated investment portfolios and more diversified portfolios as a tool for managing market risk through the VaR calculation. To this end, the historical simulation model was applied, considering daily returns over the past two years, under a 95% confidence interval. In view of this, the study set out to answer the following research question: "**Do more diversified equity funds present less risk?**" .The results found indicated that the diversification funds strategy was able to reduce risk and proved to be an important tool to be considered in an equity portfolio. These results were different from what was found by Storck and Motoki (2021), with emphasis on the fact that these authors studied multimarket funds in the free strategy category.

The central contribution of this study is to provide subsidies to investors and asset managers by providing a simulation and a practical application of VaR in the analysis of equity investment funds' portfolio diversification. Considering the relevance of the investment fund industry in Brazil, this study plays a relevant role for investors, asset managers and regulators, as it takes a look at the importance of diversification in the portfolios of FIAs.

This study is divided into five parts and is comprised by this introduction, followed by the review of relevant studies. Subsequently, the methodological aspects are described, followed by the analysis of the results and the final considerations.

2 Literature Review

The investment fund industry had a net fund raising of BRL 296.4 billion in Brazil by July 2021; and, according to ANBIMA, the equity investment funds (FIAs) had a net worth of BRL 675 billion in August 2021 and showed a 646% growth since December 2000. These numbers give an idea of the size of the investment fund industry in Brazil and make this study relevant, since it evaluated the potential maximum loss of portfolios in more concentrated and more diversified equity investment funds, using the VaR calculation as a tool for the control and management of market risk.

Along these lines, Matos and Rocha (2009) pointed out that more than 90% of global corporate financing and investment operations are linked to the investment fund market and Funchal, Lourenço & Motoki (2016) highlighted that the investment fund industry makes up an important sector of the Brazilian economy. Meanwhile, Borges and Martelanc (2015) pointed out that economic development and monetary stability have created a favorable environment for the mutual fund industry. Nevertheless, Matos, Penna & Silva (2015) pointed out that the financial literature covering the investment fund industry is scarce and deserves to be deepened.

The National Monetary Council defines market risk, through Resolution No. 4,557 - which provides for the risk management structure and the capital management structure - of the Central Bank of Brazil, as the possibility of an occurrence of losses caused by the oscillation in market values on held positions. In this context, market risk translates into the possible loss resulting from the unfavorable oscillation of interest and exchange rates, as well as by the uncertainties of variations in the prices of shares and *commodities*, arising from external factors due to the markets sensibility.

Oliveira and Pinheiro (2018) consider that the market is not static and that market risk comes from changes not anticipated by economic agents that set the current price. Uncertainties about future economic activity, tax and pension reforms, presidential elections, Real depreciation, future ability of a company to produce value, and changes in the yield curve are examples of extrinsic factors that influence the market. Lima (2018) states that the importance of quantifying risks in the variable income market comes from the need to assess whether the gains obtained so far will not be nullified by potential losses due to market volatility. This is where this study comes in; that is, it presents a practical application of the VaR model to evaluate the diversification of equity mutual fund portfolios.

Since risk is inherent and cannot be totally eliminated, it becomes essential to adopt measures to assist in decision making and market risk mitigation. It is in this scenario that the metric *Value at Risk* (VaR) emerges and becomes a significant tool in the control and management of market risk. VaR consists of a statistical measure that estimates the maximum potential loss expected from an asset or an investment portfolio under usual market conditions, considering a certain time period and a certain confidence level, as pointed out by Assaf Neto (2018).

To estimate VaR, Damodaran (2009) mentions three main methods: i) historical simulation model, ii) parametric model (variance-covariance or delta-normal) and iii) model developed from Monte Carlo simulation. The first approach is based on the assumption that the historical data correspond to a representative future model, while the parametric model is based on the assumption that the returns follow a normal distribution. Monte Carlo simulation, on the other hand, relies on parametric distributions of each risk factor and uses computer software to predict conditions that may occur and shape what would happen to the assets in the portfolio under these future conditions.

Jorion (1997) points out that VaR is an indicator that represents the largest expected loss in a given time interval and as a function of a confidence interval. According to Lima (2018) the VaR calculation proceeds according to the following methodology: The VaR measure is the measure in monetary units ($) of the maximum expected loss in a given period of time with a certain confidence level under normal market conditions and provided in absolute terms from the current value of the investment.

The formulation for the VaR for a single asset with a risk factor is presented in Equation (1):

$$VaR\ (\alpha\%, 1\ period) = Investiment\ \times\ \sigma_{period}\ \times\ Z_{\alpha\%} \quad (1)$$

where $Z_{\alpha\%}$ is the confidence level for the VaR calculation and σ_{period} is the risk of the asset for one period (period of the returns database).

Regarding the models used to calculate the value at risk, Ando and Lopes (2010) applied the parametric method and historical simulation model (non-parametric) in an equity portfolio with 5 assets, considering 252 daily observations. The application result of *backtesting* showed that both methods are acceptable to estimate VaR. In a complementary way, Gomes (2015) conducted a study to evaluate the risk in a portfolio of variable income investments in a period of strong volatility, marked by a downward trend of Ibovespa. Gomes (2015) quantified the VaR for a portfolio of 5 shares from the historical and parametric simulation models, considering a period of time observation of daily returns between July 2012 and June 2013. Thus, it was concluded that the models results provided relatively consistent results between each other. In addition, the historical method presented a higher result for VaR, which led Gomes (2015) to state that the normal distribution underestimates the results observed in practice.

Furthermore, Caselato (2009) covered the efficiency of the parametric model and the historical simulation model in order to see which method is more accurate in a historical period of 100 and 200 daily returns. The portfolios evaluated are forward structures of interest rates based on DI future and the results indicated that the most accurate method was the historical simulation model. According to Caselato (2009), the use of a scenario with 200 observations makes the historical simulation model even more efficient when compared to a scenario with only 100 observations and points out that the inappropriate choice of the historical period may result in a scenario that is not sufficient to reflect reality, because material facts may be omitted and the consequences may not be representative.

Silva Alves et. al (2018) led a study of the market risk in different investment options based on the following economy sectors: oil and gas, financial, healthcare, Real estate and construction, mining and retail. For this purpose, 6 equity portfolios with 3 assets in each portfolio were evaluated and the historical simulation methodology was adopted to calculate the VaR. For the 5% significance level, the results indicated that the healthcare portfolio presented the highest risk, followed by the mining sector. The authors also mentioned that historical simulation model proved to be suitable for VaR calculation.

In addition to VaR being a risk management measure for an equity investment portfolio, the research of Arêdes (2013) indicated that the VaR calculation by the historical simulation model was more suitable than the parametric VaR for the *commodity* evaluated, the rice. Arêdes (2013) highlighted the high variance of *commodity* prices and the performance of VaR as a risk management tool.

Still in the *commodities* context, the research of Rugani and Silveira (2015) showed that, in the 312 observations evaluated, coffee is more volatile when compared to Ibovespa and the dollar. Since market risk depends on the behavior of the asset's price in the face of market conditions, VaR is a predictive tool used in market risk management for decision-making. The results of the research noted that the historical simulation method was more efficient than the parametric one given that the distribution of coffee prices does not resemble the pattern of a normal curve. Finally, the research of Ferreira and Ribeiro (2006) highlights that the effects of diversification help in reducing risk. The reduction in the participation of an asset in a portfolio reflects an increase in its relative importance in the overall risk of the portfolio, which in turn does not necessarily pay off in terms of return.

Thus, the importance of the research objective of evaluating the potential maximum loss in more concentrated investment portfolios and more diversified portfolios using the VaR calculation as a tool for market risk control and management is demonstrated, considering seven portfolios of equity investment funds (FIAs).

3 Methodological Procedures

To verify the effects of diversification in a portfolio of equity investment funds from a market risk perspective, the maximum expected potential loss of seven equity portfolios was quantified based on a 95% confidence level ($\alpha = 5\%$). This confidence level is justified by the fact that it has been used in most of the references researched and because it is widely adopted in market practice. It is worth mentioning that we used the portfolios of equity investment funds for analysis, in accordance with the study by Pimentel and Bossan (2020).

Historical simulation model was the methodology chosen in this study for VaR calculation, whose rationale is duly presented in the theoretical framework of this research. This method considers the empirical distribution of past returns to reflect the future probability distribution. Among the advantages of using this method, we highlight the fact that there is no need to calculate the covariance matrix, besides not assuming that the returns follow a normal distribution. Figure 1 shows in a simplified way the proposal of using past returns as a parameter to forecast the maximum expected potential loss of an investment portfolio in a given time, according to Caetano (2018).

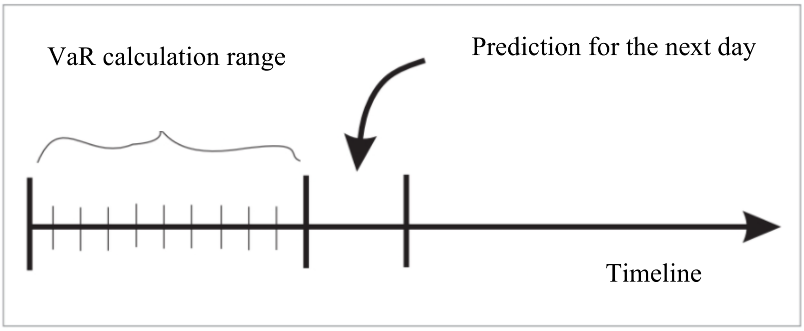

Figure 1 *Visual representation of the VaR concept.*
Source: *adapted from Caetano (2018).*

The selection of the hypothetical portfolios involved consulting the position of investment funds, on the base date of December 31, 2020, through the website of the Comissão de Valores Monetários [Securities and Exchange Commission- CVM]. In order to evaluate the effects of diversification, it was decided to select as reference two mono-equity funds, three sector funds (steel Industry, infrastructure, and banks), a free equity fund, and a passive index fund (Ibovespa), whose objective is to replicate the performance of the theoretical portfolio composed of the equities with the highest trading levels in the Brazilian equity market.

The passive equity fund mentioned above is a fund with shares of *an Exchange Traded Fund* (ETF) that has as its main purpose to reflect the financial performance of an assets group that compose the market index recognized by the CVM. When buying the fund's equities, the investor indirectly obtains the shares of the portfolio that compose the reference index. This is one of the main benefits, because the investor is exposed to a diversified portfolio without having to buy and sell each asset individually.

Table 1 shows the list of selected portfolios and the assets that compose them. Additionally, by standardization and methodological choice, only stocks from companies that have had an IPO (*Initial Public Offering*) for at least two years were selected.

Table 1
Composition of the hypothetical portfolios: number of equities and the analyzed assets code.

Hypothetical Portfolio	Number of Equities and Assets
Equity (**a**)	925,798 VALE3
Equity (**b**)	2,203,300 PETR3
Steel Industry (**c**)	627,500 BRAP4, 1,297,652 CSNA3, 2,002,102 GGBR4, 3,125,264 GOAU4, 415,400 RAPT4, 224,500 LEVE3, 745,100 POMO4, 173,750 TUPY3 and 3,172,486 USIM5
Infrastructure (**d**)	488,700 BRDT3, 27,600 CCPR3, 726,900 CCRO3, 362,082 CMIG4, 302,700 CPFE3, 121,400 CYRE3, 47,400 ELET3, 268,500 ENBR3, 1,456,700 EVEN3, 1,411,400 EQTL3, 726,200 GOLL4, 53,080 HBOR3, 1,049,500 LPSB3, 468. 400 LOGG3, 468,400 LOGN3, 3,700,600 OIBR3, 791,900 PETR3, 537,300 RAPT4, 1,195,322 RAIL3, 1,411,400 RANI3, 97,000 SBSP3, 5,304,260 STBP3, 439,500 SQIA3, 800 TGMA3, 1,032,397 TRIS3 and 79,600 VIVT3
Banks (**e**)	108,800 ABCB4, 392,300 BBAS3, 304,500 BBDC3, 1,158,803 BBDC4, 331,000 BPAN4, 122,400 BRSR6, 250,000 B3SA3, 1,676,011 ITSA4, 80,000 ITUB3 and 758,946 ITUB4

Free equities (**f**)	516,000 AMAR3, 75,500 AZUL4, BBDC3 196,200, BRDT3 333,700, 161,900 ELET3, EQTL3 301,200, 205,800 GOLL4, 158,500 IGTA3, 99,200 ITUB4, 492,300 JBSS3, 857,700 MGLU3, 250,400 MULT3, 231,370 RAIL3, 370,200 SUZB3, 499,700 TRIS3, 251,000 QUAL3 and 153,900 VVAR3
Ibovespa (**g**)	217,187 XBOV11

Source: *Research data.*

The analysis corresponds to the base date of December 31, 2020 and the time period studied corresponds to D+1. The time range considered includes 494 days (493 observations), which comprises a scenario of historical data for the last 2 years, i.e., from 01/02/2019 to 31/12/2020. Such fact corroborates the information discussed by Machry (2003) if the number of observations is too small, there is a possibility of omitting relevant facts. However, if the number of observations is too large, it can be considered unrepresentative observations. Therefore, a time range of 2 years was defined, which can be considered an intermediate range between the very small and very large number of observations.

Assuming that the assets are marked to market (MtM), the step of constructing the historical prices series of the evaluated assets is fundamental and involved the capture of data on the "*Yahoo Finance*" website referring to the closing price of each asset traded on the stock exchange - [B]3, adjusted for the payment of dividends and splits. Having said that, the historical variation of the risk factors was taken from the following logarithmic function:$r_t = \ln(\frac{P_d}{P_{d-1}})$,where P_d represents the closing price of the equity on the day adjusted for dividends and stock splits (D) and Pd-1 represents the closing price of the equity on the previous day adjusted for dividends and stock splits (D-1).

The variations mentioned above were applied to the exponential of the current risk factor price to obtain the simulated price for each asset. With the simulated price for each asset, the value of the portfolio in the simulated scenario was obtained. Then, the expected portfolio value of losses and gains was calculated by the difference between the MtM of the portfolio in the base scenario and the MtM of the portfolio in the simulated historical scenario, as shown below. Borges and Materlanc (2015) pointed out that larger funds outperform smaller funds in times of uncertainty. Meanwhile, Elton, Gruber & Blake (2012) point out that larger funds can obtain possible scale gains in trading. With that in mind, and as a methodological choice, in this study the funds were not segregated by asset size, but by strategy adopted; thus, it is possible to investigate different forms of exposure to risk and focus on diversifying investments.

Table 2

Example of the rationale chosen to evaluate the hypothetical mono-equity portfolio (a).

Date Basis	**VALE3** (BRL)	**Returns**	**Simulated Price** (BRL)	**Simulated Portfolio** (BRL)	**Profit and Losses** (BRL)
02/13/19	40.70	0.0266	85.94	79,562,468.06	- 2,112,628.46
02/14/19	40.85	0.0037	83.99	77,756,295.47	- 1,806,172.59
02/15/19	41.85	0.0049	84.09	77,850,070.53	93,775.06
02/18/19	40.08	- 0.0140	82.52	76,395,055.75	- 1,455,014.78
:	:	:	:	:	:
12/30/20	83.68	0.0044	84.04	77,814,843.23	557,356.97

Source: *Research data.*

Finally, the VaR calculation was obtained by calculating the percentile of all data of the expected value of losses and gains for the confidence level evaluated (1– α).

4 Results and Analysis

For the purpose of the analysis intended for this study, the results indicated that the historical simulation model was the most appropriate for the VaR calculation when compared to the parametric method. As an example, from the graph of closing prices of the hypothetical mono equity portfolio (**a**), composed of common shares of Vale, it was possible to conclude that the sampled price series is not steady.

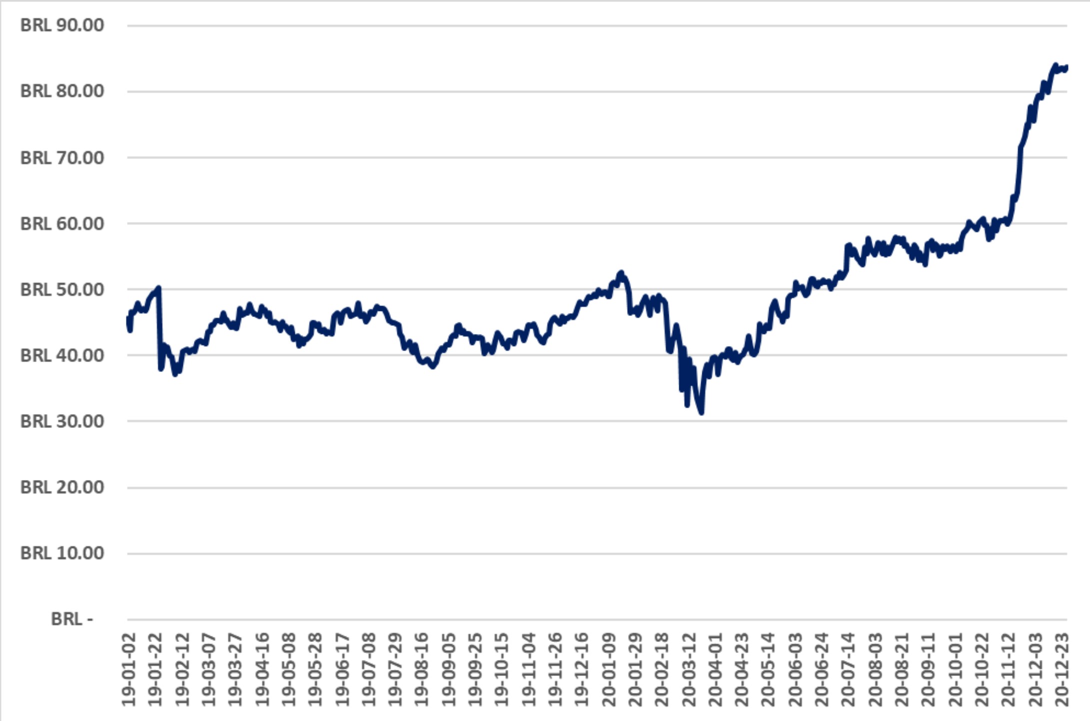

Figure 2 *Closing price of Vale's common equity, adjusted for dividend payments*.
Source: *survey data*.

When looking at the histogram of the logarithm of Vale's equity returns, represented in Chart 2, notes that the curve is asymmetric to the left, out of the normal curve pattern. As a complementary character, the descriptive statistics of the logarithmic returns of Vale's equities confirmed that the curve is not similar to the normal curve pattern, as it presents an asymmetry coefficient equivalent to - 0.58 and kurtosis, 14.63.

Returns Logarithm on Vale Common Equities (VALE3)

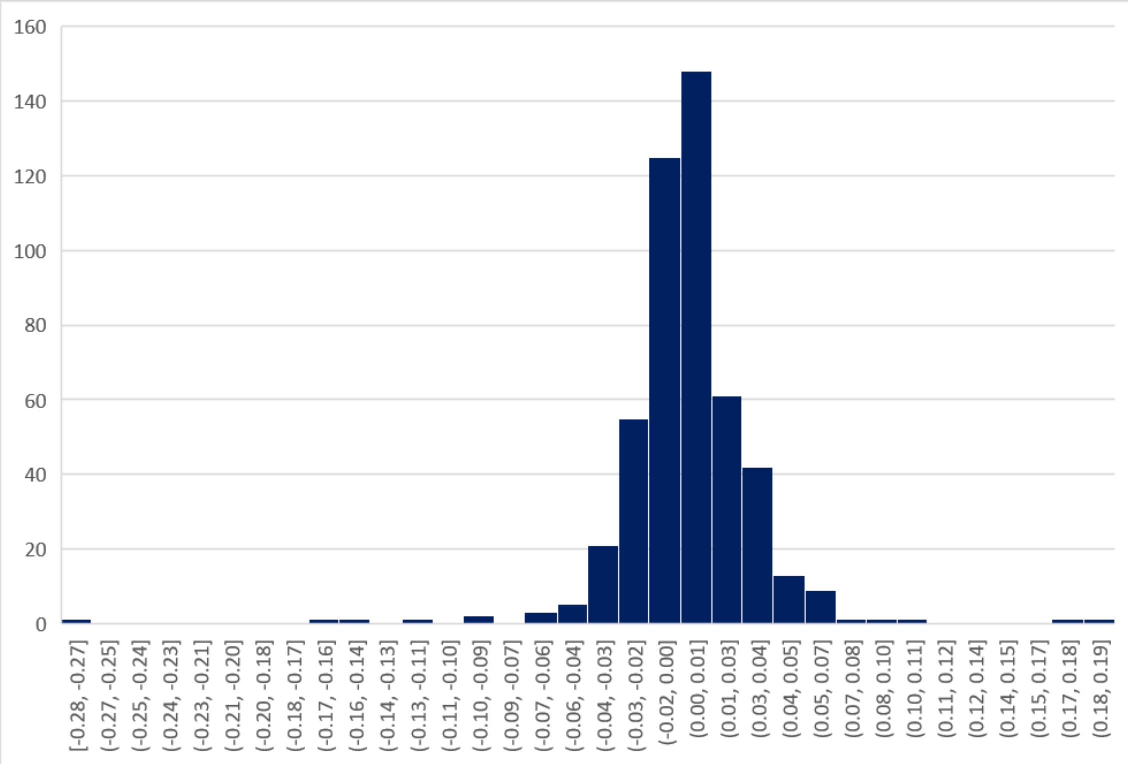

Figure 3 *Histogram of the logarithm of Vale common equity returns*
Source*: Research data*

Similarly, the hypothetical mono-equity portfolio (b), composed by Petrobras common stocks, presented the same behavior regarding the non-approximation of a normal curve. The logarithm histogram of PETR3 results, showed asymmetry to the left with an asymmetry coefficient of -2.46 and kurtosis of 26.22. Thus, the parametric model was rejected for the VaR calculation in these situations, since it assumes the normality hypothesis of the risk factors' returns distribution. Alternatively, the historical simulation method was selected, considering the fact that the historical simulation model does not require any assumption of the exchange distribution as a normal distribution.

When building the historical series, it was noted the presence of few *outliers* concentrated in the month of March 2020, which, for the most part, match the dates on which the systemic *circuit breaker* events occurred in the Brazilian stock market and were due to the uncertainties arising from the COVID-19 pandemic in Brazil. We chose not to remove them from the historical series because these events are relevant in a study that aims to identify maximum expected loss. Table 3 shows the VaR results, both in monetary value and in percentage, for each portfolio evaluated, considering the significance level of 5%.

Table 3
Portfolio position on 12/31/20 (BRL) and VaR, expressed in monetary value (BRL) and percentage (%).

Portfolio	Position	VaR (BRL)	VaR (%)
Mono equity (**a**)	BRL 77,470,776	- BRL 4,579,977	5.91%
Mono equity (**b**)	BRL 61,472,070	- BRL 3,960,120	6.44%
Steel Industry (**c**)	BRL 226,275,435	- BRL 13,618,378	6.02%
Infrastructure (**d**)	BRL 269,660,415	- BRL 12,342,891	4.58%
Banks (**e**)	BRL 119,916,592	- BRL 5,803,596	4.84%
Free equities (**f**)	BRL 126,312,891	- BRL 4,912,672	3.89%
Ibovespa (**g**)	BRL 24,900,489	- BRL 961,853	3.86%

Fonte: *Dados da pesquisa.*

The results obtained allow us to consider that it is possible to assert with 95% confidence that the maximum potential loss of the mono equity portfolio of Vale (**a**) on January 1, 2021 would not exceed the amount of BRL 4,579,977, which corresponds to 5.91% of the total portfolio. For comparative purposes of this analysis, the VaR expressed in percentage points is the most appropriate, since the portfolios position on 12/31/20 is not uniform and varies between BRL 24 MM to BRL 269 MM. We highlight 3 portfolios (**a, b, c**) that presented VaR greater than 5.9% in relation to their total portfolio. Under the market risk and considering the distribution of past returns to predict the future behavior, the portfolio with the highest risk is the one composed only by Petrobras equities (VaR = 6.44%), followed by the steel sector portfolio (VaR = 6.02%) and the Vale mono equity portfolio (VaR = 5.91%). Additionally, we note that these 3 portfolios have a common characteristic: they are composed of exporting companies in which the results of their operations are associated with the prices of commodities, generally cyclical.

The sector portfolios of infrastructure (**d**) and banks (**e**) showed VaR of 4.58% and 4.84%, respectively. Thus, the VaR values are lower than the VaR of the aforementioned commodities portfolios (**a, b, c**). The results show that the most diversified portfolios were those that presented the least risk, and this result is different from that found by Storck and Motoki (2021), who studied multimarket funds in the free strategy category. Just as the free equity fund has in its portfolio several assets from different sectors, the index ETF (Ibovespa) itself is diversified, which helps to reduce the concentration risk. The VaR obtained for the free equity portfolio (**f**) was 3.89% and for the portfolio that replicates the Ibovespa index performance (**g**), 3.86%. In addition, it is noted that the VaR percentage of portfolio (b) is almost double that of portfolios (**f**) and (**g**).

We conclude that market risk is inherent and the VaR calculation is a tool that can be used in risk management and control to predict the maximum expected loss of an equity investment portfolio over a predetermined environment under the desired confidence level. Although the historical simulation method has many advantages, it has the limitation that the historical period may not reflect the current reality. As a suggestion for future studies, it is proposed the evaluation of the weighting of returns in the construction of the historical series in which more recent events have greater weight. Finally, it was found that the maximum expected portfolio loss, in percentage terms, is higher in more concentrated portfolios when compared to diversified portfolios. Thus, the results lead to the inference that the diversification strategy helped reduce risk and is an important tool to be considered when allocating capital in an equity portfolio.

5 Final Considerations

Casaccia, Galli, Macêdo & Leitão (2011) pointed out that investment funds have grown in Brazil in an evident way since the implementation of the Real plan in 1994. By July 2021, the investment fund industry had a net fundraising of BRL 296.4 billion in Brazil; and, according to ANBIMA, the equity investment funds (FIAs) had a net worth of BRL 675 billion in August 2021 and showed a growth of 646% since December 2000. These numbers give an idea of the size of the industry in the country and make this study relevant insofar as it evaluated the potential maximum loss in portfolios of more concentrated and more diversified equity investment funds using the VaR calculation as a tool for controlling and managing market risk. In view of this, the study set out to answer the following research question: "Do more diversified equity funds present less risk?".

For the VaR calculation, the historical simulation model was adopted, considering 493 daily returns and seven investment fund certainties, under the confidence level of 95%. The study results pointed that the maximum expected loss is higher in more concentrated portfolios, as in the case of funds that hold a single equity (mono-equity funds). From this, the diversification strategy of the funds was able to reduce risk and proved to be an important tool to be considered in an equity portfolio. These results were different from what was found by Storck and Motoki (2021), with the detail that these authors studied multimarket funds of the free strategy category.

They found that the maximum expected portfolio loss, in percentage terms, is higher in more concentrated portfolios when compared to diversified portfolios. Thus, the results suggest that the diversification strategy assisted in reducing risk and is an important tool to consider when allocating capital in an equity portfolio.

The main contribution of this study is to provide subsidies to investors and asset managers by providing a simulation and a practical application of VaR in the analysis of diversified portfolios of equity investment funds. Considering the relevance of the investment fund industry in Brazil, this study has a relevant role for investors, asset managers and regulators, since it takes a look at the importance of diversification in the investment portfolios of FIAs. Among the study limitations is the analysis of a single market and the number of funds analyzed. Therefore, as suggestions for future research, it is advisable to expand the fund's sample by analyzing developed and emerging markets.

References

Associação Brasileira das Entidades dos Mercados Financeiro e de Capitais (2021). Consolidado Histórico de Fundos de Investimento. Disponível em: https://www.anbima.com.br/pt_br/informar/estatisticas/fundos-de-investimento/fi-consolidado-historico.htm

Banco Central Do Brasil. Resolução Nº 4.557, de 23 de fevereiro de 2017 (2017). Dispõe sobre a estrutura de gerenciamento de riscos e a estrutura de gerenciamento de capital. Disponível em: https://www.bcb.gov.br. Recuperado em 20 de maio de 2021.

Ando, L., & Lopes, C. M. C. Estudo sobre o uso de Value At Risk para Gestão de Risco. *Anais* do 19º SINAPE – Simpósio Nacional de Probabilidade e Estatística, São Pedro. Universidade Presbiteriana Mackenzie.

Arêdes, A. F. (2013). Gerenciamento de risco na comercialização do arroz. *Perspectivas Online: Humanas & Sociais Aplicadas*, 6(3), 55-67.

Assaf Neto, A. (2018). *Mercado financeiro*. 14. ed. São Paulo, SP, Atlas.

Borges, E. C., & Martelanc, R. (2015). Sorte ou habilidade: uma avaliação dos fundos de investimento no Brasil. *Revista de Administração*, 50(2), 196-207.

Caetano, M. A. L. (2018). *Análise de risco em aplicações financeiras*. São Paulo: Blucher.

Casaccia, M. C., Galli, O. C., Macêdo, G. R., & Leitao, C. (2011). Análise do desempenho de fundos de investimentos: um estudo em ações brasileiras no período de janeiro de 2004 a agosto de 2009. *Revista Organizações em Contexto*, 7(13), 1-30.

Caselato, L. (2009). *Uma comparação dos modelos de Value at Risk aplicados em carteiras de renda fixa.* Tese (Mestrado em Administração). Pontifícia Universidade Católica de São Paulo, São Paulo.

Comissão de Valores Mobiliários – CVM. Disponível em: https://www.gov.br/cvm - Acesso em 04 de maio de 2021.

Damodaran, A. (2009). *Gestão estratégica do risco: uma referência para a tomada de riscos empresariais*. Porto Alegre, Bookman.

Elton, E. J., Gruber, M. J., & Blake, C. R. (2012). Does mutual fund size matter? The relationship between size and performance. *The Review of Asset Pricing Studies,* 2(1), 31-55.

Funchal, B. L. D., & Motoki, F. Y. S. (2016). Sofisticação dos investidores, liberdade de movimentação e risco: um estudo do mercado brasileiro de fundos de investimento em ações. *Revista de Contabilidade e Organizações*, 10 (28), 45-57. https://doi.org/10.11606/rco.v10i28.121505

Gomes, R. S. (2015). *Avaliação do risco financeiro em uma carteira de renda variável através do Value at Risk (VaR).* Trabalho de Conclusão de Curso (MBA em Finanças e Gestão de Risco). Instituto de Economia, Universidade Federal do Rio de Janeiro, Rio de Janeiro.

Hendricks, D. (1996). *Evaluation of Value-at-Risk Models Using Historical Data*. Federal Bank of New York, Economic Policy Review.

Jorion, P. (1997). *Value at risk: the new benchmark for controlling market risk*. New York: McGraw-Hill.

Lima, F. G. (2018). *Análise de Riscos*. 2. ed. São Paulo, SP, Atlas.

Matos, G. A. de S., Iquiapaza, R. A., & Ferreira, B. P. (2014). Analysis of the Exposure to Losses of Brazilian ETFs According to the Value at Risk (VAR) and Expected Shortfall (ES)

Market Risk Assessment Techniques. *Brazilian Business Review*, 11(4), 84–106. https://doi.org/10.15728/bbr.2014.11.4.4

Matos, P. R. F., Penna, C. M., & Silva, A. B. G. (2015). Mutual Investments Funds in Shares in Brazil: Incentives, Management and Convergence. *Brazilian Business Review*, 12(2), 110–142. https://doi.org/10.15728/bbr.2015.12.2.6

Matos, P. R. F., & Rocha, J. A. T. da. (2009). Stocks and Mutual Funds: Common Risk Factors?. *Brazilian Business Review,* 6(1), 21–41. https://doi.org/10.15728/bbr.2009.6.1.2

Oliveira, V. I. & Pinheiro, J. L. (Org.) (2018). *Gestão de risco no mercado financeiro*. São Paulo, SP, Saraiva.

Pimentel, R., & Bossan, V. (2020). Incerteza de mercado e o desempenho de fundos de investimentos em ações no brasil. *Revista Universo Contábil*, 15(4), 127-146. doi:http://dx.doi.org/10.4270/ruc.2019431

Ribeiro, C. D. O., & Ferreira, L. A. S. (2005). Uma contribuição ao problema de composição de carteiras de mínimo valor em risco. *Gestão & Produção*, 12, 295-304.

Rugani, F. D. L., & Silveira, S. D. F. R. (2006). Análise de risco para o café em Minas Gerais. *Revista de Economia e Agronegócio*, 4(3), 343-364.

Silva Alves, J., Amarante, J. B. G., de Oliveira Júnior, R. S., Santana, R. V. A., & Rodrigues, M. V. (2018). Aplicação do VaR (*Value at Risk*) na análise de carteiras de investimentos contendo títulos com ações de diferentes setores da economia nacional. *Anais* do Simpósio de Engenharia de Produção da Região Nordeste (Seprone) & Simpósio de Engenharia de Produção do Vale do São Francisco (Sepvasf), Juazeiro.

Storck, B. A., & Motoki, F. Y. S. (2021). Fundos de investimento multimercado: a liberdade de ação do gestor importa?. *Revista de Contabilidade e Organizações*, 15, e175889. https://doi.org/10.11606/issn.1982-6486.rco.2021.175889