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The Paradox Fallacy: An Analysis of the Risk-Return Binomial in the Brazilian Capital Market

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Resumo

Objective: The aim of this study was to analyze the existence of Bowman's Paradox (BP) in the context of Brazilian companies listed on Brazil, Bolsa, Balcão (B3).
Method: The descriptive study, using secondary data and with a quantitative approach, analyzed quarterly data, from the period 2008-2018, of 292 companies listed in B3 and a total of 9,387 firm observations/year.
Results: The evidence reinforced the hypothesis of a positive association between risk and return, both for market proxies and for accounting data. However, it was found that economic and/or regulatory uncertainties can affect the predictability of returns, resulting in a spurious negative relationship between risk and return.
Implications/Contributions: The results reinforce the assumptions of modern finance theory, especially the idea of a positive association between risk and return. It contributes to the debate on investment portfolio management in the Brazilian context, even using accounting data. The evidence has implications for investors, especially non-institutional ones and other economic agents who seek to understand the relevant variables in risky investment decision-making.

Keywords: Portfolio Selection, Risk-Return Binomial, Bowman's Paradox.

How to cite:

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Introduction

The aim of this study was to analyze the existence of Bowman's Paradox (BP) in the context of Brazilian companies listed on Brazil, Bolsa, Balcão (B3). According to Nickel and Rodriguez (2002), the risk-return binomial is the basis of investment decision models and consists of the ex-ante expectation that investors will be willing to assume greater risk if they are compensated for it. Therefore, risk and return will be positively associated.

However, Bowman (1980) presents evidence that this expectation is not confirmed when analyzed from accounting data, suggesting that there is a paradox, which later took its name (Bowman's Paradox). In contradiction, risk and return can show negative correlations.

It so happens that, from the perspective of the Modern Theory of Finance, investors are averse to losses, and that is why they seek to maximize their returns, so that assets are priced based on the set of information available in the market, including accounting (Fama, 1970; Markowitz, 1952). In this sense, investment decisions will be anchored on available information, as well as on the risk and expected return (Re), sometimes estimated based on the CAPM – Capital Asset Pricing Model. According to Lintner (1965) and Sharpe (1964), the CAPM considers that Re is a function of the return on a risk-free asset (Rf) plus a risk premium (Pr) that increases the more risky the potential investment is.

For Penman (2016), the profit (loss) presented in the financial statements is useful data for the evaluation and pricing of assets. In this regard, Johnstone (2021) points out that, in the asset pricing process, those investors who are able to make more accurate expected return estimates tend to obtain a more consistent risk/return ratio. Additionally, this last author reinforces that the set of accounting information available allows investors to assess the specific risk (of the firm) more accurately. The performance observed in the company is compared to the expected, therefore, adjustments will be made to the assumptions used in the pricing models, especially those related to risk.

Therefore, the ex-ante negative relationship between risk-return would be a counterintuitive association, although it is possible that ex-post occurs for several reasons, highlighting: (i) cognitive biases of investors and managers (Kahneman & Tversky, 1979; Kliger & Tsur, 2011); (ii) failure to implement the strategy (Holder et al., 2016); (iii) economic uncertainty in the context of the firm (Muñoz et al., 2020); and (iv) level of competition in the industry (Christensen et al., 2020), among others.

Although the finance literature presents hypotheses that explain the potential causes of the negative relationship between ex-post risk and return, several studies have been developed in different economic contexts to analyze under which conditions BP is confirmed (Dimic et al., 2015; Patel et al., 2018; Singh & Singh, 2017). In summary, BP has been reinforced in adverse socioeconomic contexts that make it difficult to predict the firm's future performance (Becerra & Markarian, 2021). For example, for companies that present systematic negative results and below the sector median (Andersen et al., 2007; Henkel, 2009), as well as for companies with low marketability of shares, but with high growth potential (Chen, 2017).

In the Brazilian context, the finance and accounting literature presents more consistent evidence that the risk-return relationship is positive, both for market and accounting proxies (Amorim et al., 2012; Amorim et al., 2014; Artuso & Chaves Neto, 2010). However, Silveira's (1990) and Vieira's (2012) research sought to specifically analyze the BP and found results that support the negative relationship between risk-return based on accounting data. Other recent works have found inverse or non-significant relationships, although the explanations given are not based on the BP proposals (Mikosz et al., 2020; Perobelli et al., 2016; Pimentel, 2015).

Given the differences observed in the national literature, this study sought to answer the following question: **What is the association between risk and return based on accounting and market data in the context of listed Brazilian companies?** The descriptive study, using secondary data and a quantitative approach, analyzed quarterly data, from the period 2008-2018, of 292 companies listed in B3 and a total of 9,387 firm observations/year.

This research differs from those previously developed in the Brazilian context because it uses a set of quarterly data, which captures market variability over quarters and years, and analyzes the contemporary and outdated association between accounting and market risk-return proxies. The study also uses a more consistent methodological approach than that used by Silveira (1990) and Vieira (2012), who suggest the existence of BP.

In addition, the study presents evidence that the analysis of the relationship between stock returns and risk, measured from accounting metrics, must consider the existence of a

lagged relationship between them, which is adjusted over the quarters, through the disclosure of quarterly financial information. Therefore, the results of previous national studies that analyzed the contemporary association may have observed the absence of a relationship or, even, the inversion of the signs as a result of spurious effects. Finally, the study presents evidence of a positive relationship between risk and return in the Brazilian context, but indicates that factors such as economic and regulatory uncertainty, industry structure and stages of the firm's life cycle can reverse this relationship, as highlighted by Henkel (2009).

From an empirical point of view, the results weaken the hypothesis that there is a paradox in the ex-ante relationship of the risk-return binomial. Therefore, it remains an applicable premise in the evaluation and decision-making process for investments in the Brazilian capital market. The results reinforce the role of accounting numbers as a mechanism for adjusting expectations regarding expected returns, since the positive relationship observed is consistent with the bases of the CAPM. Furthermore, it demonstrates that industry and/or firm characteristics can influence the risk-return relationship, falsely suggesting that there is a paradox. In this context, portfolio managers, institutional and non-institutional investors, among other economic agents, can benefit from the results presented.

2 Literature Review

2.1 Relevance of Accounting Information in the Context of Asset Pricing

According to Kothari (2001), the relevance of accounting information configures a line of research that has been developed since the work of Ball & Brown (1968) and Beaver (1968), who analyzed the relevance of accounting numbers for the market of capitals. However, in recent decades there have been changes in the metrics used by investors for analysis, forecasting and decision-making on resource allocation (Barth et al., 2021).

Despite of that, the confirmatory role of accounting information was kept, since, unlike other sources of financial information, recognition, measurement and disclosure standards make accounting a mechanism that enables different users to adjust their expectations regarding performance and cash flows futures of the firm, more accurately pricing the expected risks and returns (Paolone, 2020).

According to Markowitz and Dijk (2008), in the process of portfolio structuring and risk management, the proper appropriation of available information about the assets allows the risk-return assessment to be more accurate, as the expected return (Re) is a function of the return of a risk-free asset (Rf) plus the premium for the assumed risk [βa (Rm - Rf)]. In this equation, risk is measured from asset volatility in relation to market volatility (systematic risk) (Chen, 2017).

It turns out that this pricing process is carried out based on historical and current data, before the investment takes place and/or the presentation of the company's actual result, as it is about estimating the expected (potential) return, that is, the future performance. For example: to price company X's assets, today, we use data available on its performance (market share, strategy, observed returns on assets, equity and other value drivers, etc.), but it is unknown whether the company will present, in the future, the performance observed so far, which supports the estimated value (today) and the price paid for it.

For Markowitz and Dijk (2008), the investor, as a loss-averse individual, will be willing to pay more for a risky asset if, and only if, he receives a higher risk premium. However, this does not guarantee that, ex-post , the observed returns (R_i) are equal to or higher than expected (R_e), since, for example, the firm's performance may be lower than what the market expected, resulting in an observed return lower than the expected. Even though there was a higher ex-ante risk, this is an ex-post relationship, which can occur for several reasons.

From the perspective of Kahneman and Tversky's Theory of Prospect (1979), the premise of unlimited rationality in classical finance does not consider that individuals heterogeneously take property of the available information. In addition, there are cognitive biases (overconfidence, availability biases, anchoring, etc.) that influence both the assessment of available data and decision making, which can lead to error in judgment and decision making. The Prospect Theory is the most used one to explain BP (Nickel & Rodriguez, 2002).

Another possible explanation for a lower than expected return refers to the economic and market conditions in which the firm operates. According to Muñoz et al. (2020), the economic environment can influence estimation error (ex-ante) or performance below expectations (ex-post). Under these conditions, the tendency is that the expected superior return on high-risk assets will not be confirmed. In turn, Henkel (2009) observed that the characteristics of the distribution of performance of firms in each industry explain, to a large extent, the occurrence of the so-called BP, as in sectors where there is an asymmetric distribution to the left (predominance of results below the median), the risk-return binomial suffers the effects of a spurious relationship not explained in the literature. Furthermore, in industry where performance predictability is

lower, it is possible that the risk-return relationship is inverted, as it will result in a high estimation error, suggesting the existence of a paradox.

Another explanation for the existence of performance above or below expectations stems from the level of negotiability of the firm's shares and its growth potential (Chen, 2017). In this sense, certain companies may have a low level of negotiability (liquidity) and have growth potential not identified by the market (the opposite is true). Therefore, in this context, there would be companies with low risk (assuming a relatively constant price) and with a much higher ex-post return, which would suggest the existence of BP. However, if the potential investor performs the valuation assuming the risk involved, the expected return will be higher or lower, according to the risk-return binomial rule, but this is not necessarily what will happen. Thus, in this scenario, as new information becomes available, economic agents will adjust their assumptions to improve the accuracy of their models.

2.2 Is There Really a Paradox? Previous Evidence on the Risk-Return Ratio

The discussion about the risk-return relationship is at the heart of decision-making on investment and financing, but it was based on the work of Markowitz (1952), Modigliani and Miller (1963), Sharpe (1964) and Lintner (1965) that research on the subject has intensified. Fabozzi et al. (2002) highlight that, in the context of risk management and portfolio selection, although current investors have sophisticated options and tools, the portfolio optimization proposal based on diversification is still predominant. From this perspective, investors will seek to assess and decide on the allocation of resources seeking to maximize the expected return and reduce portfolio risk.

For this, investors will seek to appropriate the set of information available about the analyzed firms so that they can estimate, with greater accuracy, the expected returns on potential investments (Kothari, 2001). Considering that risk is measured, in general, from the volatility of a return metric (e.g.: stock returns, earnings, dividends, return on assets, return on equity, etc.), as it is observed greater risk, investors will incorporate directly or indirectly into their valuation models through the weighted average cost of capital. Fernandez et al. (2021) have carried out an annual survey on the cost of capital considered in the evaluation processes of companies in several countries and the evidence found reinforces that countries with greater political, economic and social uncertainties tend to have a higher weighted average cost of capital, because the Investors incorporate uncertainties about the expected performance of the analyzed assets in their models.

In this context, Shum and Tang (2010) sought to analyze the relationship between risk and return in listed companies in Brazil, Russia, India, China and South Africa from 2003 to 2007. The authors observed a positive relationship between risk and the return, as expected, and highlighted that China and Brazil tend to present, more consistently, an award for higher risk. Results were consistent for different risk proxies used.

Using a time series analysis, Chiang et al. (2015) analyzed data from emerging and developed countries and reinforced the evidence that there is a positive relationship between risk and return, including Brazil, in particular, in times of economic stability. This result was also observed by Singh and Singh (2017). However, Bortoluzzo et al. (2014) had observed that from 2003 to 2007 there was no positive association between risk and return. According to these authors, other factors would explain, in a more consistent way, the stock return in the Brazilian market, such as size, book-to-market, asset liquidity, among others. Despite this observed picture, Val et al. (2014) point out that the use of high frequency data can improve the estimation of risk and return, which would reinforce the expectation of a positive association between risk and return. The evidence that reinforces the positive association is diverse, however, factors that cause spurious relationships (Gospodinov et al., 2017), such as, economic context (Salvador, 2012), exchange rate volatility (Ely, 2015), intertemporal effect of series (Singh & Singh, 2016), among others, can weaken the predictability of risk and the expected return and, therefore, the ex-post positive relationship may not be confirmed. Given the evidence, the following research hypothesis was analyzed:

H_1: There is a positive association between the Beta Coefficient and the Return on Shares of Brazilian listed companies.

Despite the analysis of risk and return, based on market data, reinforcing the expected positive relationship, the results based on accounting data are still controversial. This controversy is partially justified by the fact that, in addition to competing with several other sources of information, the accounting model does not incorporate in the financial statements a series of events that are priced by the market (O'Regan, 2015). This practice avoids, on the one hand, problems with the incorporation of biases of economic agents in the financial statements, given the uncertainties involved in the recognition and measurement process. On the other hand, it impairs the ability of accounting numbers to explain the market value of companies (Barth et al., 2021). However, Gregoire and Martineau (2021) observe that accounting information works as a mechanism for adjusting expectations and, therefore, with each disclosure, there is a change in the price and/or volume of shares traded. Jia et al. (2020) reinforce that

accounting information minimizes the biases of optimism and pessimism that can commonly be seen in the capital market, especially in times of economic uncertainty.

According to Nickel and Rodriguez (2002), there is an extensive literature that sought to analyze the existence of BP. In turn, the literature on business valuation has reinforced the usefulness of accounting numbers in asset pricing, in addition to sustaining that accounting numbers constitute the fundamentals for asset pricing, therefore, the relationship between risk and return follows that predicted by the Theory of Finance (Lewellen, 2010; Penman, 2011).

Penman and Zhu (2014) demonstrate that expected earnings growth is the connection between market risk and firm risk. Analyzing data from 1962 to 2009, the authors observed that there is an association between the profit growth rate and the expected return, which would reinforce the positive relationship between risk and return. Lyle et al. (2013) observed, based on the Ohlson model, that despite finding a positive association between the cost of capital and the expected return, economic shocks affect systematic risk and invert the association between risk and return. Konchitchki et al. (2016) corroborate this finding and point out that greater earnings volatility and risk of bankruptcy are associated with greater expectation of a firm's future return. Other works reinforce the hypothesis that risk/return proxies based on accounting data are associated with market proxies and, therefore, follow the expected relationship of the binomial (Werneck et al., 2010; Amorim et al., 2012, 2014; Araújo & Machado, 2018; Campos et al., 2014; Giner & Reverte, 2006; Lopes & Alencar, 2010; Marinho et al., 2013; Martinez & Castro, 2011; Souza Filho et al., 2017). In view of this evidence, we sought to analyze the following hypothesis:

H_2: There is a positive association between the Coefficient of Variation in Return on Equity (ROE) and the ROE of Brazilian listed companies.

However, some studies do not confirm the informativeness of accounting numbers in explaining the expected returns of firms (Mikosz et al., 2020; Muñoz et al., 2020; Perobelli et al., 2016; Pimentel, 2015). These adverse results regarding the risk-return relationship have reinforced the literature on BP and explain this paradox as arising from cognitive biases, methodological problems and errors in strategy implementation (Nickel & Rodriguez, 2002). In view of the controversies, in order to analyze the association between risk proxies, based on accounting data and market return, the following hypothesis was verified:

H_3: There is a positive association between the ROE Coefficient of Variation and the Return on Shares of Brazilian listed companies.

3 Methodological Procedures

Descriptive research, using secondary data and using a quantitative approach, analyzed quarterly data for the period 2008-2018. Data was obtained from ComDinheiro and, in addition, from the B3 website. Specifically, data on stock returns were extracted from daily quotations for the period 12/31/2007 to 03/31/2019, available on the Yahoo Finance website. The sample consisted of 9,387 company/year observations referring to 292 listed companies, excluding those classified in the financial sector due to the difference in their financial structure when compared to the others.

Quantitative variables were winsorized between 1% and 99% to reduce the effect of influencing data. As an analysis technique, panel data regression was used. To choose the type of panel, the Chow, Breusch-Pagan and Hausman tests were performed, however, we chose to use the panel data model with random effects due to the maintenance of industry control, which, in this discussion, is essential, given the evidence already observed by Andersen et al. (2007) and Henkel (2009). The results with the use of other types of panel and other specifications were discussed in the robustness tests and sought to assess the consistency of the results for different specifications.

3.1 Models and Variables

To analyze the research hypotheses were used models shown in equations 1, 2 and 3. The respective models considered that current returns are explained by the proxies of risk and market return (Beta) and accounting (Return variation rate on Equity). The use of the lagged relationship arises from the fact that returns and risk and return proxies are estimated ex-ante and that the market will carry out ex-post adjustments when the financial information is disclosed.

$$\mathrm{Ret}_{it} = \beta_0 + Beta_{it-1} + \sum_{i=1}^{6} Controls + \sum_{i=1}^{5} Industry + \sum_{i=1}^{10} Year + \varepsilon_{it} \quad (1)$$

$$\mathrm{Ret}_{it} = \beta_0 + \sigma ROE_{it-1} + \sum_{i=1}^{6} Controls + \sum_{i=1}^{5} Industry + \sum_{i=1}^{10} Year + \varepsilon_{it} \quad (2)$$

$$\mathrm{ROE}_{it} = \beta_0 + \sigma ROE_{it-1} + \sum_{i=1}^{6} Controls + \sum_{i=1}^{5} Industry + \sum_{i=1}^{10} Year + \varepsilon_{it} \quad (3)$$

As a return proxy, based on market data, the Return on Shares (Ret) was used, according to Campos et al. (2014) and Pimentel (2015). The stock returns used were those observed in the quarter following the disclosure of accounting information (quarterly), as it is the period in which the market

makes price adjustments due to the availability of accounting information (Penman, 2011; Penman & Zhu, 2014). As a proxy for accounting return, the Return on Equity was used. This metric was used in the work of Bowman (1980) and, later, in national and foreign works that sought to analyze the existence of BP (Nickel & Rodriguez, 2002; Silveira, 1990; Vieira, 2012).

As well as Amorim et al. (2012, 2014) and Souza Filho et al. (2017), the market risk proxy was constituted through the beta coefficient (β), which captures the firm's risk level in relation to systematic (market) risk. Betas were calculated quarterly due to the fact that accounting data are available on the same basis. As an accounting risk proxy, the ROE Coefficient of Variation (σROE) was used. As in Silveira (1990) and Vieira (2012), who analyzed BP in the Brazilian context through annual data, the σROE was calculated for each year based on the variability of ROEs over the quarters in each firm/year. This operationalization strategy considers that the market adjusts prices and, therefore, stock returns, as quarterly results are made available to the market.

To control other environmental factors that can influence the relationship between risk and return, the effects Size (Tam), the Indebtedness Level (NivEnd), the Liquidity Level (ILI), the Industry (SegEcon), the the adoption of International Standards (IFRS), the stages of the Firm's Life Cycle, according to Dickinson (2011), and the Year were considered. Previous evidence suggests that these factors can influence the relationships observed between the risk-return proxies used (Amorim et al., 2012; Andersen et al., 2007; Patel et al., 2018; Perobelli et al., 2016; Pimentel, 2015). The definitions, the operationalization of the variables and the expected signs were presented in Appendix A.

4 Data Analysis and Discussion of Results

Initially, the descriptive statistics of the variables used in the models was analyzed (Tab.1). On that occasion, it was observed that the average return on shares (Ret) in the quarter following the publication of the financial statements was -0.5%, ranging from -65.4% to 68.0%. When observed in the quarter to which the financial statements refer, the average return was 0.001, with a minimum value of -0.956 and a maximum of 1.783. Despite the difference in the average, it was not significant, but it does suggest that the market makes price adjustments after the disclosure of the financial statements.

Table 1. Descriptive statistics of the variables used in the models

	Note	μ	σ	Min	Max
Panel A - Quantitative variables used in the models					
Ret_{it+1}	9,387	-0,005	0,190	-0,654	0,680
Ret_{it}	9,387	0,001	0,307	-0,956	1,783
β_{it+1}	9,335	0,432	0,472	-0,853	1,968
β_{it}	9,387	0,447	0,488	-0,856	1,976
ROE_{it}	9,387	0,077	0,457	-2,721	2,209
σROE_{it}	9,387	0,129	0,878	-5,757	6,174
Tam_{it}	9,387	21,620	19,609	15,207	27,254
$NivEndFin_{it}$	9,387	0,615	0,237	0,058	1,000
ILI_{it}	9,387	0,602	0,793	0,000	6,071
Panel B - Categorical variables used in the models					
B1 – Life Cycle Stages (Dickinson, 2011)					
	Obs.	%	E.P	Logit [95% Inter. Conf.]	
Introduction	985	0,105	0,003	0,099	0,111
Growth	1931	0,206	0,004	0,198	0,214
Maturity	3714	0,396	0,005	0,386	0,406
Turbulence	2260	0,241	0,004	0,232	0,250
Decline	497	0,053	0,002	0,049	0,058
B2 – B3 Industries					
industrial goods	1.734	0,185	0,004	0,177	0,193
Cyclic Consumption	3.096	0,330	0,005	0,320	0,339
Basic Materials	1.076	0,115	0,003	0,108	0,121
Oil, Gas and Biofuels	259	0,028	0,002	0,024	0,031
Others	3.222	0,343	0,005	0,334	0,353

Ret^{i}– Market Return (quarterly) for the quarter following the publication of the financial statements; βeta_{i} – (quarterly) of assets in the current quarter of publication of the financial statements; ROE – Return on Equity; – σROE Coefficient of Variation; TAM – Natural logarithm of total assets, as a proxy for company size; $NivEnd_{it}$ – Level of indebtedness of the company; ILI_{it} – Company's Immediate Liquidity Ratio. All variables were windsorized between 1% and 99% per quarter/year.
Source: Research data

With regard to the Beta (β) average, the specific risk proxy had an average of 0.432 in the quarter following the disclosure of the financial statements and ranged from -0.853 to 1.968. In turn, in the base quarter of the financial statements, the Beta was 0.447, ranging from -0.856 to 1.976. It should be noted that Beta captures the volatility of stock returns compared to the market return. Thus, when analyzing the ROE - Return on Equity, it appears that the average was 0.077 with a variation between -2.721 and 2.209. In the ROE Coefficient of Variation, a risk proxy based on accounting data, there was an average of 0.129, a minimum value of -5.757 and 6.174.

The variables Size (Tam), Financial Indebtedness Level and Liquidity had averages of 21.62, 0.615 and 0.602, respectively. In the three variables, there was a relative dispersion, which can be explained by the fact that the sample is composed

of companies from different economic segments and periods (44 quarters). The analysis of categorical variables shows that 70.70% of the observations were classified in Stages of the Life Cycle of Introduction (10.5%), Growth (20.6%) and Maturity (39.60%). In turn, it was found that 66.7% of the observations are related to companies in the industries of Industrial Goods, Cyclic Consumption, Basic Materials and Oil, Gas and Biofuels. The other industries were grouped, as they did not show, in isolation, statistical significance in the analyzed models.

Subsequently, the average returns between companies with lower and higher risk were compared (Table 2). The results show that, in general terms, the companies in the sample classified as having higher risk (upper quartile of Beta and Coefficient of Variation of ROE) tended to present higher returns.

Table 2. Comparison of return metrics between groups with higher (Q4) and lower risk (Q1)

	Lower Risk (Q1)				Higher Risk (Q4)						
	μ	σ	Min	Max	μ	σ	Min	Max	Q4-Q1	t	KS
Panel A: Beta risk proxy (β) in t											
Ret_{it+1}	-0,017	0,169	-0,588	0,629	0,006	0,210	-0,606	0,680	0,022	***	***
Ret_{it}	0,005	0,328	-0,956	1,783	0,001	0,357	-0,956	1,783	-0,005	NS	NS
ROE_{it}	0,058	0,526	-2,721	2,209	0,064	0,461	-2,721	2,209	0,006	NS	NS
Panel A: Proxy σROE risk in t											
Ret_{it+1}	-0,020	0,219	-0,654	0,647	-0,003	0,188	-0,652	0,593	0,017	***	***
Ret_{it}	0,006	0,532	-3,463	5,829	0,015	0,420	-4,551	4,393	0,008	NS	***
ROE_{it}	-0,104	0,769	-2,721	2,209	0,079	0,320	-2,721	2,209	0,183	NS	***

*Note: Lower Risk (Q1) Group of observations of Beta or σROE in the 1st. Quartile; Highest Risk (Q4) Group of observations of Beta or σROE in the 4th. Quartile. B: Beta Coefficient; σROE: ROE Coefficient of Variation. *, **, *** Statistically significant at the 10%, 5% and 1% levels. NS: Not Significant. The t-test was performed for differences between groups. To perform the test, the homogeneity of variances (ANOVA) between the groups was previously observed. Additionally, as the returns did not show normal distribution (the Shapiro-Wilk/Shapiro-Francia tests were performed for normality), despite being a large sample, the Kruskall-Wallis (KS) test was used for differences between the medians. Substitute to test t when required assumptions are not met.*

Source: Research data.

However, no statistically significant differences were found in all comparisons, but non-parametric tests were more consistently significant. This evidence consists of initial indications that there is a positive relationship between the risk and return of listed companies.

Next, the correlation between the variables used in the models was analyzed (Appendix B). What is verified is that, in general terms, the correlations observed between the risk and return proxies are weak (below 50%), but positive and statistically significant. It was also found that this relationship tends to be more persistent in lagged relationships. For example, the Beta of the base quarter of the financial statements is positively associated with the Return on Shares in the subsequent quarter (after the release of the financial statements). This dynamic was observed both for intra-proxies of risk/return and between them. This evidence reinforces the positive relationship between risk and return, including between proxies measured from accounting data, although it occurs with a lag effect and not contemporary as studies on BP tend to use (Nickel & Rodriguez, 2002; Silveira, 1990; Vieira, 2012).

Subsequently, hypotheses 1, 2 and 3 were analyzed based on the regression models, as shown in Table 3. Initially, a general model was estimated with the entire period and, controlling for the effect of the adoption of international accounting standards (IFRS), the models were statistically significant at the 1% level.

Table 3. Statistics of panel data regression models

Panel A – Statistics of models for the period 2008-2018						
	Ret_{it} $(H_1)^{a}$		Ret_{it} $(H_2)^{a}$		ROE_{it} $(H_3)^{a}$	
Intercept	**-0.185*****	**(0.029)**	**-0.138*****	**(0.026)**	0.206	(0.179)
β_{it-1}	**0.017*****	**(0.005)**				
σROE_{it-1}			-0.001	(0.002)	**0.110*****	**(0.014)**
$IFRS_{it}$	**0.165*****	**(0.009)**	**0.119*****	**(0.009)**	**-0.091*****	**(0.029)**
TAM_{it}	0.002	(0.001)	**0.003*****	**(0.001)**	0.002	(0.009)
$NivEnd_{it}$	-0.015	(0.010)	**-0.027*****	**(0.010)**	**-0.116****	**(0.067)**
ILI_{it}	**0.006***	**(0.003)**	**0.006****	**(0.003)**	-0.002	(0.010)
$INTR_{it}$					**-0.057****	**(0.025)**
$TURB_{it}$					-0.031	(0.021)
$DECL_{it}$	**-0.024*****	**(0.008)**	**-0.030*****	**(0.007)**		
Wald	722.40***		619.57***		126.12***	
Comments	9.387		9.387		9387	
R^2 D | E | G	9.39 | 12.79 | 9.52		9.10 | 16.42 | 9.42		5.37 | 15.07 | 6.39	
No. of firms	292		292		292	
Panel Type	EA		EA		EA	
Industry Control	Yes		Yes		Yes	
Year Control	Yes		Yes		Yes	
Panel B – Statistics of models for the period 2008-2009						
intercept	**0.243*****	**(0.012)**	**-0.116****	**(0.059)**	-0.120	0.237
β_{it-1}	**0.073****	**(0.012)**				
σROE_{it-1}			**-0.018****	**(0.009)**	**0.071****	**0.035**
Other controls	Yes		Yes		Yes	
Panel C – Statistics of models for the period 2010-2018						
Intercept	-0.018	(0.030)	-0.044	(0.028)	0.192	(0.152)
β_{it-1}	**0.014*****	**(0.005)**				
σROE_{it-1}			0.001	(0.002)	**0.110*****	**(0.014)**
Other controls	Yes		Yes		Yes	

*Note: ***, **, * Statistically significant at 1%, 5% and 10%, respectively. Robust standard errors clustered across firms. Source: Research data.*

In terms of explanatory power, there was a general R^2 varying between 6.69% and 9.52%. Considering the established hypotheses, it was found that there is a positive and statistically significant relationship between risk (β_{it-1}) and return (Ret_{it}), measured with market data, which reinforces hypothesis 1. When analyzing the association between the measured risk proxy based on accounting data (σROE_{it-1}) and stock returns, no statistical significance was verified, and the expected positive relationship was not confirmed; therefore, hypothesis 2 was not confirmed. It was also found that the relationship observed between risk and return proxies, based on accounting data, confirms hypothesis 3 and reinforces the expectation that the greater the risk, the greater the return. However, it should be noted that this relationship is lagged, that is, current risk (σROE_{it-1}) is positively associated with (ROE_{it}) subsequent return.

These results partially converge with what was observed by Amorim et al. (2012; 2014), and Penman and Zhu (2014), but given the limitations of accounting numbers, as observed in Mikosz et al. (2020) and Pimentel (2015), the returns did not show positive and significant relationships with the risk proxy, measured from accounting data (σROE_{it-1}).

In order to reduce a potential bias in the coefficients due to the change in accounting standards (IFRS), when estimated with data from the entire period, the respective models per period (2008-2009 and 2010-2018) were estimated. The results show that, in the transition period (2008-2009), the expected relationships for hypotheses 1 and 3 were confirmed, however, for hypothesis 2, the coefficients were negative and statistically significant. This result reinforces previous evidence that periods with high uncertainty affect the predictability of earnings and, therefore, the expected relationship may be reversed.

It is noteworthy that, in the years of 2008 and 2009, in addition to being a transition period, the capital market suffered the consequences of the 2008 Subprime Crisis. In addition, it is known that many uncertainties priced by the market cannot be recognized in the financial statements, as a result of regulatory restrictions. When estimating the period 2010-2018, it appears that hypotheses 1 and 3 were again confirmed and that the expected sign in hypothesis 2 became positive, but not statistically significant. This result is interesting, as it reinforces the evidence that periods of economic, political, social or regulatory uncertainty can impair the predictive capacity of accounting numbers (Becerra & Markarian, 2021; Ely, 2015; Muñoz et al., 2020).

The analysis of the control variables also demonstrates that larger companies with greater liquidity are associated with higher returns and that those classified in Life Cycle Stages of Introduction and Decline tend to present lower stock and accounting returns.

In order to obtain more consistent evidence regarding the relationship between risk and return, using market proxies and from accounting numbers, the regression models were estimated using the Beta quartiles as risk (βit-1) and (σROEit-1). As shown in Table 4, in general terms, the models were statistically significant and the overall Determination Coefficients increased. Using this strategy of operationalization of risk proxies, the models reinforced the idea that risk and return are positively associated, therefore, the three hypotheses were confirmed.

Table 4: Statistics of regression models with panel data (Quartiles of risk proxies)

Panel A - Statistics of models for the period 2008-2018						
	Ret_{it} (H_1)		Ret_{it} (H_2)		ROE_{it} (H_3)	
Intercept	-0.120***	(0.029)	-0.137***	(0.026)	0.018	(0.142)
$Q2\beta_{it-1}$	**0.011****	**(0.005)**				
$Q3\beta_{it-1}$	0.008	(0.005)				
$Q4\beta_{it-1}$	**0.021*****	**(0.006)**				
$Q2\sigma ROE_{it-1}$			**0.0226*****	**(0.006)**	**0.360*****	**(0.029)**
$Q3\sigma ROE_{it-1}$			**0.0162*****	**(0.006)**	**0.347*****	**(0.030)**
$Q4\sigma ROE_{it-1}$			0.00551	(0.006)	**0.365*****	**(0.034)**
$IFRS_{it}$	**0.119*****	**(0.009)**	**0.121*****	**(0.009)**	**-0.074*****	**(0.027)**
TAM_{it}	0.001	(0.001)	0.00125	(0.001)	-0.004	(0.007)
$NivEnd_{it}$	**-0.025****	**(0.010)**	**-0.0214****	**(0.010)**	-0.062	(0.055)
ILI_{it}	**0.006****	**(0.003)**	**0.00518***	**(0.003)**	-0.004	(0.009)
$INTR_{it}$					**-0.046****	**(0.022)**
$TURB_{it}$					-0.019	(0.020)
$DECL_{it}$	-0.030***	(0.008)	-0.0271***	(0.007)		
Wald	717.19***		734.60***		246.08***	
Comments	9.387		9.387		9.387	
R^2 D | E | G	9.35 | 13.26 | 9.52		9.12 | 21.41 | 9.62		9.83 | 34.13 | 14.98	
No. of firms	292		292		292	
Panel Type	EA		EA		EA	
Industry Control	Yes		Yes		Yes	
Year Control	Yes		Yes		Yes	
Panel B - Statistics of models for the period 2008-2009						
Intercept	**-0.105***	**(0.062)**	-0.081	(0.060)	0.014	0.263
$Q2\beta_{it-1}$	**0.040*****	**(0.015)**				
$Q3\beta_{it-1}$	**0.031****	**(0.014)**				
Q4βit-1	**0.037****	**(0.017)**				
$Q2\sigma ROE_{it-1}$			-0.012	(0.015)	**0.099*****	**(0.030)**
$Q3\sigma ROE_{it-1}$			**-0.030****	**(0.015)**	**0.092*****	**(0.033)**
$Q4\sigma ROE_{it-1}$			**-0.054*****	**(0.019)**	0.078	(0.050)
Other controls	Yes		Yes		Yes	
Panel C - Statistics of models for the period 2010-2018						
Intercept	-0.022	(0.031)	**-0.048***	**(0.028)**	-0.065	(0.153)
$Q2\beta_{it-1}$	0.005	(0.006)				

$Q3\beta_{it-1}$	0.005	(0.006)				
$Q4\beta_{it-1}$	**0.019*** **	**(0.007)**				
$Q2\sigma ROE_{it-1}$			**0.027*** **	**(0.006)**	**0.368*** **	**(0.031)**
$Q3\sigma ROE_{it-1}$			**0.023*** **	**(0.006)**	**0.359*** **	**(0.032)**
$Q4\sigma ROE_{it-1}$			**0.014** **	**(0.006)**	**0.378*** **	**(0.037)**
Other controls	Yes		Yes		Yes	

Note: Q2, Q3 and Q4 refer to the 2, 3 and 4 quartile of the risk proxies used β, (σROE)

****, **, * Statistically significant at 1%, 5% and 10%, respectively. Robust standard errors clustered across firms.*

Source: Research data.

The results also showed that the period of 2008 and 2009, as observed in Table 3, hinders the analysis of the relationship, because, in the Brazilian context, in addition to being a period of transition of accounting standards, the world capital market suffered the consequences of the Subprime crisis. These results reinforce the evidence obtained by Campos et al. (2014), Muñoz et al. (2020) and Singh and Singh (2016). For the period 2010-2018, it was found that the three hypotheses were confirmed and that, as the risk increases, the return tends to be higher as predicted in the finance literature. The analysis of the control variables reinforces that larger companies with greater liquidity tend to have higher returns, and that those with greater financial indebtedness tend to have lower returns.

4.1 Robustness and Sensitivity Tests

To verify the robustness and sensitivity of the results, additional estimates were made, using models with panel data with fixed effects and various specifications. In this case, sector control is omitted, which generates a significant variable bias problem, as the previous literature systematically reforms that the analysis of the risk-return relationship must consider sectorial and/or market aspects (Andersen et al., 2007; Henkel, 2009). The results reinforced the findings presented in Tables 3 and 4, however, the models presented weaker general statistics (R^2, Wald, etc). Furthermore, in line with what was observed by Andersen et al. (2007) and Henkel (2009), the effect of performance below the sector was verified and a negative association was observed, influencing the relationship between risk and return of the companies in the sample. When controlling for superior performance, it was found that the positive relationship between risk and return is confirmed for the three hypotheses. Henkel (2009) observes that when there is an asymmetric distribution in the risk and return proxies of firms compared to the sector distribution, or when the predictability of returns is impaired (Val et al., 2014; Becerra & Markarian, 2021), it is possible that there are noises and that a spurious negative relationship may arise when related to risk and return proxies.

5 Final Considerations

The aim of this study was to analyze the existence of Bowman's Paradox (BP) in the context of Brazilian companies listed on Brazil, Bolsa, Balcão (B3). For this purpose, quarterly data from 292 companies in the period 2008 to 2018 were analyzed, with the aid of descriptive statistics, test of differences between means and regression analysis with panel data.

The results confirmed the analyzed hypotheses that there is a positive association between risk and return, both from accounting data and market data. However, this relationship is more consistently observed when considering the lag effect, as the market adjusts return expectations to each new information relevant to the pricing of assets. It was also found that the idea that there is a paradox regarding the risk-return relationship is a fallacy, because, despite the criticism and evidence of works that analyze the so-called "Bowman's Paradox" (Nickel & Rodriguez, 2002), the observed sign inversion is partly due to the fact that the asset pricing process is not considered to be ex-ante.

Therefore, the risk and return, estimated today, will not be exactly what will be observed in the future, therefore, it makes no sense to analyze the association between ex-post and contemporaneous risk and return proxies. After the realization of economic events, it is necessary to understand which factors influenced the estimation error, since, with each new relevant information available, investors will adjust their expectations regarding the future performance of firms.

In addition, despite the evidence that accounting information is useful for asset pricing (Penman, 2011; Penman & Zhu, 2014), it is necessary to take into account that accounting data are measured based on normative parameters that restrict the recognition of uncertainties in the financial statements. Therefore, their predictive capacity will be greater when adjusted for risk related to the firm's future cash flows (Werneck et al., 2010; Konchitchki et al., 2016; Penman, 2016). In addition, environmental factors, such as the distribution of firms' returns in relation to the industry (Henkel, 2009) or economic, political, social and normative uncertainties make it difficult to predict future returns, which indicates that the relationships observed ex-post may not be confirm, as noted (Becerra & Markarian, 2021; Campos et al., 2014; Mikosz et al., 2020; Muñoz et al., 2020).

The observed results weaken the idea that there is a "Bowman's Paradox", which, from the perspective of the finance literature, does not find logical support (Markowitz & Dijk, 2008) and reinforce that investors expect a higher return as the risk increases. In addition, they reinforce the role of

accounting in this process, but show that adverse factors, such as the environment of economic uncertainty and/or regulatory changes, can impair the ability of accounting numbers to explain stock returns.

The results contribute to the various economic agents that carry out analysis and evaluation of companies, such as credit analysts, accountants, financiers and researchers interested in the subject, as it demonstrates that the BP proposal in the Brazilian context is fallacious and that, probably, the observed results in Silveira (1990) and Vieira (2012) derive from the research design used, resulting in spurious relationships not investigated at the time.

Specifically, the literature published in major national journals has not confirmed the positive association between risk and return based on accounting data, which attribute such anomaly to data characteristics and/or institutional factors that weaken the application of traditionally used models (Mikosz et al., 2020; Muñoz et al., 2020; Perobelli et al., 2016; Pimentel, 2015).

Despite these contributions, the study needs to advance in explaining under what conditions, beyond the environment of economic uncertainty, a spurious relationship between risk and return metrics can emerge. About this, Henkel (2009) highlights that the asymmetric distribution of return proxies in relation to the sector can generate such noise. Furthermore, it is possible that factors such as competitiveness, evaluation and judgment biases affect both the estimation and the subsequent performance, so the ex-post in the positive relationship between risk and return would not be confirmed. As a suggestion for future research, the analysis of this pseudo-paradox should be made in order to understand more precisely which specific mechanisms result in an inversion in the ex-post correlations between risk and return.

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Appendix A. Operationalization of variables used in models

Variable	Description	Operationalization
Ret_{it}	Return on Shares Determined Quarterly	$ln(P_{t+1}/P_t)$ where P_{t+1} is the stock price in the last trading floor and P_t in the first trading floor of the quarter.
ROE_{it}	Return on PL in Period t	LL/μPL in μ fwas calculated between quarters.
$Beta_{it}$	Quarter Beta Coefficient	$(Cov(r_i,r_m)/(Var(r_{it})$ where r_i is the company daily return andr_m, IBOVESPA daily
σROE_{it}	ROE Coefficients of Variation	σROE/μROE whereσ e μ were calculated in each year using quarter data.
Tam_{it}	Firm Size	Natural logarithm of total assets
$NivEnd_{it}$	Indebtedness Level	(Total Liability)/(Total Assets)
IL_{liit}	Immediate Liquidity Index	Available/(Current Assets)
IFRSit	IFRS	Dummy variable with value 1 to post-IFRS period and 0 to pre-IFRS.
$CVida_{it}$	Life Cycle Stage	Dummy variable with value 1 to i-th Dickson Lifecycle Stage (2011) and 0 to others.
$SegEcon_i$	Economic Segment	$SegEcon_{it}$: Dummy variable with value 1 to i-th B3 economic segment and 0 to others.
$Trim_{it}$	Quarter	Dummy variable with value 1 to i-th quarter and 0 to others.

Source: Bowman (1980), Figenbaum & Thomas (1986), Silveira (1990), Nickel & Rodriguez, (2002), Henkel (2009), Vieira (2012), Sampaio et al. (2018).

Appendix B. Correlation matrix between variables used in models

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ret_{it}	(1)	1.000							
Ret_{it+1}	(2)	**0.043*** **	1.000						
β_{it}	(3)	-0.015	**0.040*** **	1.000					
β_{it+1}	(4)	-0.024	-0.001	**0.561*** **	1.000				
ROA_{it}	(5)	0.014	0.050***	0.058***	0.053***	1.000			
σROA_{it}	(6)	0.027***	0.034***	-0.013	-0.014	0.224***	1.000		
ROE_{it}	(7)	0.014	**0.023** **	-0.002	-0.002	0.115***	0.098***	1.000	
σROE_{it}	(8)	**0.021** **	-0.001	-0.022**	-0.020*	0.052***	0.592***	0.235***	1.000
Tam_{it}	(9)	-0.014	0.027***	0.371***	0.381***	0.307***	0.107***	0.034***	0.007
$NivEnd_{it}$	(10)	0.007	-0.045***	-0.032***	-0.035***	-0.417***	-0.142***	-0.047***	-0.049***
ILI_{it}	(11)	0.0104	0.037***	0.0137	0.025***	0.197***	0.064***	0.036***	0.028***
MAT_{it}	(12)	0.017*	0.022**	-0.013	-0.010	0.128***	0.016	0.048***	0.007
$INTR_{it}$	(13)	-0.010	-0.023**	0.002	0.007	-0.156***	-0.065***	-0.061***	-0.031***
$CRESC_{it}$	(14)	-0.007	-0.005	0.026**	0.022**	0.069***	0.032***	-0.002	0.009
$TURB_{it}$	(15)	-0.003	0.017*	-0.019*	-0.013	-0.042***	0.002	0.008	0.008
$DECL_{it}$	(16)	-0.008	-0.041***	0.015	-0.004	-0.111	-0.007	-0.032***	-0.001
BI_i	(17)	-0.002	-0.025**	-0.053***	-0.059***	-0.022**	-0.026**	-0.026**	-0.018*
COM_i	(18)	0.011	0.002	0.045***	0.041***	0.016	-0.006	-0.006	-0.014
CC_i	(19)	-0.004	-0.000	0.057***	0.053***	-0.013	0.009	-0.012	-0.006
MB_i	(20)	0.008	0.001	0.074***	0.077***	-0.013	-0.001	-0.032***	-0.018*
PGB_i	(21)	-0.030***	-0.017	0.070***	0.066***	-0.114***	-0.030***	0.006	0.001
		(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Tam_{it}	(9)	1.000							
$NivEnd_{it}$	(10)	-0.040***	1.000						
ILI_{it}	(11)	-0.014***	-0.474***	1.000					
MAT_{it}	(12)	0.059***	-0.117***	-0.0005	1.000				
$INTR_{it}$	(13)	-0.107***	0.127***	-0.087***	-0.277***	1.000			
$CRESC_{it}$	(14)	0.129***	-0.009	0.081***	-0.412***	-0.174***	1.000		
$TURB_{it}$	(15)	-0.094***	0.032***	0.008	-0.456***	-0.193***	-0.287***	1.000	
$DECL_{it}$	(16)	-0.037***	0.037***	-0.042***	-0.191***	-0.081***	-0.120***	-0.133***	1.000
BI_i	(17)	-0.193***	0.084***	-0.002	-0.007	-0.043***	0.040***	-0.000	0.004
COM_i	(18)	0.134***	-0.015	-0.001	0.031***	0.003	-0.007	-0.016	-0.029***
CC_i	(19)	-0.087***	0.017*	-0.057***	-0.055***	0.093***	-0.101***	0.054***	0.072***
MB_i	(20)	0.062***	-0.028***	0.058***	0.045***	-0.034***	-0.014	0.004	-0.034***
PGB_i	(21)	0.087	0.010	0.074***	-0.034***	-0.049***	0.033***	0.016	0.050***
		(17)	(18)	(19)	(20)	(21)			
BI_i	(17)	1.000							
COM_i	(18)	-0.059***	1.000						
CC_i	(19)	-0.334***	-0.087***	1.000					
MB_i	(20)	-0.171***	-0.044***	-0.252***	1.000				
PGB_i	(21)	-0.080***	-0.021**	-0.118***	-0.061***	1.000			

Source: Research data.