

Evaluation of investment funds through different performance measures

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RESUMO

Objetivo - O objetivo deste trabalho é examinar a avaliação dos fundos de investimento em ações brasileiros a partir de diferentes medidas de desempenho.

Quadro teórico - Na literatura, estão disponíveis diversos índices que podem ser utilizados para avaliar o desempenho de fundos de investimento.

Desenho / metodologia / abordagem - Foram coletados dados de retornos mensais de 1.901 fundos de investimento em ações brasileiros. O desempenho dos fundos foi estimado por meio de quatro índices: índice de Sharpe, índice de Sortino, alfa de Jensen e índice de Treynor.

Resultados - Os resultados mostraram que as medidas de desempenho estão positivamente associadas. Isso significa dizer que não há diferenças significativas no ranqueamento dos fundos de investimento em ações brasileiros em termos de performance.

Implicações teóricas, práticas e sociais - A comparação de diferentes índices de desempenho pode contribuir para a literatura sobre o tema ao fornecer subsídios para que os pesquisadores definam, adequadamente, os índices a serem considerados nos estudos sobre performance em fundos.

Originalidade / valor - Esta pesquisa preenche uma lacuna na literatura no que se refere à análise das medidas de desempenho dos fundos de investimento.

Palavras-chave - Fundos de investimento. Fundos de ações. Desempenho.

ABSTRACT

Purpose - The aim of this study is to examine the evaluation of Brazilian equity funds from different performance measures.

Theoretical framework - In the literature, several indexes are available that can be used to evaluate the performance of investment funds.

Design/methodology/approach - Monthly return data were collected from 1,901 Brazilian equity funds. Fund performance was estimated using four indexes: the Sharpe ratio, the Sortino ratio, Jensen's alpha, and the Treynor ratio.

Findings - The results showed that all four performance measures are positively associated. This means that there are no significant differences in the ranking of Brazilian equity funds in terms of performance.

Research, Practical & Social implications - The comparison of different performance indexes contributes to the literature on the subject by providing further data for researchers to adequately define the indexes considered in studies on the performance of funds.

Originality/value - This study fills a gap in the literature regarding the analysis of performance measures of investment funds.

Keywords - Mutual funds. Equity funds. Performance.

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1. INTRODUCTION

Investment funds constitute a condominium, which can be open or closed, through which investors (shareholders) attribute to a professional the role of decision making on fund's resources allocation in capital markets. In Brazil, according to Normative Instruction No. 409/2004 of the Brazilian Securities Commission (CVM, 2004), which disposes about the composition, administration, operation and disclosure of information on investment funds, the funds are established by authorized financial institutions on Central Bank of Brazil (BACEN) and CVM.

One of the main advantages provided by funds is the possibility of individual investors having access to investment alternatives without the need to deeply know the capital markets and to constantly monitor investment operations. Another advantage is that better remuneration conditions are usually obtained, since funds are managed by professionals. The funds' superior returns also derive from their expressive volume of resources and risk mitigation due to portfolio diversification. (SCHUTT; CALDEIRA, 2016).

On the other hand, it should be mentioned that not all funds are efficient, i.e., present higher performance. The contract between the shareholder or investor (principal) and fund manager (agent) constitutes an agency relationship, which means that the fund manager will not always act in the best interests of shareholders, thus compromising efficiency and, as consequence, performance. According to Padilha (2012), fund efficiency is measured by the level of accumulated returns and low levels of undesirable risky products. Thus, it is necessary to assess the performance of investment funds regarding their risk-return ratio. In this study, the term high performance means higher rates of risk-adjusted return.

The purpose of this study is to examine the evaluation of Brazilian equity mutual funds based on different performance measures. In the literature, several indexes are available to assess funds' performance, such as Sharpe ratio, Sortino ratio, Jensen's alpha and the Treynor ratio, which are all considered in this research. Since different performance measures involve different estimation procedures, it is natural to assume differences in the classification of funds by their performance, depending on the index employed.

As a result, previous research that addresses funds' performance, usually takes into account more than a single measure. For example, Silva and Iquiapaza (2017) compared the performance of socially responsible funds and conventional funds through Sharpe ratio and

Jensen's alpha. Milani et al. (2019) evaluated the impact of sustainable management on funds performance, also using Sharpe ratio and Jensen's alpha. Orleans e Bragança and Sales Pessoa (2017) evaluated the ability of fund managers to generate positive alphas by analyzing the annualized average return, annualized average excess return, annualized average volatility and annualized average Sharpe ratio.

Despite this, it is still unclear whether the use of different performance measures can lead to distortions in the assessment of Brazilian mutual equity funds in terms of performance ranking, especially if we consider the equivalent results for different performance measures observed in previous fund research. For example, Borges Júnior and Malaquias (2019) found similar results for the relationship between share restrictions and performance, measured by Sharpe ratio, Sortino ratio and Jensen's alpha; Gonzalez (2013) studied the risk and return relationship of Brazilian equity funds, and the findings were similar for Sharpe ratio, Treynor ratio and Jensen's alpha, suggesting indifference among indexes; and Silveira and Milani (2015) compared the performance of surviving and non-surviving funds, the results were the same for Sharpe ratio, Sortino ratio and Treynor ratio.

Similar results were observed in surveys from other countries, besides Brazil. Sunarsih (2015) analyzed Islamic mutual funds' performance through Sharpe ratio, Treynor ratio and Jensen's alpha, finding equivalent results for these three performance measures. Chowdhury, Habibullah and Nahar (2018) observed that both, Jensen's alpha and M2 measure from Modigliani, might indicate whether or not a given fund obtained a return higher than market benchmark. Bhagyasree and Kishori (2016) found similar evidence for different equity funds categories performance based on Sharpe ratio, Treynor ratio and Jensen's alpha.

In view of the exposed, there is a gap in the literature, which this study aims to fill, about the analysis of funds' performance measures, in order to identify potential differences in funds evaluation regarding its performance, arising from the use of different risk-adjusted return indexes (Sharpe ratio, Sortino ratio, Jensen's alpha and Treynor ratio). The comparison of different performance measures may contribute to the literature by providing evidence for researchers to adequately define the indexes to be considered in studies about funds' performance. Furthermore, from a practical point of view, it is expected that this research helps investors and analysts when choosing the performance measures to evaluate investment funds.

2. THEORETICAL FOUNDATION

2.1. Investment funds

An individual can directly choose the assets for investment purposes or can seek professional management through investments on fund shares. In the case of this last alternative, it should be mentioned that investing in funds requires the analysis of portfolio manager efficiency in financial resources allocation, in order to verify whether the costs and risks incurred meet the investor's expectations. Therefore, possible costs and benefits provided by investment funds must be evaluated. (OLIVEIRA FILHO; SOUSA, 2015; MENDONÇA JÚNIOR; CAMPANI; LEAL, 2017).

There are at least two ways of managing investment funds: active and passive strategies. The active strategy is one in which a manager exploits market's inefficiency, buying poorly priced assets and selling them at higher prices, speculatively, aiming to surpass a benchmark profitability. In passive management, fund managers seek to reproduce a market index profitability, such as Ibovespa or IBrX. Therefore, it is possible to classify funds based on the benchmark in which they are linked to, such as the Ibovespa, IBrX and ISE. (CASACCIA *et al.*, 2011; MILANI; CERETTA, 2012).

It should be mentioned, however, that sometimes a fund's performance may not reach established benchmarks. Eling and Faust (2010) conducted a survey of hedge funds and mutual funds in emerging markets to assess their performance. For this purpose, they employed five performance measurement models, including Sharpe ratio. As a result, their findings indicated that some hedge funds generate significant positive alpha, while most mutual funds do not outperform traditional benchmarks.

The funds classification may also occur based on their underlying investment portfolios. For example, the Brazilian Securities Commission (CVM) organizes investments into four major classes: fixed income, foreign exchange, multimarket and equity. These modalities are options for investors who want to diversify their portfolio by investing in different kinds of assets. It can be seen that, among so many possibilities, investors face the dilemma of choosing the best options. Hence the benefits provided by investment funds, since the portfolio selection takes place through professional management.

Usually, the benefits of investing in fund shares are more accentuated for small investors, who obtain access to greater investment options, underlying the funds' portfolios, as well as professional management of their financial resources at a low cost. On the other hand, by delegating the responsibility for resources allocation to fund managers, an agency relationship is established making it difficult to ensure that managers will always act in the interests of the principal (shareholder). For this reason, it is necessary to employ mechanisms that properly evaluate funds' performance efficiency. (CASACCIA *et al.*, 2011; FONSECA *et al.*, 2018).

2.2. Investment fund performance evaluation

Efficiency in fund management is related to manager ability to meet investor expectations from a perspective that considers the risk-return relationship. Measuring and analyzing funds' performance, and observing their persistence, may help investors in making decisions regarding how much and in which fund to invest. However, the fund performance is not easily comparable, given the diversity of their characteristics and factors in which each fund is conditioned. (MILANI; CERETTA, 2012).

The risk-return relationship also guides the criteria for fund portfolio selection. This assumption was initially addressed by Portfolio Theory, whose bases are attributed to Markowitz (1952), in which a mean-variance model is proposed as a criterion for portfolio selection and its risk-return analysis. The Portfolio Theory suggests that investors diversify their investments, based on the profitability and returns variability of the portfolio assets. Based on this premise, many pricing models were developed in order to understand the way in which returns are impacted by risk. (FERNANDES; FONSECA; IQUIAPAZA, 2018).

Some of those models resulting from the approach proposed by Markowitz (1952) were the Capital Asset Pricing Model (CAPM), proposed by Sharpe (1964), Lintner (1965) and Mossin (1966), which relates the expected return of an asset to its market risk. According to Fonseca *et al.* (2018), the main assumption that supports CAPM is that the return of a financial asset depends, to a great extent, to the variation of the market portfolio returns. Barillas and Shanken (2018) complement that in the CAPM the asset risk premium depends on the market beta, since it is a measure of systematic risk.

From CAPM, several risk-adjusted performance indexes were developed, which are employed to evaluate investment funds performance. Among these, a very known performance measure is the Sharpe ratio, proposed by Sharpe (1966). According to Borges Júnior and Malaquias (2018), the Sharpe ratio is a measure of return per unit of risk, i.e., it measures the excess return in relation to the risk-free rate, also called the risk premium, weighted by returns volatility.

Casaccia *et al.* (2011) states that the Sharpe ratio is widely used in investment funds evaluation due to its simplicity, since the higher the Sharpe ratio of a portfolio, the better its performance. According to Eling (2008), the Sharpe ratio may be considered the best performance measure to analyze returns across the investment industry, both from a theoretical point of view, since it is consistent with maximizing expected utility, and from a practical view, because it is easy to understand. Oliveira Filho and Sousa (2015) highlight that the Sharpe ratio has become very popular in Brazilian financial market as well, being used to establish performance rankings of investment funds.

Previous studies have already examined the Sharpe ratio as a measure of investment funds performance. For example, Eling (2008) analyzed 38,954 investment funds in the period between 1996 to 2005, in order to understand whether the choice of a certain performance measure affects the classification of hedge funds and mutual funds. Eleven performance measures were considered, namely: Sharpe ratio, Omega, Sortino ratio, Kappa 3, returns growth rate, Calmar ratio, Sterling ratio, Burke ratio, excess return in relation to risk, a conditional relationship between Sharpe ratio and Sortino ratio and, finally, the modified Sharpe ratio. The results showed that funds ordering in terms of performance was not affected by the different performance measures.

Subsequently, Joaquim and Moura (2011) investigated the performance of Brazilian hedge funds from 2007 to 2011, calculating their Sharpe ratio, Jensen's alpha and using three linear models with alternative factors. In addition, performance persistence was evaluated using contingency tables, Spearman's rank correlation and a simple parametric regression. Among the main results, the study showed that more than 39% of the analyzed funds had positive alpha for all performance measures and the persistence of returns tends to decrease with the increase in time horizon.

Malaquias and Borges Júnior (2019) analyzed the effect of the interaction between liquidity constraints and tax planning on the performance of 8,008 Brazilian multimarket

funds from January 2004 to September 2017, the performance was measured by Sharpe ratio. The results indicated that investment funds that implemented, at the same time, redemption restrictions and tax planning presented higher risk-adjusted return rates. As robustness tests, Malaquias and Borges Júnior (2019) also considered samples composed only of funds with a positive Sharpe ratio and fund rankings ordered by Sharpe ratio. However, the results were not robust for these different performance measures.

Despite its advantages, the Sharpe ratio has some limitations. Oliveira Filho and Sousa (2015) point out as the main limitation the possibility of obtaining estimates from negative values, which makes comparisons unfeasible, as the ordering rule may not make logical sense, since funds with higher risk would be classified as better ones. Thus, some studies have opted to exclude funds with a negative Sharpe ratio from the sample when evaluating funds' performance, such as Malaquias and Borges Júnior (2019).

An alternative performance measure to Sharpe ratio, even with some similarities, is the Sortino ratio. McLeod and Van Vuuren (2004) state that, unlike Sharpe ratio, Sortino ratio uses the downside deviation instead of the standard deviation as a measure of risk, i.e., only those returns that are below a target specified by the user, or even a required rate of return, are considered risky. Thus, in many aspects, the Sortino ratio is a better choice, especially when measuring and comparing the performance of managers whose strategies imply in return distributions distortions.

Some previous studies suggest that there seem to be no significant differences in terms of fund ranking through their performance, when measured by Sharpe ratio and Sortino ratio. Fonseca et al. (2007) analyzed Brazilian investment funds, segregating them into fixed income and variable income funds, in order to verify if there would be superiority between them in terms of risk and return. Therefore, performance was evaluated using Sharpe ratio and Sortino ratio. The results showed no statistically significant differences of the average returns in the analysis period.

Maestri and Malaquias (2018) developed a research with the objective to identify whether the characteristics of fund managers and the composition of their portfolios influence Brazilian multimarket funds' performance. A total of 6,002 multimarket funds were analyzed from September 2009 to December 2015 using linear regression models with panel data, whose dependent variables corresponded to the Sharpe ratio and Sortino ratio performance measures. The main results indicated that the composition of the portfolio and the amount of

funds under a manager's responsibility significantly influence fund performance, both for Sharpe ratio and for Sortino ratio.

In addition to Sharpe ratio and Sortino ratio, the literature has presented relevant results employing the Treynor ratio and Jensen's alpha. The Treynor ratio uses the beta (systematic risk) of the portfolio as a measure of risk, instead of standard deviation (TREYNOR, 1965). Varga (2001) states that, when negative, like Sharpe ratio, Treynor ratio makes comparisons unfeasible, despite the latter measuring the excess return per unit of systematic risk and the former considering the general risk.

Jensen's alpha represents the differential between portfolio return in excess to risk-free rate and CAPM return (JENSEN, 1968). According to Varga (2001), Jensen's alpha shows how much a manager added value to a portfolio with several other funds, by taking a risk different from the market risk. Thus, this measure disqualifies managers who are successful regardless of market highs and lows from fluctuations in the beta coefficient.

Varga (2001) implemented and applied several performance measures to the ten largest equity funds of the Brazilian market in order to show the main difficulties in applying them. By using the Sharpe ratio, Treynor ratio, Jensen's alpha and an added value ratio, Varga (2001) indicated different ranking orders for the funds according to each performance measure. Therefore, according to Vargas (2001), the choice of performance measure may influence the investment fund evaluation and, consequently, the investor's decision-making process.

Figure 1 presents a summary of performance measures discussed in this section and considered in this study.

Figure 1 – Performance measures considered on this research

Measure	Equation	Source
Sharpe ratio	$\text{Sharpe ratio} = \frac{R_p - R_f}{\sigma_p}$	Sharpe (1966)
Sortino ratio	$\text{Sortino ratio} = \frac{R_p - R_f}{\sigma_p^d}$	Sortino e Price (1994)
Jensen's alpha	$\text{Jensen's alpha} = R_p - [R_f + \beta * (R_m - R_f)]$	Jensen (1968)
Treynor ratio	$\text{Treynor ratio} = \frac{R_p - R_f}{\beta}$	Treynor (1965)

Notes: R_p = average portfolio return; R_f = average return of risk-free rate; σ_p = returns standard deviation; σ_p^d = negative returns standard deviation; β = beta coefficient; R_m = average market return (Ibovespa).
Source: own elaboration (2021).

3. METHODOLOGICAL PROCEDURES

In this study, in order to examine the evaluation of Brazilian equity mutual funds from different performance measures, monthly returns data were collected from 1,901 Brazilian equity mutual funds through April 2018 to March 2019, from the Economatica database, resulting in about 21,100 observations of returns. The time horizon for the analysis was defined because the data collection took place in mid-April 2019, being, therefore, the moment with the most recent data available until then. Thus, the initial period in April 2018 was given in order to contemplate the 12 months of information about funds' returns.

According to the classification of equity mutual funds by Brazilian Association of Financial and Capital Market Entities (ANBIMA), the sample comprised funds from nine categories, namely: i) dividend stocks; ii) indexed stocks; iii) active index stocks; iv) investment stocks abroad; v) free stocks; vi) sectoral stocks; vii) small caps stocks; viii) sustainability/governance stocks; and ix) value/growth stocks. Table 1 shows the amount of funds in the sample by each ANBIMA category.

Table 1 – Sample composition

ANBIMA Classification	Amount
Dividend stocks	58
Indexed stocks	68
Active index stocks	259
Investment stocks abroad	296
Free stocks	1,002
Sectoral stocks	36
Small caps stocks	38
Sustainability/governance stocks	19
Value/growth stocks	128
Total	1,901

Source: own elaboration (2021).

The performance measures used in this study were Sharpe ratio, Sortino ratio, Jensen’s alpha and Treynor ratio. The Sharpe ratio can be obtained from the difference between the average portfolio return and the average return of the risk-free rate divided by the returns standard deviation, according to Equation 1. The Brazilian treasury bonds rate was used as a proxy for the risk-free asset.

$$\text{Sharpe ratio} = \frac{R_p - R_f}{\sigma_p} \quad (1)$$

Where:

R_p = average portfolio return;

R_f = average return of the risk-free rate;

σ_p = returns standard deviation.

The Sortino ratio represents a variation of Sharpe ratio that considers the standard deviation of negative returns, being obtained, therefore, through the difference between the average portfolio return and the average return of the risk-free rate divided by the standard deviation of the downside, according to Equation 2.

$$\text{Sortino ratio} = \frac{R_p - R_f}{\sigma_p^d} \quad (2)$$

Where:

R_p = average portfolio return;

R_f = average return of the risk-free rate;

σ_p^d = downside standard deviation.

Jensen's alpha consists of the difference between the average portfolio return and the average return of the risk-free rate plus the beta multiplied by the difference between the average market benchmark return and the average return of the risk-free rate. The Brazilian treasury bonds rate was used as a proxy for the risk-free asset, according to Equation 3.

$$\text{Jensen's alpha} = R_p - [R_f + \beta * (R_m - R_f)] \quad (3)$$

Where:

R_p = average portfolio return;

R_f = average return of the risk-free rate;

β = beta coefficient;

R_m = average market benchmark return (Ibovespa);

Finally, the Treynor ratio represents the difference between the average portfolio return and the average return of the risk-free rate divided by the beta coefficient. Likewise, Brazilian treasury bonds rate was used as a proxy for the risk-free asset, according to Equation 4.

$$\text{Treynor ratio} = \frac{R_p - R_f}{\beta} \quad (4)$$

Where:

R_p = average portfolio return;

R_f = average return of the risk-free rate;

β = beta coefficient;

For the analysis of the fund performance measures, Spearman and Kendall rank correlation coefficients were employed. Spearman's correlation coefficient is a non-parametric statistical technique that measures the degree of correlation between variables based on rankings (ANDAKU; PINTO, 2003). Similarly, Kendall's correlation coefficient also estimates the correlation of two variables based on rankings, but it is a more robust procedure in relation to Spearman's correlation regarding the smoothness of the influence function and the sensitivity of errors (CROUX; DEHON, 2010).

The different performance measures were compared using Spearman and Kendall rank correlation coefficients. If the correlation coefficients between the variables have a value of 1, then the ranks for the performance measures will be equal, suggesting, therefore, that there would be no difference in the funds ordering regarding their performance, regardless of the measure considered. Hence the choice of Spearman and Kendall rank correlation coefficients to examine the evaluation of Brazilian equity investment funds based on different performance measures.

4. RESULTS

Initially, Table 2 presents the descriptive statistics for funds' performance measures, namely: Sharpe ratio, Sortino ratio, Jensen's alpha and Treynor ratio. In addition to the number of observations in the sample, Table 2 shows mean, standard deviation, minimum and maximum values observed for each performance measure.

Table 2 - Descriptive statistics

Variable	# obs.	Mean	Standard Deviation	Min.	Max.
Sharpe	21,116	3.2595	6.6727	-2.8010	20.3840
Sortino	21,116	5.1562	12.4188	-4.2017	51.8150
Alpha	21,100	17.1303	61.6068	-70.2474	256.2940
Treynor	21,100	46.2578	179.6374	-341.1394	664.5577

Notes: Sharpe = Sharpe ratio; Sortino = Sortino ratio; Alpha = Jensen's alpha; Treynor = Treynor ratio. Brazilian treasury bonds rate was used as a proxy for the risk-free asset.
Source: own elaboration (2021).

It is observed that, on average, the investment funds have a Sharpe ratio of 3.26, Sortino ratio of 5.15, Jensen's alpha of 17.13 and Treynor ratio of 46.26, suggesting a positive average performance of funds from the sample. It should be mentioned, however, that the average was not very adequate to provide general information regarding funds' performance measures, due to the high dispersion of verified values.

The Treynor ratio was the measure with the highest dispersion (standard deviation of 179.64), with an observed minimum value of -341.14 and a maximum of 664.56. Following, still in terms of dispersion, was Jensen's alpha (standard deviation of 61.61), whose minimum and maximum values were -70.25 and 256.29, respectively. Dispersion was significantly smaller for Sharpe ratio (standard deviation of 6.67) and Sortino ratio (12.42).

The descriptive statistics for the mutual funds' performance found in this research show differences when compared to previous studies. For example, Borges Júnior and Malaquias (2019) found an average of 1.472 for Jensen's alpha, -0.085 for Sharpe ratio and 1.246 for Sortino ratio. In addition, Maestri and Malaquias (2018) indicated an average of 0.225 for Sharpe ratio. These differences may result from analysis of time and investment fund categories. Borges Júnior and Malaquias (2019), as in this study, evaluated equity mutual funds, but from the period between 2009 and 2016, encompassing periods of crisis in which poor fund performance would be expected. Regarding Maestri and Malaquias (2018), their sample was composed with hedge funds, which differ from equity mutual funds.

From the calculations of performance measures (Sharpe ratio, Sortino ratio, Jensen's alpha and Treynor ratio), I sought to examine the funds rank order for each measure. In other words, an attempt was made to identify whether different performance measures could lead to distortions in funds ranking regarding its performance. The correlations between Sharpe ratio, Sortino ratio, Jensen's alpha and Treynor ratio were analyzed using Spearman's R_s (Spearman's rank correlation coefficients) and Kendall's Tau (Kendall's rank correlation coefficient).

Table 3 presents Spearman's rank correlation coefficients between the four performance measures, namely: i) Sharpe ratio; ii) Sortino ratio; iii) Jensen's alpha; and iv) Treynor ratio.

Table 3 - Spearman's rank correlation coefficients

Variable	Sharpe	Sortino	Alpha	Treynor
Sharpe	1.0000			
Sortino	0.9974*	1.0000		
Alpha	0.6999*	0.7032*	1.0000	
Treynor	0.8595*	0.8569*	0.6046*	1.0000

Notes: Sharpe = Sharpe ratio; Sortino = Sortino ratio; Alpha = Jensen's alpha; Treynor = Treynor ratio.

* statistical significance at 1%.

Source: own elaboration (2021).

It is observed in Table 3 that Sharpe ratio showed a very strong correlation with Sortino ratio (0.9974), which suggests that there are no differences in terms of funds' performance ranking when measured by these two indexes. The Sharpe ratio also showed a strong correlation with Treynor ratio (0.8595), which reinforces the primacy of this ratio to measure funds performance. Although moderate, the results also confirmed the existence of a correlation between Sharpe ratio and Jensen's alpha (0.6999). As for the findings for the other performance measures, there was a strong correlation between Sortino ratio and Treynor ratio (0.8569), as well as between Sortino ratio and Jensen's alpha. Finally, the correlation between Treynor ratio and Jensen's alpha was moderate (0.6046).

In general, these results make it possible to state that the performance measures considered in this study (Sharpe, Sortino, Alpha and Treynor) do not generate significant differences in terms of funds ranking based on their performance, since the Spearman's rank correlation coefficients indicated that all four performance measures are correlated with each other. Thus, in a hypothetical situation, investors who decide to invest in funds with high past performance, *ceteris paribus*, will have similar choices, regardless of whether the analysis employed Sharpe ratio, Sortino ratio, Jensen's alpha or Treynor ratio.

The evidence shown in Table 3 is in line with some previous studies. As an example, Casaccia et al. (2011) verified superior performance from Sharpe ratio and Treynor ratio in Brazilian investment funds when compared to Ibovespa, thus increasing the consonance in the performance evaluation through both indexes. Likewise, the results corroborate Eling (2008), who stated that the choice for a certain performance measure does not affect the fund performance ranking.

In order to corroborate the findings from Spearman's rank correlation coefficients, shown in Table 3, the data were also analyzed using Kendall's rank correlation coefficients.

According to Croux and Dehon (2010), Kendall's correlation is more robust and a little more efficient than Spearman's correlation due to the influence function smoothness and error sensitivity. Therefore, it is employed as a robustness test in relation to the results observed from the Spearman's correlation.

Table 4 shows Kendall's rank correlation coefficients between the four performance measures, namely: i) Sharpe ratio; ii) Sortino ratio; iii) Jensen's alpha; and iv) Treynor ratio. Kendall's correlation coefficients were estimated from Tau-a (there are no adjustments for ties) and Tau-b (there are adjustments for ties) statistics.

Table 4 - Kendall's rank correlation coefficients

Variable	Sharpe	Sortino	Alpha	Treynor
Sharpe	0.9988 1.0000			
Sortino	0.9630* 0.9655*	0.9961 1.0000		
Alpha	0.5743* 0.5751*	0.5693* 0.5709*	0.9984 1.0000	
Treynor	0.8035* 0.8046*	0.7945* 0.7967*	0.5200* 0.5208*	0.9984 1.0000

Notes: Sharpe = Sharpe ratio; Sortino = Sortino ratio; Alpha = Jensen's alpha; Treynor = Treynor ratio. The values in the table represent the Kendall's rank correlation coefficients observed for each variable. The coefficients for tau-a are shown in the respective upper line. The coefficients for tau-b are shown in the respective bottom line.

* statistical significance at 1%.

Source: own elaboration (2021).

It can be seen in Table 4 that the results for Kendall's correlation were similar to those observed when Spearman's correlation was used (Table 2). The findings indicated a very strong correlation between Sharpe ratio and Sortino ratio (Tau-a 0.9630 and Tau-b 0.9655); strong correlation between Sharpe ratio and Treynor ratio (Tau-a 0.8035 and Tau-b 0.8046); and moderate correlation between Sharpe ratio and Jensen's alpha (Tau-a 0.5743 and Tau-b 0.5751). Additionally, the Sortino ratio was strongly correlated to the Treynor ratio (Tau-a 0.7945 and Tau-b 0.7967), and moderately correlated to Jensen's alpha (Tau-a 0.5693 and Tau-b 0.5709). Finally, the correlation between Jensen's alpha and Treynor ratio was moderate (Tau-a 0.5200 and Tau-b 0.5208).

Therefore, the results in Table 4 reinforce that the use of different performance measures does not imply significant differences in funds ranking regarding their performance. Therefore, fund shareholders, or even potential investors, would not be harmed if they considered only one performance measure in the decision to allocate resources in funds with good performance, due to the correlation between the four performance indexes, evidenced in this research.

These results also explain why previous studies that assess fund performance found similar results among different performance measures. For example, Borges Júnior and Malaquias (2019) found equivalent results for the relationship between redemption restrictions and Brazilian mutual funds' performance, measured by Sharpe ratio, Sortino ratio and Jensen's alpha. In a previous study about managers characteristics and portfolio composition, Maestri and Malaquias (2018) found no difference in the performance of Brazilian multimarket funds, measured by Sharpe ratio and Sortino ratio. Additionally, Wu *et al.* (2017) evaluated the consistency of European mutual funds' performance in terms of earnings volatility, their results were similar to Sharpe ratio, Jensen's alpha, Sortino ratio and Treynor ratio, besides other measures considered. Thus, it is understood that the similarities in these findings refer to the positive correlation existing between funds' performance measures.

5. CONCLUSION

The purpose of this study was to examine the evaluation of Brazilian equity mutual funds based on different performance measures, in order to verify possible differences in funds performance ranking. Monthly returns data of 1,901 Brazilian equity mutual funds were collected from the Economatica database during the period of April 2018 to March 2019. The funds' performance was estimated using four performance measures: Sharpe ratio, Sortino ratio, Jensen's alpha and Treynor ratio. Spearman and Kendall rank correlation coefficients were used to analyze the association between performance measures.

The results showed that all performance measures, namely Sharpe ratio, Sortino ratio, Jensen's alpha and Treynor ratio, are positively associated. This means that there are no significant differences in the performance ranking of Brazilian equity mutual funds, regardless of the measure considered. Spearman's $R\hat{o}$ and Kendall's Tau were robust for both rank correlation coefficients studied. Therefore, it is concluded that, regardless of the risk-

adjusted return index (Sharpe, Sortino, Jensen's Alpha and Treynor), the performance evaluation of investment funds would get the same results.

The findings of this research bring contributions both from a theoretical and practical perspective. From a theoretical point of view, this study provides a possible explanation for the equivalent results among different performance measures observed in previous research about funds. Borges Júnior and Malaquias (2019), Maestri and Malaquias (2018) and Wu et al. (2017), for example, considered different performance measures and found equivalent results. This study demonstrates, empirically, that Sharpe ratio, Sortino ratio, Jensen's alpha and Treynor ratio are positively correlated, thus explaining the equivalence in the evaluation of funds through different performance measures, verified in the literature.

Regarding practical implications, the findings of this research may help shareholders and potential fund investors in the choice of performance measures fund performance evaluation, since it provides a comparison of four important indexes. As the results evidenced the existence of a positive correlation between the risk-adjusted return metrics, analysts and investors may choose only one of the four measures to assess the performance of mutual funds, since there would be no statistically significant difference in the funds ranking based on performance, regardless of the measure considered.

Despite the advances provided by this study, it is worth mentioning some limitations. Initially, the evidence documented here is limited to the sample, which is comprised of Brazilian equity mutual funds. In addition, the results cannot be generalized to other fund performance measures, i.e., it cannot be said that other performance indexes, besides those considered here, would also not give rise to differences in terms of fund ranking regarding their performance.

For this reason, for future research, it is recommended to expand the sample to other fund categories, especially multimarket funds, which are similar to international hedge funds, since they are widely covered in the literature, in order to corroborate the conclusions presented here. Even within the scope of equity funds, the analysis of performance measures could be made from different categories among mutual funds, such as dividend stocks, indexed stocks, active index stocks, free stocks and others. It is also suggested that other performance measures be evaluated. Although the Sharpe ratio, Sortino ratio, Jensen's alpha and Treynor ratio constitute the main performance measures for evaluating investment funds, the use of other indices may contribute to a deeper understanding of the phenomenon.

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