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Do companies that use derivatives for hedging reduce their risks?

Empresas que usam derivativos para hedge conseguem uma redução do risco?

¿Las empresas que usan derivados para cobertura logran la reducción del riesgo?

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Abstract
The purpose of this study is to evaluate the impact of using derivatives to hedge risks by companies with shares listed on the São Paulo Securities Exchange ([B]³). Employing a sample of 359 firms analyzed between 2010 and 2017, separated between users and non-users of derivatives by means of a dummy variable, panel regression was applied, with a risk measure acting as the dependent variable and size, leverage, book-to-market ratio, liquidity and use or not of derivatives serving as the independent variables. The results obtained by the models were submitted to robustness tests and indicated, as expected, that the use of derivatives for hedging was associated with a reduction of the risk of price variations in the period studied, as has been verified in developed countries. This study can shed light on the use of derivatives before the advent of IFRS 9 on January 1, 2018, regulating the classification and disclosure of derivative financial instruments. Besides this, the study can help managers perceive the impact of adopting hedging policies in the stock market.
Keywords: Derivative contracts; Hedge; Risk; Corporate finance

Resumo
Este estudo se propôs a avaliar o impacto da utilização de derivativos para fins de proteção (*hedge*) no risco das companhias de capital aberto negociadas na Bolsa de Valores de São Paulo ([B]³). A partir de uma amostra composta por 359 empresas analisadas entre os anos de 2010 e 2017 e separadas entre usuárias e não usuárias de derivativos por meio de variável *dummy*, foi empregada a metodologia de regressão de dados em painéis, tendo como variável dependente o risco e como variáveis independentes o uso ou não de derivativos, o tamanho, a alavancagem, o *book-to-market* e a liquidez. Os resultados obtidos pelos modelos passaram por testes de robustez e indicaram, assim como era esperado, que o uso de derivativos para *hedge* está acompanhado de uma redução no risco das companhias, assim como verificado em países desenvolvidos. Diante disso, este estudo poderá auxiliar na compreensão dos reflexos do uso de derivativos antes das alterações implementadas pela norma que regulamenta a contabilização e a divulgação dos instrumentos financeiros derivativos (IFRS 9), que passou a vigorar em 1º de janeiro de 2018. Além disso, o estudo contribui para que os gestores de empresas percebam o impacto da adoção de políticas de *hedge* no mercado acionário.
Palavras-chave: Contratos derivativos; Hedge; Risco; Finanças corporativas

Resumen
Este estudio tuvo como objetivo evaluar el impacto del uso de derivados con el fin de cubrir el riesgo de las empresas que cotizan en la Bolsa de Valores de São Paulo ([B]³). A partir de una muestra de 359 compañías analizadas entre 2010 y 2017 y separadas de usuarios y no usuarios de derivados utilizando una variable ficticia, la metodología de regresión se utilizó en datos de panel, con el riesgo como variable dependiente y como variables independientes el uso o no de derivados, tamaño, apalancamiento y liquidez. Los resultados obtenidos por los modelos se sometieron a pruebas de robustez e indicaron, como se esperaba, que el uso de derivados para cobertura está acompañado por una reducción en el riesgo de las compañías, como se ve en los países desarrollados. Por lo tanto, este estudio puede ayudar a comprender los efectos del uso de derivados antes de los cambios implementados por la norma que regula la contabilidad y divulgación de instrumentos financieros derivados (NIIF 9), que entró en vigencia el 1 de enero de 2018. Además, este estudio contribuye a que los gerentes de las empresas se den cuenta del impacto de la adopción de políticas de cobertura en el mercado de valores.
Palabras clave: Contratos derivados; Cobertura; Riesgo; Finanzas corporativas

1 Introduction

The use of financial instruments for hedging is one of the main tools used by firms to manage the risks related to price variations. In this respect, Freeman, Cox and Wright (2006) found that a substantial portion of firms use derivatives to manage their risks. Additionally, Bartram (2019) highlighted that the majority of large nonfinancial firms use financial derivatives. In this line, according to Saito and Schiozer (2007), the risks that most influence the use of derivatives by listed Brazilian companies are, in decreasing order, exchange rate, interest rate and commodity prices. Since the use of derivatives can integrate firms' financial policies and help them manage the risks tied to the variation of prices, the objective of this study is to ascertain the relationship between the use of derivatives for hedging and the reduction of the risks faced by companies with shares listed on the São Paulo Securities Exchange ([B]³).

Despite the importance of using derivatives as one of the main instruments to hedge risks by large, medium and even small firms, there is still room to study this use in the Brazilian context, since until the middle of the last decade it was difficult to obtain information about the corporate use of derivatives. Thus, this study expands the national literature by examining the relationship between the use of derivatives and the impact on the risk perception of firms. The study can also contribute by helping managers perceive the impacts of adopting hedging policies on firms' stock market performance.

Additionally, the theme is opportune because International Financial Reporting Standard (IFRS) 9 took effect in Brazil on January 1, 2018, by means of Technical Pronouncement 48, issued by the Accounting Pronouncements Committee, while the analysis carried out in this study (between 2010 and 2017) sheds light on the behavior of the market regarding the use of derivatives before the adoption of the new standard. Besides this, as stressed by Bartram (2019), an interesting and important question to investigate is the effect of the new standard on corporate risk, since derivatives are very versatile financial instruments, which can be used both to hedge risks and for speculation (often disguised as hedging), as previously analyzed by Hentschel and Kothari (2001). Therefore, the basic question addressed by this work is: **Do companies that use derivatives for hedging reduce their risks?**

Many studies have been conducted to analyze the impacts of hedging on firms around the world. Allayannis and Weston (2001), Jin and Jorion (2006), Machado (2007), Maekay and Moeller (2007), Rossi Júnior and Laham (2008), Bartram, Brown and Conrad (2011), Serafini and Sheng (2011) and Ribeiro, Machado and Rossi Júnior (2013) all have analyzed the use of derivatives and their impacts on the value of firms. Campello et al. (2011) and Coutinho, Sheng and Lora (2012) studied the impact of using financial derivatives on the cost of capital, while Gay, Lin and Smith (2011) and Zhou and Wang (2013) examined the use of derivatives for hedging and the relationship with both the cost of capital and firm value. These studies will be discussed in more detail in the next section.

Financial derivatives (future/forward, swap and option contracts) are among the most common instruments used for protection against risks of future price variations that affect either revenues or costs. However, they can also be used for speculative purposes. Therefore, Novaes and Oliveira (2005), Chernenko and Faulkender (2011) and Lopes, Schiozer and Sheng (2013) analyzed the use of financial derivatives for speculation. Rossi Júnior (2013) went further, and indicated the existence of firms classified as selective hedgers – users of derivatives that change their volume of instruments according to their exposure to exchange rate risk. Other studies have focused on the complexity of derivatives, such as those of Campbell, Downes and Schwartz (2015), Chang, Donohoe and Sougiannis (2016) and Antônio et al. (2019). In this line, Antônio et al. (2020) reported that the use of derivative instruments for hedging has not yet been completely incorporated in the rating agencies' models.

Based on the studies mentioned above, and in particular those covering the Brazilian market, we identified an opportunity to investigate the impact of using derivatives for hedging risks to ascertain whether

the behavior of Brazilian firms is similar to that of companies in developed markets. Although the general findings have been that the use of derivatives for hedging is positive for companies, other methods exist that can be applied to verify whether or not the results diverge from what has been presented to date, and of course are relevant. Therefore, this study sought to analyze the impact of using derivatives on the risks of Brazilian firms with shares listed for trading in the [B][3] between 2010 and 2017. This study is also opportune as an alert to users of accounting information of the tenuous line between speculation and protection, in line with the discussion of Bartram (2019), i.e., derivatives can be effective and efficient tools to hedge corporate risks, but they can also be used for speculation, generally under the guise of hedging.

The preliminary hypothesis here is that the use of derivatives as a form protection has a negative relationship with the risks faced by firms. In other words, firms that use derivatives have lower risks compared with those that do not use these financial instruments. That expectation is supported by the references mentioned so far and the reasoning that by using hedging, firms are reducing uncertainties about their bottom-line results, and thus obtaining more trust from investors and mitigating their risks. This occurs due to the reduction of the volatility of revenues, costs and/or profits of companies that used derivatives for hedging purposes.

The results obtained by the models applied were submitted to robustness tests, indicating (as expected) that the use of derivatives for hedging was accompanied by a reduction of risk of the firms sampled in the period studied. Therefore, this work can shed light on the use of derivatives before the alterations implemented by IFRS 9, regulating the classification and disclosure of derivative financial instruments, which took effect on January 1, 2018. Finally, this study contributes to the comprehension of managers about the impact of hedging policies on the stock market performance, and consequently the value of firms.

This study is organized in five sections including this introduction, which is followed by a review of the literature on the theme, description of the methodology, analysis of the results and final considerations.

2 Literature Review

Articles devoted to analyzing the use of derivatives by firms around the world, for the purpose of verifying the management of risks, the impact on firm value and cost of capital, and the purpose of their use (hedging or speculation), have in general found a positive impact, especially when used for protection. Various studies have indicated that the use of derivatives to manage risks is viewed favorably by investors, such as those of Koonce, Lipe and McAnally (2008) and Koonce, Miller and Winchel (2015). In turn, Antônio et al. (2019) reported that derivatives can be used to protect firms from negative outcomes due to price variations and to provide more stable results.

With respect to the fact that derivatives are not always used for hedging, the study of Rossi Júnior (2013) can be mentioned, which analyzed the purpose of using derivatives by firms during the financial crisis of 2008, based on a sample of 98 listed Brazilian companies. The author found that 60 used derivatives for hedging, 22 were classified as selective hedgers, and 16 as speculators. The method used was to measure the risk exposure of each firm, weighted by use of derivatives.

Also, on the theme of the use of derivative instruments by Brazilian firms, Novaes and Oliveira (2005), Rossi Júnior (2007), Saito and Schiozer (2007) and Lopes, Schiozer and Sheng (2013) all investigated the objective of using financial derivatives, whether for hedging or speculation. Novaes and Oliveira (2005) analyzed 23,767 currency swap contracts of companies and financial institutions in 2002 and identified that 42 listed corporations used the contracts for hedging and 51 for speculation. The authors also found a positive correlation between the existence of foreign debt and firm size. Finally, they observed that the existence of export revenues positively affected the probability speculation.

Rossi Júnior (2007) analyzed nonfinancial firms that used currency derivatives in the period from 1996 to 2004 and identified differences in the reasons for using those instruments and the volume used. The authors found that large firms with greater exposure to foreign currencies and thus higher volatility of the financial cost in local currency were more likely to use exchange rate derivatives.

In a study comparing Brazil with other countries, Saito and Schiozer (2007, p. 97) stated that “as verified in the United States and Germany, the evidence suggests that the managers of Brazilian nonfinancial companies mainly use derivatives for the purpose of managing risk, not for speculative purposes.” Further according to the authors, the classes of risks that have the greatest impact on the decision to use derivatives in the period studied were exchange rates, interest rates, commodity prices and others. Subsequently, Lopes, Schiozer and Sheng (2013) found, from analyzing a sample of 29 thousand over-the-counter transactions contracted by nonfinancial firms between 2003 and 2011, that a strong speculative trend held sway from 2003 to 2008, while this behavior was not identified from 2009 to 2011.

With respect to the use of financial derivatives and their purposes, the results of the papers mentioned above indicate greater usage for hedging than for speculation. Hence, it is logical to argue that the impact of their use on balance has been positive, since hedging seeks to protect companies from the impacts (negative or positive) of their operations, reducing their uncertainties and exposures related to market frictions (DEMARZO; DUFFIE, 1995; BROWN, 2001; DADALT; GAY; NAM, 2002; ARETZ; BARTRAM, 2010; MAGNANI, 2017). In general, this can be observed in the majority of the studies analyzed, although articles

exist that did not conclude there was a gain from using financial derivatives for hedging (CLARK; JUDGE; MEFTEH, 2006; JIN; JORION, 2006; MACHADO, 2007; LIN; SMITH, 2007; NGUYEN; FAFF; HODGSON, 2010).

Of the papers analyzed, two did not find any advantages of using derivatives in relation to not using them. The first is Hentschel and Kothari (2001), who analyzed whether firms using derivatives were reducing or increasing their risks. Based on a sample of 425 large American firms, the authors found no economically significant effects on companies by using derivatives. In turn, Jin and Jorion (2006) studied the impact of using hedging instruments on 119 American companies in the oil and gas sector and did not find evidence of the effect of their use on firm value. One of the possible reasons for this result, according to the authors, was the fact that due to the nature of the oil and gas industry and the easy access to hedging instruments related to this sector, it is easy for external investors to identify risks and protect themselves, so that the use of hedging by companies does not provide any advantage, since investors can obtain their own protection.

Several articles have examined the impact on market value of using derivatives, such as Berkman and Bradbury (1996), Allayannis and Weston (2001), Machado (2007), Rossi Júnior and Laham (2008), Bartram, Brown and Conrad (2011), Serafini and Sheng (2011) and Ribeiro, Machado and Rossi Júnior (2013).

Berkman and Bradbury (1996) investigated firms in New Zealand and applied the fair value instead of the notional value of derivatives, finding support for the hypothesis that the use of derivatives was positively related with the existence of growth options.

Allayannis and Weston (2001) analyzed 720 large American firms between 1990 and 1995 and found a positive relationship between firm value and the use of foreign currency derivatives. The hedging premium found was statistically and economically significant for firms with exposure to exchange rates. The authors also found consistent evidence that hedging leads to growth of firm value, and that firms that adopt a hedging policy experience growth of their value greater than that of firms that remain unprotected, while firms that begin using derivatives and then cease doing so experience reduction of their value in comparison with firms that remain protected.

Based on a sample of nonfinancial companies in 47 countries, Bartram and Brown (2011) found strong evidence that the use of derivatives both reduces the total risk and the systematic risk of firms. This study's findings are consistent with those of Allayannis and Weston (2001), who found the use of derivatives to be associated with a hedging premium.

Of the Brazilian studies of the impact of using derivatives on firm value, Machado (2007) analyzed 33 companies producing basic materials listed on the Bovespa (predecessor of [B^3]) during the period from 2001 to 2006; Rossi Júnior and Laham (2008) employed a sample of companies also listed on the Bovespa from 1996 to 2005; Serafini and Sheng (2011) analyzed the 48 most liquid nonfinancial firms listed on the Bovespa from 1999 to 2007, and Ribeiro, Machado and Rossi Júnior (2013) investigated nonfinancial companies listed on the same exchange in the period between 2004 and 2007.

In all those studies, the authors found evidence of a positive correlation between the use of derivatives and higher firm value, except for Serafini and Sheng (2011), who only found this correlation in firms that just started using derivatives. Given the periods of the information analyzed in these Brazilian studies, limitations exist regarding the use of financial derivatives because until 2018 there were no rules on detailed disclosure, leaving the decision up to the discretion of each firm regarding relevance.

The studies mentioned so far allow inferring that the chief objective of contracting derivatives is to hedge risk. It is still important to mention other studies in this respect, namely Brown (2001), Guay and Kothari (2003), Maekay and Moeller (2007), Carneiro and Sherris (2008), Chen (2011) and Zhou and Wang (2013).

As in the case of firm value, the examinations carried out in the cited articles, with focus on risk management, in general found positive results for the use of derivatives to reduce risk. Of the reservations expressed by the authors, the work of Guay and Kothari (2003) can be mentioned, who concluded that the use of derivatives only covered a small portion of the total risks of large nonfinancial companies, while Carneiro and Sherris (2008) described the limitations of previous studies regarding the level of disclosure of companies. Chen (2011) analyzed the risk of more than 5,000 hedge funds and observed that those using derivatives had on average 27% less risk.

With respect to the association of risk management through derivatives and the cost of capital, Gay, Lin and Smith (2011) identified a reduction of that cost, attributable both to the low market beta and the small-minus-big (SMB) beta. The management of risk can alter the expected cash flow, and hence increase the value of the firm. The authors identified that firm size was positively correlated with hedging decisions, while having greater liquidity was negatively correlated. The results supported the notion that firms use derivatives to reduce financial risk, but that this risk has a systematic component that is priced by the market. They found evidence of lower cost of capital of new users of derivatives, more noteworthy in the 1992-1996 period, attributable to reductions of firms' market and SMB betas.

Allayannis and Ofek (2001) used a sample of S&P 500 nonfinancial firms for 1993 and found evidence that firms using derivatives to hedge currency risk achieved a significant reduction of that risk, suggesting that these firms used derivatives for hedging more than for speculation in the currency market. They also found that the level of exposure to exchange rates (due to foreign sales and trade) is an important factor for the decision to contract protection.

By examining the relationship of the use of derivatives and the impact the interest rate spreads on borrowings, Campello et al. (2011) showed that hedgers typically pay lower spreads and are less likely to have capital expenditure restrictions in their loan contracts. Therefore, firms that manage their risks have greater facility to obtain external financing for investments, with lower interest rates or lesser restrictions on capital investments in their loan contracts.

In Brazil, the level of disclosure was one of the limiting factors of studies on the use of derivatives until the middle of the last decade, but Deliberation 566/2008 and Instruction 475/2008, both issued by the Brazilian Securities Commission (CVM), changed this scenario. Murcia and Santos (2009) analyzed the impacts of those normative acts on the quality of disclosure of listed companies in Brazil based on the financial statements for 2007 and 2008, since the statements for those two years were subject to different accounting standards, allowing comparison of statements based on those different standards.

They concluded that the disclosure of derivative financial instruments was better in 2008, but that firms did not fully disclose all the information required by the new standards, and it was not correct to state that the standards prompted companies to use derivatives only for hedging, as indicated by the losses suffered in 2008 due to speculative transactions with those instruments.

In a case study of the financial statements of the food company Sadia S. A. before and after the issuance of CVM Deliberation 566/2008 (statements of December 31, 2008), Santos et al. (2010) identified an improvement of the accounting disclosures, but there was still lack of disclosure of all the risks to which the company was exposed when using hedging. Hence, they concluded that the company still did not disclose "sufficient information for all stakeholders to understand the risk of the company when using financial derivatives improperly or incorrectly" (p. 192).

The general perception is that the use of derivatives has a positive impact on firms that use them, provided this is for protection. According to Lopes, Schiozer and Sheng (2013), in the period from 2003 to 2008, many companies used derivatives for speculation, causing a negative impact on their results, and in some cases causing huge losses, occurrences that probably affected the issuance of CVM Deliberation 566/2008 and CVM Instruction 475/2008, requiring the presence, although only in notes to the financial statements, of disclosure of the use of derivatives along with information on their notional value.

Of the works analyzed, the two most pertinent here are those of Allayannis and Ofek (2001) and Bartram, Brown and Conrad (2011), both of which are similar to the present study, and found a reduction of risks and thus improvement of results, contrary to the finding of Allayannis and Weston (2001) that the use of derivatives is associated with a "hedging premium". The next section describes the methodology, database, metrics, hypotheses and variables.

In light of the studies summarized, the preliminary hypothesis of this study is that the use of derivatives for protection is negatively correlated with risk, i.e., firms that use derivatives tend to have lower risk compared to firms that do not use these financial instruments. That expectation is based on the general consensus of the references mentioned and the reasoning that by using hedging, companies are reducing the volatility of their revenues, costs and profits, thus acquiring greater trust of investors and mitigating their risks.

3 Research Method

3.1 Data

To investigate whether the use of derivatives reduces the risk of firms, we gathered data on 359 firms with shares traded on the [B][3] exchange. The data on the use of derivatives were obtained from the explanatory notes to the financial statements posted at the CVM website. The data referring to the other variables were collected from the Economática® database and organized into an unbalanced panel between 2010 and 2017. The study period was defined because starting in 2010 there was convergence in Brazil to International Financial Reporting Standards (IFRS), and in January 2018 the rules on accounting for derivative financial instruments were altered by IFRS 9. Besides these aspects, we followed criteria similar to those adopted previously by Antônio et al. (2020). Table 1 presents the variables used and their respective information sources.

Table 1 – Sources of data

Variables	Construction of the Variable (Formula)	Sources
Risc	Beta of the CAPM model	Economática®
Total Notional Value of Derivatives	Ln (notional value of derivative contracts)	Explanatory Notes
Total Assets	Ln (total assets)	Economática®
Leverage	Quotient of current liabilities to total liabilities ($CL_{i,t}$ / $TL_{i,t}$)	Economática®
Book-to-Market	Book price over market price	Economática®
Liquidity	Current assets + long-term assets over current liabilities + long-term liabilities ($CA_{i,t}$ + $LTA_{i,t}$) / ($CL_{i,t}$ + $LTL_{i,t}$)	Economática®

Source: Own Elaboration.

The derivatives used by the companies are those for the purpose of hedging interest rates and exchange rates. The respective contracts were denominated in various currencies, and were converted to Brazilian currency (the real, R$) at the exchange rate of the last day of the respective year.

The panel database contained 1,192 observations (data collected annually) of 282 firms. The companies sampled were nonfinancial, since financial institutions are generally the main counterparties in hedging contracts.

3.2 Panel data methodology

The panel data methodology has some benefits in comparison with the other econometric methods applied to cross sectional data, such as: i) increase of degrees of freedom with rising number of observations; and ii) reduction of multicollinearity of the variables (HSIAO, 1986). Besides these aspects, according to Wooldridge (2006) and Gujarati and Porter (2011), the estimation methods with panel data are classified as having pooled effects, fixed effects or random effects. Therefore, it was necessary to choose the most adherent model by applying the Chow, Breusch-Pagan, and Hausman statistical tests.

The first test applied was the Chow test, which checks the null hypothesis (H_0) that the use of the model estimated with pooled data is preferable for estimation with fixed effects. The second was the Breusch-Pagan test, in which the null hypothesis is that the model estimated by the pooled data method is preferable to the random-effects method. The third test was that of Hausman (1978), which involves the null hypothesis that the random-effects method is preferable to the method with fixed effects.

After estimating the model, we applied the standard econometric tests for verification of the statistical assumptions of the estimated parameters. Among these tests we used the test of the existence of multicollinearity by means of the variance inflation factor (VIF); the Breusch-Pagan test of the homoscedasticity of the residuals of the model; and the serial autocorrelation test of Wooldridge applied to panel data.

Additionally, for the purpose of examining the consistency of the results found, we applied the instrumental variable method and the dynamic panel estimated by the generalized method of moments (GMM), as developed by Arellano and Bond (1991). The first seeks to reduce the endogeneity related to omitted variables (ALLAYANNIS et al., 2012) and the second deals with the concern about the dynamic endogeneity of the variables (CHEN; KING, 2014).

As the instrumental variable of the model, we used the tax benefit of debt variable, constructed as the quotient between the tax benefit of debt (calculated as 34% of the financial expenses in the period) and the total assets of each firm. This variable was used previously by Géczy, Minton and Schrand (1997), Rossi Júnior and Laham (2008), and Fauver and Naranjo (2010), based on the argument that it is a good instrumental variable for the hedging construct.

Finally, to test for possible problems of dynamic endogeneity we applied the test of Wooldridge for serial autocorrelation applied to panel data, in which the null hypothesis is the absence of serial autocorrelation. Below we present the hypothesis based on the literature review and the proposed model.

3.3 Model and variables

Given the main objective is to verify whether firms that contract hedging by means of derivatives to protect against fluctuations of interest rates and exchange rates indeed manage to reduce their risks, and based on Allayannis and Ofek (2001) and Bartram, Brown and Conrad (2011), we test the following hypothesis:

$$H_1: Greater\ use\ of\ hedging\ is\ associated\ with\ lower\ risk\ of\ firms.$$

For this purpose, we apply the model denoted by Equation 1 below.

$$\mathrm{Risk}_{i,t} = \beta_0 + \beta_1 \mathrm{Hedge}_{i,t} + \beta_2 \mathrm{Size}_{i,t} + \beta_3 \mathrm{Leverage}_{i,t} + \beta_4 \mathrm{Liquidity}_{i,t} + \beta_5 \mathrm{Book-to-Market}_{i,t} + a_i + \varepsilon_{i,t} \quad (1)$$

Where:

- $\mathrm{Risk}_{i,t}$: the risk variable is proxied by the beta of the CAPM estimated for each firm in each year.
- $\mathrm{Hedge}_{i,t}$: denotes the use of hedging of each firm in each year in the panel dataset. The variable is represented by two proxy variables. The first consists of the quotient between the total notional value of derivatives contracts of each firm in each year and the total value of assets each year. The reference literature uses this variable to represent the degree of protection acquired by each firm. The second variable is a dummy that assumes value of 1 if the firm used a derivative financial instrument for protection in a particular year and 0 otherwise.
- $\mathrm{Size}_{i,t}$: represents the size, measured by the natural logarithm (ln) of total assets.

- $\text{Leverage}_{i,t}$: represents the indebtedness of each firm in each year, constructed by dividing the Current liabilities + long-term liabilities by total liabilities (current liabilities + long-term liabilities + stockholders' equity).
- $\text{Liquidity}_{i,t}$: represents the general liquidity of the firm, constructed by dividing the sum of current assets plus long-term assets by the sum of current liabilities and long-term liabilities.
- $\text{Book} - \text{to} - \text{Market}_{i,t}$: is a proxy for the growth opportunities of the firm, constructed by dividing the accounting (book) value by the market value of the firm's shares.

It is important to mention our adoption of the Ibovespa as the index to obtain the value of beta as a proxy for the behavior of the Brazilian stock market. This is in line with the previous studies of Antônio, Sticca and Ambrozini (2018) and Moshirian, Ng and Wu (2009). We also stress that the adjusted market return model is a simplification of the market model. The model's variable of interest is Hedge and a negative sign is expected of the coefficient β_1. Thus, if the sign found is statistically significant and negative, our hypothesis will not be rejected. In turn, the variables Size, Leverage, Liquidity and Book-to-Market are control variables included in the model.

The next section contains the descriptive statistics, the statistical tests inherent to the panel data method, the basic econometric assumptions of the estimated models and the corresponding results.

4 Analysis of the Results

4.1 Descriptive statistics

Table 2 below reports the descriptive statistics used here, such as: the total number of observations of each variable, the average for the entire period and corresponding standard deviation, and the minimum and maximum for the period. It can be observed from the mean value of the dummy variable for the firms using derivatives that approximately 45% of the 286 companies composing the dataset for the entire period used corporate hedging. With respect to the notional value, the value of the derivatives contracted represented about 4% of firms' total assets during the entire period.

However, this variable has a relatively high standard deviation, suggesting high variability of this variable in relation to the firms in the sample, meaning that the firms have wide disparity in their hedging policies. Table 2 provides a preliminary view of the behavior of the firms that used derivatives in each economic sector studied. It can be seen that on average, half of the firms used derivatives (dummy variable near 0.50), and this distribution is relatively homogeneous across sectors.

Table 2 – Descriptive statistics

Part A – Descriptive statistics of the entire sample

Variables	Obs.	Mean	Standard Dev.	Minimum	Maximum
		Dependent			
Beta (Risk)	1.247	0,651	0,615	-1,649	3,257
		Independent			
Notional value	2.205	0,04	0,12	0,00	4,07
Derivatives dummy	2.205	0,45	0,50	0,00	1,00
Size	2.184	13,89	2,90	-0,40	20,62
Leverage	2.184	104,65	524,97	0,00	18910,19
Liquidity	2.173	22,07	190,92	0,00	4109,30
Book-to-Market	1.463	2,40	7,85	-25,58	153,87

Part B – Descriptive statistics grouped by sector

Sector: Commerce

Variables	Obs.	Mean	Standard Dev.	Minimum	Maximum
Risk	120	0.746	0.564	-0.864	2.930
Notional value	252	0.045	0.262	0.000	4.066
Derivatives dummy	252	0.361	0.481	0.000	1.000
Ln assets	251	11.967	4.545	-0.405	19.713
Leverage	251	199.580	1.258.353	0.000	18.910
Liquidity	250	47.274	268.739	0.000	3.209
Book-to-Market	130	3.017	3.764	-5.896	19.274

Part B – Descriptive statistics grouped by sector					
Sector: Non-cyclical consumption					
Variables	**Obs.**	**Mean**	**Standard Dev.**	**Minimum**	**Maximum**
Risk	a	0.545	0.668	-0.472	2.380
Notional value	48	0.102	0.180	0.000	0.668
Derivatives dummy	48	0.333	0.476	0.000	1.000
Size	46	13.147	4.619	2.585	16.474
Leverage	46	36.508	33.630	0.024	117
Liquidity	46	185.660	702.860	0.665	4.109
Book-to-Market	34	0.055	2.980	-16.072	2.269
Sector: Electricity					
Variables	**Obs.**	**Mean**	**Standard Dev.**	**Minimum**	**Maximum**
Risk	120	0.455	0.511	-1.173	1.811
Notional value	284	0.027	0.061	0.000	0.457
Derivatives dummy	284	0.525	0.500	0.000	1.000
Size	284	14.823	2.583	2.773	18.964
Leverage	284	63.112	65.733	0.000	621
Liquidity	277	4.333	20.088	0.041	307
Book-to-Market	190	1.612	1.175	-1.639	6.977
Sector: Industry					
Variables	**Obs.**	**Mean**	**Standard Dev.**	**Minimum**	**Maximum**
Risk	705	0.721	0.676	-1.649	3.257
Notional value	1126	0.039	0.087	0.000	1.113
Derivatives dummy	1126	0.483	0.500	0.000	1.000
Size	1120	14.143	2.071	4.533	20.618
Leverage	1120	117.371	421.873	1.681	7.037
Liquidity	1120	3.096	26.701	0.005	877
Book-to-Market	799	1.806	6.464	-25.575	153.869
Sector: Services					
Variables	**Obs.**	**Mean**	**Standard Dev.**	**Minimum**	**Maximum**
Risk	246	0.566	0.416	-0.912	1.722
Notional value	425	0.032	0.078	0.000	0.817
Derivatives dummy	425	0.412	0.493	0.000	1.000
Size	413	14.169	2.319	2.544	18.297
Leverage	413	54.474	22.801	0.081	139
Liquidity	413	10.760	79.176	0.133	1.236
Book-to-Market	282	4.359	10.821	-6.511	149.627
Sector: Telecommunications					
Variables	**Obs.**	**Mean**	**Standard Dev.**	**Minimum**	**Maximum**
Risk	30	0.227	0.615	-1.417	1.220
Notional value	70	0.010	0.028	0.000	0.189
Derivatives dummy	70	0.329	0.473	0.000	1.000
Size	70	11.803	4.963	3.216	18.448
Leverage	70	70.088	110.530	0.000	546
Liquidity	67	276.073	665.295	0.017	3.273
Book-to-Market	28	5.011	26.926	-22.359	140.510

Source**:** Own Elaboration.

4.2 Results of the proposed model

In this subsection we present the results of the proposed model estimated by the panel data, dynamic panel data and instrumental variable methods. First, Table 4 shows the results of the statistical tests for choosing the model for estimation. In all cases the tests indicate that estimation with robust random effects is more adequate in the panel data method. The serial autocorrelation statistic rejects the null hypothesis of absence of serial autocorrelation, making it necessary to estimate the models by the dynamic panel data method according to the generalized method of moments (GMM).

Table 4 – Statistical tests of the models

Models	1	2
Breusch-Pagan test / Cook-Weisberg test for heteroscedasticity	6.06	8.63
P-value	0.0139	0.0033
Mean VIF	1.08	1.17
Wooldridge serial autocorrelation test for panel data	337.01	338.03
P-value	0.00	0.00
Chow test	4.95	5.14
P-value	0.000	0.000
Breusch-Pagan test	496.66	504.73
P-value	0.000	0.000
Robust Hausman test	1.09	10.01
P-value	0.955	0.075

Source**:** Own Elaboration.

Table 5 below reports the results of the models estimated by the panel data, dynamic panel data and instrumental variables methods. In both models 1 and 2 there is a negative and statistically significant relationship of the firms' beta, except for the estimation of the dynamic panel for model 2, which is not statistically significant.

Further regarding this variable, but with a different dependent variable, the models estimated by dynamic panel data and instrumental variables point to a positive and statistically significant relationship with stock price volatility. It can thus be inferred that a greater degree of hedging is associated with greater stock price volatility. This can be explained by the complexity of the information about the use of derivatives. Because of this complexity, users may not completely incorporate the information regarding the protection provided by derivative financial instruments.

In relation to the dummy variable representing derivatives, the model estimated by the panel data method suffers from serial autocorrelation problems. Analysis of the models estimated by dynamic panel data and instrumental variables shows no statistically significant relationship with the firms' betas, while with respect to the stock price volatility, there is a negative and significant relationship, indicating that during the period studied, the firms that used derivative financial instruments for hedging managed to minimize the volatility of their stock prices.

Table 5 – Results of the estimates of the proposed models (Model 1)

Dependent variable:	**Risk**					
Notional value	-0.2610*	-0.1807**	-0.2615**			
Derivatives dummy				-0.1345**	-0.1157	-0.1331***
Risk (-1)		0.3283***			0.3434***	
Size	0.0691***	-0.0140	0.0691***	0.0789***	0.0334	0.0787***
Leverage	0.0003	0.0007**	0.0003	0.0003	0.0008***	0.0003
Liquidity	-0.0061	0.0071	-0.0060	-0.0068	0.0079	-0.0067
Book-to-Market	-0.0066***	-0.0015*	-0.0066***	-0.0066***	-0.0018	-0.0066***
Constant	-0.3808	0.6190	-0.3803	-0.4548	-0.0689	-0.4536*
Models		1			2	
Estimation of the model:	**RobRE**	**DynP**	**IV**	**RobRE**	**DynP**	**IV**
Observations	1192	829	1192	1192	829	1192
R²	0.047		0.047	0.037		0.037
F-statistic						
Chi-square statistic	33.92***	38.58***	33.92***	31.9***	56.62***	33.96***

Legend:
Estimation of the models: RobRE: Robust random effects; DynP: Dynamic panel estimated by GMM; IV: Instrumental variables with random effects.
Level of statistical significance: *** 1%; ** 5%; e * 10%.

Source**:** Own Elaboration.

The test statistic of the coefficient β_1, which accompanies the variable Hedge, is negative and significant. This allows inferring in favor of the research hypothesis that greater use of hedging would be associated with lower risk. This result is in line with those obtained by Allayannis and Ofek (2001) and Bartram, Brown and Conrad (2011). Furthermore, Bartram (2019) indicated that firms that use derivatives in countries with strong creditor rights enjoy smaller reductions in their stock price volatility than is the case of firms in countries with easier access to derivatives.

Our results also corroborate those of Koonce, Miller and Winchel (2015), that the use of derivatives to manage risks is seen positively by investors, with reflection on firms' betas based on the covariance between firms' returns and market returns. In a complementary manner, our results are also in line with the finding of Bartram (2019), that companies mainly use derivatives to reduce risk.

Antônio et al. (2019) suggested that derivatives can be used for protection and to achieve more stable results. Based on this, we expand the results observed here and stress that reduced risk can be related to the greater stability of results of firms that use hedging, reflected in a lower perception of risks about the bottom-line results.

With respect to the control variables, we first note the positive and significant (at 1%) coefficient of the variable Size, indicating that larger companies tend to incur greater risk. For the control variable Leverage, the coefficient is also positive and significant at 1%, demonstrating that greater leverage is associated with a higher risk level. In contrast, the control variable Liquidity has a negative but not significant coefficient, so no statistical inference can be obtained. Nevertheless, this indicates adherence of the model, since intuition says that greater liquidity should be associated with lower risk.

Regarding the r^2 value of the models, it was approximately 5%, meaning that the models estimated with the independent variables hedge, size, leverage and liquidity managed to explain 5% of the variation of the risk faced by companies (dependent variable).

With respect to the econometric assumptions, Table 5 shows that the distribution of the residuals of model 1 cannot be classified as homoscedastic, so the models were estimated with a robust variance-covariance matrix. Regarding the assumption of multicollinearity, it can be seen that in model 1, the average VIF value is 1.06. According to Fávero (2015), when a model presents mean VIF lower than 5, it does not suffer multicollinearity problems. In the next subsection we present another model estimated for the purpose of increasing the robustness of the estimation.

Based on the empirical evidence found by the models, there is no way to reject our research hypothesis, so we conclude that during the period studied, greater use of derivatives contracts for minimization of risks tied to interest rates and exchange rates, i.e., hedging corporate transactions, was associated with lower risk levels. Thus, we achieved the main objective of the work, which was to verify whether the use of derivatives tended to reduce risk (stock price volatility) of Brazilian companies with shares listed for trading in the [B]^3. The next section contains our final considerations.

5 Conclusions

Few studies have been published in Brazil about the impact of using derivatives for hedging by firms, although mention can be made of the papers of Machado (2007), Rossi Júnior and Laham (2008), Serafini and Sheng (2011) and Ribeiro, Machado and Rossi Júnior (2013), investigating the relationship between using derivatives for protection in relation to firm value. These researchers all identified a positive correlation between the use of derivatives and firm value. Although that higher valuation does not necessarily mean the firms had lower risks, the positive impact on value can indicate that their utilization was related with lower risks.

Considering the country's economic scenario, marked by the large variation of interest rates and exchange rates in the period analyzed (2010-2017), it is logical to think that policies to manage risks, particularly to diminish the impact of economic uncertainties on firms' results, were successful in reducing risk, as identified in other countries by Allayannis and Ofek (2001) and Bartram, Brown and Conrad (2011). That was the main question addressed in this study, but with focus on Brazilian companies. This study's findings are aligned with those of Koonce, Miller and Winchel (2015), that the use of derivatives to manage risks is viewed positively by investors.

Analysis of the results regarding the main question of this work – Do companies that use derivatives for hedging reduce their risks? – indicates that the use of derivatives for hedging by listed Brazilian firms in the period studied was negatively correlated with risk. In other words, firms employing derivatives to hedge risks tended to reduce those risks. This outcome was significant and robust according to the tests applied, as described in the previous sections. In general, our results corroborate those of Allayannis and Ofek (2001), Allayannis and Weston (2001) and Bartram, Brown and Conrad (2011) in similar studies.

The main practical contribution of this study is related to expanding the perspective of executives, based on analysis of the perception of risks associated with the use of derivatives by companies, regarding the formulation of financial policies, especially those including protection by hedging. This aspect is in line with the results reported by Antônio et al. (2019), who highlighted that the use of derivatives can protect businesses and produce more stable results. The greater stability of results obtained from using derivatives can lead to less perception of risk by the market. However, this study also warns users of accounting information of the tenuous line between speculation and protection, as was pointed out by Bartram (2019), who found that derivatives can be effective and efficient tools for hedging while also serving for speculative purposes, possibly in the guise of hedging. In Brazil, the market generally seems to perceive the use of derivatives with a positive bias, overlooking the speculative facet these instruments can have.

This study can also promote a better understanding of the reflections of using derivatives before the advent of the standard that now regulates the classification and disclosure of derivative financial instruments

(IFRS 9), which took effect on January 1, 2018. Finally, the study contributes to the perception of managers regarding the impact of adopting hedging policies on the stock market performance of firms.

The main limitation of this study, as is the case of other studies related to the use of derivatives in Brazil, is the lack of temporal comparability, because there is no precise and transparent information about the derivatives contracts of companies before 2010 (MURCIA; SANTOS, 2009), limiting the period of analysis. Besides this, the results obtained are limited to the Brazilian context in the period analyzed. For future works, we can suggest the addition of new control variables for the relationship between hedging and risk. Finally, we suggest studies focused on the effects of the new standard (IFRS 9) to evaluate the reflections on the risks faced by companies.

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