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Practical assessments on the use of financial derivatives as risk management tools

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ABSTRACT

This study examines the risk management strategies of non-financial corporations in less efficient financial markets, such as Portugal and Spain. These markets have liquidity constraints and limited availability of derivatives to hedge corporate risk exposures. The study analyzes how these companies dealt with these challenges and how their hedging strategies affected their performance. The results show a complex relationship between the use of derivatives, earnings volatility, and the market value of companies. The study contributes to business practice by helping companies assess the effectiveness of their hedging strategies and may also influence regulators to adapt rules for less liquid markets.

Keywords: Derivatives; Hedge Accounting; Risk Management.

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Avaliações práticas sobre a utilização de derivados financeiros como instrumentos de gestão do risco

RESUMO

Este estudo analisa as estratégias de gestão de risco das sociedades não financeiras em mercados financeiros menos eficientes, como Portugal e Espanha. Estes mercados têm restrições de liquidez e uma disponibilidade limitada de derivados para cobrir a exposição ao risco das empresas. O estudo analisa a forma como estas empresas lidaram com estes desafios e como as suas estratégias de cobertura afetaram o seu desempenho. Os resultados mostram uma relação complexa entre a utilização de derivados, a volatilidade dos resultados e o valor de mercado das empresas. O estudo contribui para a prática empresarial ao ajudar as empresas a avaliar a eficácia das suas estratégias de cobertura e pode também influenciar os reguladores na adoção de regras para mercados menos líquidos.

Palavras-chave: Derivados; Contabilidade de Cobertura; Gestão de Risco.

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1. Introduction

The classical model of Modigliani & Miller (1958) suggests that capital markets are perfect and that the cost of capital does not affect the capital structure of firms. However, in the financial markets of Iberian countries such as Portugal and Spain, the lack of financial market liquidity and the absence of precise derivatives reflecting the underlying assets are characteristics that lead to imperfect financial markets. In addition, arbitrage between these countries and the rest of the world increases the challenges for companies operating in these markets.

These imperfections may reduce the effective management of financial risks by entities because of the difficulties they face in applying the accounting standards related to hedging. As a result, these companies may be required to measure the effects of hedging transactions directly in the results for the period, separately from the financial effects of the hedged assets. These shortcomings pose a significant challenge to entities seeking appropriate instruments to protect themselves against the risks specific to their economic activities.

The potential effects of risk management using derivatives have been extensively discussed by various authors in the context of high liquidity in financial markets, especially regarding the accounting treatment of these derivatives (Abdel-khalik & Chen, 2015; Campbell, 2015; Choi et al., 2015; Tessema & Deumes, 2018). The focus of these studies is due to the importance and advanced development of financial markets, which provide a conducive environment for analyzing the effects of risk management using derivatives.

In other contexts, such as the European context, researchers such as Titova et al. (2020) have focused their efforts on understanding how the performance and volatility of financial institutions' stock returns are related to their exposure to derivatives contracts. In addition, Panaretou et al. (2013) showed that derivatives, as measured by accounting standards, increased the predictability of earnings for a sample of firms listed on the London Stock Exchange.

While the management of financial risk has been extensively studied (see Campbell et al., 2019), the relationship between the use of derivatives, accounting measures and underlying assets in organizational performance remains relatively unexplored, particularly in financial markets that do not have the same high liquidity characteristics as the US and UK financial markets. In addition, unlike financial institutions, companies operating in less developed financial markets do not have direct access to financial market participants and high transaction liquidity to effectively implement their hedging strategies.

Therefore, the main objective of this study is to analyze how risk management strategies are reflected in the results of these companies in an environment where liquidity is limited and the availability of different underlying assets for hedging is not extensive. By focusing on the challenges faced by these companies in implementing their hedging strategies, this paper differs from others in the literature.

Filling this knowledge gap aims to provide these companies with valuable information to address the specific challenges of risk management under these conditions. A comprehensive study in this area can improve management practices, provide strategic insights, and enhance asset protection and informed decision-making, taking into account the specificities of less developed financial markets. In this context, the study of Portuguese and Spanish companies offers a valuable opportunity to understand risk management strategies in these specific conditions. These companies face challenges such as a lack of funding and the need to manage risk in medium-sized companies, while at the same time seeking protection in assets with different underlying characteristics, which may give rise to additional risks, such as those related to spreads.

The challenges faced by companies in this context of less developed financial markets can give rise to concerns such as financial losses and negative effects on market value. With this in perspective, this article is divided into two parts. The first part examines the impact of risk management on earnings in a simplified way, considering only its accounting measurement. The second part provides a more comprehensive analysis, which considers the underlying asset of the derivative. The first analysis provides a broad overview of companies' risk management strategies and allows the identification of general patterns and trends in the use of derivatives. The subsequent classification of derivatives by underlying asset is critical, taking into account differences in availability, liquidity and hedging capacity. Accounting standards, such as IFRS 9, also play a role in determining the appropriateness of derivatives based on the nature of the underlying and the specific activity involved.

The results showed that indiscriminate use of derivatives was associated with increased earnings volatility, while derivatives measured as hedging and speculative/trading instruments showed an inverse relationship with volatility. This suggests that many companies acquired derivatives to manage financial risks but found it difficult to treat them as hedging instruments due to accounting requirements. The results also showed a positive relationship between the use of derivatives as hedging instruments and stock returns. This positive relationship can be attributed to the ability of derivatives to reduce volatility and mitigate the risks associated with the underlying assets, thereby having a positive impact on stock returns. These findings highlight the importance of considering the nature of the underlying assets when

analysing the impact of derivatives and provide insights into how these instruments can be used more effectively to manage risk and create shareholder value in less liquid environments.

By analyzing the classification of derivatives and underlying assets, the study contributes to practice by helping firms to assess whether these transactions are having the expected effects. These results can enable companies to identify more effective hedging strategies tailored to their specific needs and objectives, thereby strengthening their ability to cope with market uncertainties and challenges. This contribution is relevant both to business practice, by improving informed decision making, and to the literature, by increasing knowledge of the effectiveness of risk management strategies in relation to derivatives and underlying assets.

In addition, the study can also contribute to standard setters by shedding light on the specificities and challenges faced by companies in less liquid financial markets. This contribution to standard setters may lead to greater convergence of rules and improved accounting practices for companies operating in less liquid environments.

This paper is divided into five sections. Following this introduction, the second section provides a literature review, examining previous studies that have examined the influence of derivatives use on firm performance. The third section outlines the methodology used in this research. This is followed by an analysis of the data and variables used to address the research questions. Finally, the paper concludes with the results of the tests conducted and discusses the limitations of the study.

2. Literature Review

The reviewed studies address different aspects related to the use of derivatives and their impact on risk management practices and accounting in firms. Zhang (2009) examined the effect of accounting changes on the risk management of non-financial firms using derivatives. By analyzing data collected from Securities and Exchange Commission Form 10-K filings, the author found that firms became more cautious in their risk management following the adoption of new accounting standards. Other studies, such as Glaum & Klcker (2011) and Nguyen & Liu (2014), have also highlighted the importance of using derivatives to minimize earnings volatility and protect against currency risk. In addition, Beneda (2013) found that large firms are more efficient in risk management and can minimize earnings volatility through the use of derivatives, while small firms struggle in this regard. In the Asian context, the results highlighted by Lee (2019) suggest that the use of derivatives is inversely related to cash flow volatility, earnings volatility, and stock return.

In terms of the specific content of derivatives use, Manchiraju et al. (2016) examined the relationship between derivative gains, specifically hedging versus speculation, and executive compensation in US oil and gas companies, suggesting that both types of derivative gains have similar effects on executive compensation.

Despite the existing studies, there remains a gap in the understanding of the risk management practices adopted by companies operating in environments characterized by low liquidity and a lack of appropriate instruments. Against this background, the following research hypotheses are formulated in order to improve our understanding of the specific challenges faced by companies operating in such contexts:

H1. There is a significant relationship between the use of derivatives and earnings volatility for firms operating in illiquid financial markets.

H2. Derivatives measured according to hedge accounting standards are negatively related to earnings volatility in firms.

H3. Derivatives not measured in accordance with hedge accounting standards are positively related to earnings volatility in firms.

Several studies have examined the impact of derivatives on earnings predictability, transparency, and volatility. According to Panaretou et al. (2013), the use of derivatives in accordance with IFRS standards can improve earnings predictability and financial statement transparency. However, as observed by Choi et al. (2015), the implementation of certain accounting standards, such as SFAS 133, may reduce the effectiveness of derivatives in smoothing earnings and lead to increased volatility. Müller (2020) highlights the significant impact of derivatives, especially those related to currency risk, on earnings volatility and emphasises the need for appropriate accounting methods. In times of market instability, firms' challenges in complying with hedge accounting standards, as discussed by Tessema and Deumes (2018), may further contribute to earnings volatility. Campbell (2015) found an inverse relationship between unrealised changes in the fair value of derivatives and future operating earnings, particularly when fair value is reclassified into firm earnings. In addition, the ability to pass on changes in commodity prices to customers may affect the predictive power of unrealised gains/losses on cash flow hedges. These studies highlight the impact of derivatives on risk management and financial reporting. However, companies often face difficulties in accounting for these instruments appropriately and interpreting the results in relation to the underlying assets.

The need for further research on the impact of earnings volatility and the market value of companies on underlying assets, such as derivative contracts, is essential to fill the existing knowledge gap and provide a solid basis for improving financial risk management practices. Understanding the impact of earnings volatility on underlying assets can help identify more robust investment opportunities,

develop more effective hedging strategies, and reduce exposure to unnecessary risks, benefiting companies, investors, and the market. Therefore, the following hypotheses are tested to fill this knowledge gap:

H4. Derivative contracts classified as hedging instruments have a negative relationship with economic result volatility.

H5. The estimated relationships for derivative contracts classified as speculative/trading instruments differ from the estimated relationships for derivative contracts classified as hedging instruments in relation to economic result volatility.

H6. Risk management through the use of financial derivatives is positively related to financial performance.

3. Methodology

3.1. Sample

The sample of this study consists of non-financial companies located in Portugal and Spain, covering the period from 2015 to 2021. This choice is justified by the common border and the strong economic and trade ties between the two countries, which make the joint analysis more meaningful. The study starts in 2015 due to the issuance of IFRS 9 in July 2014. This timeframe allowed companies to prepare and adapt to the changes brought by the new standard, assess the impact on existing financial instruments, review accounting processes and implement the necessary changes to comply with IFRS 9 by its effective date in 2018.

The sample was selected based on specific criteria described in Table 1. Initially, 314 companies were analysed, but 54 companies were excluded because their shares were not traded on the Euronext Lisbon and Madrid stock exchanges. This exclusion was made in order to focus the analysis on companies with greater relevance and presence in the local market of these regions. In addition, ten companies were excluded due to suspension or delisting of their shares, and one organisation from the financial sector was also excluded. To maintain a balanced sample, only companies with balance sheet data for at least four financial periods were included, resulting in the exclusion of 20 organisations. This resulted in a final sample of up to 229 companies per year.

The final sample of this study consists mainly of Spanish companies in the real estate, industrial and consumer cyclical sectors. These sectors make up a significant proportion of the sample, reflecting the economic importance of these industries in Spain. Only 14% of the sample consists of Portuguese companies, indicating a predominance of Spanish companies in the data analysed (Table 2). The sample was selected based on the information contained in the Thomson Reuters Eikon database.

Table 1. Sample selection

1st: Selected filters on the Thomson Reuters Eikon:		
• Spanish and Portuguese companies.		
• Non-financial companies.		
• Companies whose shares are traded on the stock exchange.		
	Total	314
2nd: Analysis of the 314 companies		
• Selection of companies whose shares are traded on Euronext Lisbon and on the Madrid Stock Exchange.		
	Total	260
3rd: Analysis of the 260 companies		
• Exclusion of ten companies whose status on Thomson Reuters Eikon was described as suspended or the shares are no longer listed on the stock exchange.		
• Exclusion of one company with financial activity.		
	Total	249
4th: Analysis of the 249 companies		
• Exclusion of 20 companies whose Total Assets data corresponding to the year-end accounts contained information for less than four years in the observed period.		
	Total	229
Total Companies by fiscal year		
	2015	165
	2016	185
	2017	202
	2018	229
	2019	229
	2020	229
	2021	229

Table 2. Characteristics of the sampled companies

Economic Sector	Spain	Portugal	Total
Real Estate	76	0	76
Industrials	33	3	36
Consumer Cyclicals	20	11	31
Technology	15	6	21
Basic Materials	12	6	18
Healthcare	15	0	15
Utilities	11	3	14
Consumer Non-Cyclicals	7	2	9
Energy	6	2	8
Academic & Educational Services	1	0	1
Total	**196**	**33**	**229**
Frequency	**86%**	**14%**	

3.2. Data collection and variables

Dependent variables:

All data for the study, except those related to the use of derivatives, were collected from the Thomson Reuters Eikon database. To analyze the volatility of companies' earnings, quarterly data were collected for two earnings measures: earnings before extraordinary items (represented by E_Q) and net income (represented by EAT_Q). These data were used to calculate the standard deviation for each earnings measure for each company in each year. These measures of earnings volatility were included as dependent variables in the estimation model. The inclusion of two earnings measures is intended to strengthen the study and to examine the extent to which risk management activities, including the use of derivatives, are related to earnings volatility even when there are changes in the variables used to measure earnings. The approach of measuring earnings volatility through the standard deviation of quarterly data, assuming the role of the dependent variable, is consistent with the empirical studies conducted by the authors Abdel-khalik & Chen (2015), Beneda (2013), Phua et al. (2021) Zhang (2009), which lends validity to the analyses conducted.

The two calculated volatility measures were then scaled by the total assets of the companies, resulting in the variables VolE_AT and VolET_AT for each company in each period. Scaling the volatility measures by the total assets of the companies was done to provide robustness to the proposed tests.

In the second stage of this study, in addition to earnings volatility, a variable that represents the variation in the value of companies from a shareholder perspective is used to examine whether risk management activities with derivatives add financial value to companies. The variable is therefore the annual return on the companies' shares, measured as the total return on the company's shares (RetS) over a specified 52-week period, including changes in the share price and any relevant dividends. Previous studies, such as those by Nguyen & Liu (2014), Lee (2019) and Titova et al. (2020), have used dependent variables representing the value of the company to analyze the impact of the use of derivatives.

Independent variables:

Information on the use of derivatives was obtained from the annual reports and financial statements published by the companies in the sample. These documents provided information on the fair value of derivatives, their purpose, the type of instrument contracted, and the risks involved.

In the first stage of the study, derivatives were first characterized according to their indiscriminate use, using a binary variable called Derivative, which takes the value of 1 if firm i reports the fair value of any derivative contract on its balance sheet in period t, and 0 otherwise. Beneda (2013) found evidence that the use of derivatives

can reduce earnings volatility, while Phua et al. (2021) found no evidence that the use of derivatives helps protect against adverse fluctuations in firms' financial results. In this study, no clear signal was found as the sample firms reported using derivatives both as hedging instruments and for speculation/trading purposes.

For each company i, in year t, one independent variable is represented by the sum of the fair values of derivatives declared by companies as hedging instruments (FVH). The other independent variable is represented by the sum of the fair values of derivatives declared by the companies as speculative or trading instruments (FVS).

In order to construct the variables related to derivatives measured according to their underlying assets, the same methodology was used to obtain the FVH and FVS variables. The difference is that these derivatives were separated on the basis of the underlying assets of the derivative contracts reported by each enterprise in each year. The most common underlying assets are exchange rates, interest rates and commodity prices. Thus, for each type of underlying, derivatives were divided into two categories: hedging instruments and speculative/trading instruments, based on their accounting treatment. For example, the variables CurrencyH and CurrencyS represent derivatives with prices indexed to exchange rates, where the former is reported as an accounting hedge and the latter is not. Similarly, the variables InterestH and InterestS were obtained for derivatives with underlying assets represented by interest rates, and the variables CommoditiesH and CommoditiesS were obtained for derivatives with underlying assets represented by commodity prices.

The use of derivatives as hedging instruments is expected to be associated with a reduction in earnings volatility, in line with previous studies such as Campbell (2015) and Abdel-khalik & Chen (2015). On the other hand, a positive relationship is expected between the use of derivatives not covered by accounting standards and earnings volatility. This is because the fair value of these derivatives can affect the current period's earnings, and the difference between the derivative and the underlying asset that creates the risk can create greater instability in earnings (Tessema & Deumes, 2018).

In addition to the predictor variables, the estimated models include control variables that are consistent with the literature in this area of research. The methodology for calculating these control variables is presented in Appendix 1.

3.3. Analysis method

This study used short panel models, and the proposed models are characterised as unbalanced panel data, as there are missing observations for some periods. In the first stage of the study, the following equations were estimated to analyse the relationship between the use of derivatives and earnings volatility:

$$\mathbf{[VolE_{i,t},VolET_{i,t},VolET_{ATi,t},VolET\_AT_{i,t}]} = ß_0 + FVH_{it-1}\, ß_1 + FVS_{it} ß_2 + Derivative + \sum ß_j VC_{jit} + \boldsymbol{\varepsilon}_{it} (1)$$

$$\mathbf{VolE\_AT_{i,t}} = ß_0 + FVS_{it}\, ß_1 + Derivative + \sum ß_j VC_{jit} + \boldsymbol{\varepsilon}_{it} (2)$$

$$\mathbf{VolE\_AT_{i,t}} = ß_0 + FVH_{it-1} ß_1 + Derivative + \sum ß_j VC_{jit} + \boldsymbol{\varepsilon}_{it} (3)$$

Next, the following equations were estimated based on the arguments described in the second part, which aims to analyze the relationships between risk management activities (using derivative instruments) and the volatility of reported and traded results in the stock markets.

$$\mathbf{[VolET\_AT_{i,t},VolET_{i,t}]} = ß_0 + CurrencyH_{it}\, ß_1 + CurrencyS_{it}\, ß_2 + InterestH_{it-1}\, ß_3 + InterestS_{it}\, ß_4 + CommoditiesH_{it}\, ß_5 + CommoditiesS_{it}\, ß_6 + \sum ß_j VC_{jit} + \boldsymbol{\varepsilon}_{it}; (4)$$

$$\mathbf{RetS_{i,t}} = ß_0 + CurrencyH_{it-1}\, ß_1 + CurrencyS_{it-1}\, ß_2 + InterestH_{it-1}\, ß_3 + InterestS_{it}\, ß_4 + CommoditiesH_{it}\, ß_5 + CommoditiesS_{it-1}\, ß_6 + \sum ß_j VC_{jit} + Crisis + \_it; (5)$$

4. Results

4.1. Use of derivatives

Table 3 provides information on the frequency of companies' use of derivatives during the period under review. Of the 229 companies analyzed, 133, or 58% of the total, reported using derivatives in at least one financial year during this period. Of the companies that disclosed the fair value of derivatives, 42% used them as hedging instruments, i.e., to protect against financial risks. Meanwhile, 22% of the companies used derivatives for trading and/or speculation purposes, in order to profit from market fluctuations. In addition, 36% of the companies used derivatives for both hedging and trading and/or speculation. These results highlighted the relevance and diversity of the use of derivatives by the sample companies during the survey period.

Table 3. Purpose and years of use of derivative instruments.

Total number of companies with derivatives exposure by fiscal year.								**Type of measure**	**Relative frequency**
Fiscal Periods	2015	2016	2017	2018	2019	2020	2021		
Hedging	8	6	13	3	5	8	13	56	42%
Trading and/or Speculation	3	7	7	3	2	1	6	29	22%
Hedging, Trading and/or Speculation	4	2	4	5	5	6	24	48	36%
Total	**15**	**15**	**24**	**11**	**12**	**15**	**43**	**133**	
Relative Frequency	**11%**	**11%**	**18%**	**8%**	**9%**	**11%**	**32%**	**100%**	**100%**

Table 4 provides information on the financial contracts held by the sample companies, categorized by the underlying assets and the year in which they were reported. Most of the derivative contracts held by the companies were linked to exchange rates, accounting for 35% of the total. This was followed by 33% of contracts linked to interest rates. Finally, commodity prices accounted for 18% of the underlying contracts. These results highlighted the main categories of underlying assets for the financial contracts of the sample companies.

Table 4. Underlying assets - derivative contracts

Underlying Asset/ Year	2015	2016	2017	2018	2019	2020	2021	Total	Frequency
Currency	**116**	**119**	**111**	**127**	**132**	**122**	**144**	**871**	**35%**
Interest and Inflation	**111**	**113**	**102**	**124**	**137**	**114**	**131**	**832**	**33%**
Interest rates	108	110	100	122	135	112	127	814	33%
Inflation	3	3	2	2	2	2	4	18	1%
Currency / Interest	**16**	**17**	**20**	**20**	**18**	**21**	**22**	**134**	**5%**
Currency / Commodity	**4**	**4**	**6**	**8**	**6**	**8**	**6**	**42**	**2%**
Equities	**12**	**14**	**18**	**17**	**15**	**21**	**18**	**115**	**5%**
Commodity	**41**	**45**	**54**	**71**	**60**	**88**	**88**	**447**	**18%**
Copper/ Nickel	1	2	-	2	1	1	1	8	0%
Carbon dioxide/ Hydrogen	6	4	2	6	1	5	4	28	1%
Energy/Electricity	8	9	11	17	20	35	37	137	6%
Gas	7	7	9	9	9	10	10	61	2%
Gas/Oil/Electricity	2	2	2	1	1	2	3	13	1%
Oil	5	5	9	8	2	2	2	33	1%
Metals and Oil	-	-	1	1	1	1	2	6	0%
Cellulose/Pulp & Paper Pulp	-	1	2	2	4	5	6	20	1%
Commodities	12	15	18	25	21	27	23	141	6%
Other/ Not specified	**3**	**7**	**10**	**7**	**7**	**6**	**8**	**48**	**2%**
Total	**303**	**319**	**321**	**374**	**375**	**380**	**417**	**2,489**	

4.2. Part 1 - Descriptive statistics

In the first stage of the study, the variables were statistically analysed, providing measures such as mean, median, minimum, and maximum values, range, and standard deviation. These statistics are shown in Table 5[1].

[1] Measurement of variables:
Variables measured in thousand €: VolE, VolET, FVH, FVS, Frevenue, FXExp;
Variables scaled by total assets: VolE_AT and VolET_AT;
Variables measured by percentage variation: Debt and Dividends;
Measurement of the other variables: Revenue - first difference; Derivative – binary.

Table 5. Descriptive statistics - Part 1

Variable	Number of observations	Average	Median	Minimum	Maximum	Amplitude	Standard Deviation
VolE	1,234	28,052.00	1,575.80	1.41	3,920,700.00	3,920,698.59	170,290.00
VolE_AT	1,234	0.01	0.00	0.00	0.93	0.93	0.04
VolET	1,234	29,394.00	1,571.30	0.75	4,955,700.00	4,955,699.25	190,800.00
VolET_AT	1,234	0.01	0.00	0.00	0.93	0.93	0.04
FVH	534	-32,019.00	-1,285.50	-3,470,000.00	1,859,000.00	5,329,000.00	305,790.00
FVS	370	1,034.80	-55.21	-334,000.00	573,870.00	907,870.00	51,911.00
Debt	1,376	14.24	0.02	-2,773.30	11,889.00	14,662.30	352.70
FXExp	604	-7,315.20	-8.00	-1,000,000.00	342,780.00	1,342,780.00	64,100.00
Frevenue	703	2,652,300.00	374,270.00	23.00	39,737,000.00	39,736,977.00	6,188,400.00
Revenue	1,217	19,899.00	1,288.50	-16,046,000.00	16,463,000.00	32,509,000.00	1,049,900.00
Dividends	649	3.77	0.10	-1.00	727.82	728.82	42.09

Table 6 shows the correlation matrix between the study variables, with Pearson correlations in the lower triangle and Spearman's rho correlations in the upper triangle. The inclusion of the Spearman's rho correlation in this analysis is particularly relevant because of the use of the Derivative variable.

Table 6. Correlation of variables

Pearson's correlation coefficient	Spearman's Rho											
	Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
	1.VolET	1.000	.992**	.4211**	.423**	-.094*	0.019	.456**	-0.049	-0.038	.592**	.771**	-0.074
	2.VolE	.993**	1.000	.416**	.433**	-.103*	0.030	.452**	-0.048	-0.042	.591**	.770**	-0.070
	3.VolET_AT	.070*	.074**	1.000	.995**	0.019	-0.026	.126**	-.090**	-0.001	.213**	.076**	0.045
	4.VolE_AT	.065*	.070*	.000**	1.000	0.012	-0.022	.131**	-.090**	-0.001	.219**	.085**	0.051
	5.FVH	-.333**	-.291**	-.078	-0.059	1.000	.188**	-.369**	0.017	-0.058	-.115**	-.117**	-0.018
	6.FVS	-.335**	-.319**	-.073	-0.065	.381**	1.000	-0.076	-0.001	-0.012	0.062	0.005	-0.042
	7.Derivative	.144**	.152**	-.048	-.050*	-0.008	0.016	1.000	0.032	-0.003	.460**	.473**	-0.042
	8.Debt	-.006	-.006	.003	0.003	0.005	0.001	0.036	1.000	0.046	-0.035	0.005	0.045
	9.FXExp	-.236**	-.245**	.007	0.007	-0.057	-0.007	-.061*	0.003	1.000	-.067**	-0.046	0.053
	10.Frevenue	.439**	.464**	-.019	-0.020	-.102*	0.063	.265**	-0.009	-.295**	1.000	.722**	-.108**
	11.Revenue	.210**	.237**	.017	0.017	.096*	.160**	-0.009	0.000	0.034	.088**	1.000	-.108**
	12.Dividends	-.003	-0.003	.016	0.017	0.014	0.010	-0.068	-0.006	0.014	-0.020	0.005	1.000

Note: ***, ** and * indicate significance at the 1%, 5% and 10% levels (two-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

The variables VolET and VolE are significantly correlated with the variables FVH, FVS and Derivative. This indicates that the use of derivatives is associated with the volatility of companies' results. In addition, the variable VolE_AT shows a negative and significant correlation with the variable Derivative, suggesting that the use of derivatives is associated with a reduction in the volatility of the results when adjusted by the total assets of the companies. The variable FVS shows a positive and significant correlation with the variable FVH, indicating a possible relationship between the use of derivatives for speculative/trading purposes and the use of derivatives for hedging purposes. These correlations provide an insight into how the use of derivatives may affect companies' volatility and risk management strategies.

The Variance Inflation Factor (VIF) test is presented in Appendix 2. The VIF test rejected the hypothesis of multicollinearity between the variables as observed in the correlation matrix.

4.3. Part 1 - Estimated regression models

Table 7 presents the results of the estimated regression models. The diagnostic tests to determine the most appropriate panel data model are presented in Appendix 3. All models were estimated with robust standard errors to account for possible heteroskedasticity in the model.

The binary variable Derivative was used to analyse the relationship between the indiscriminate use of derivatives and the volatility of earnings. Most of the models showed a statistically significant positive relationship between the variable Derivative and the dependent variables. The predicted coefficient values of the Derivative variable are similar to those found in the study of Phua et al. (2021), but different from the results of Beneda (2013). The results do not reject Hypothesis 1, which suggests that there is a relationship between the use of derivatives and earnings volatility. The estimated positive relationship suggests that the use of derivatives may not be effective in reducing earnings volatility.

The results showed a significant inverse relationship between the FVH and FVS variables and the dependent variables in all models. This implies that derivatives classified as hedging instruments (FVH) have a negative relationship with earnings volatility, while derivatives classified as speculative/trading instruments (FVS) have a similar relationship. It is worth noting that this relationship is the opposite of the observed coefficients for the Derivative variable.

The estimated values for the FVH variable are consistent with previous studies, such as Glaum and Klcker (2011) and Campbell (2015). These studies highlight that firms are more likely to value their derivatives in accordance with accounting

standards for hedging, as they perceive the importance of reducing earnings volatility. In addition, firms are continuously concerned with the economic impact of price fluctuations and protect their future transactions from financial risks. This inverse relationship between derivatives and earnings volatility can be explained by the fact that derivatives continue to be recorded on companies' balance sheets, thus maintaining their function as hedging instruments.

Table 7. Estimation results - Part 1

	VolE		**VolET**		**VolE_AT**		**VolET_AT**		**VolE_AT**		**VolE_AT**	
FVH	-0.365	***	-0.424	***	0.000	***	0.000	***			0.000	***
	(−5.082)		(−3.703)		(−5.532)		(−5.175)		0.000		(−6.033)	
FVS	-2.341	***	-2.755	***	0.000	**	0.000	**	0.000	***		
	(−3.772)		(−3.129)		(−2.206)		(−2.478)		(−2.614)		0.000	
Derivative	130285.000	**	149173.000	*	0.006	***	0.006	***	0.006	***	-0.002	
	(2.120)		(2.020)		(18.830)		(17.160)		(-17.920)		(−0.744)	
Debt	1.097		1.844		0.000	***	0.000	***	0.000	***	0.000	***
	(0.220)		(0.321)		(−49.400)		(−47.030)		(−38.410)		(−2.407)	
FXExp	0.136		0.017		0.000	***	0.000	***	0.000	*	0.000	***
	(0.636)		(0.053)		(2.756)		(2.732)		(1.925)		(2.672)	
Frevenue	0.016	***	0.017	***	0.000		0.000		0.000		0.000	
	(3.974)		(3.376)		(−0.207)		(−0.360)		(−0.769)		(−0.452)	
Revenue	-0.016	**	-0.017	**	0.000	***	0.000	***	0.000		0.000	**
	(−2.664)		(−2.121)		(−3.146)		(−2.939)		(−1.079)		(−2.502)	
Dividends	234.272	**	274.421	**	0.000	***	0.000		0.000	*	0.000	**
	(2.162)		(2.065)		(−7.021)		(−7.046)		(−1.741)		(−2.407)	
R-square & LSDV	53.45%		53.45%		48.43%		50.16%		38.77%		47.07%	
Adjusted R-square	50.92%		50.92%		26.38%		30.40%		10.60%		16.86%	
Observations	156		156		159		159		209		297	
F-statistic	415.230		730.007		3.065		6.25E+16		3.905		78.542	
P-value(F)	<0.001		<0.001		<0.001		<0.001		<0.001		<0.001	

The estimated values for the FVS variable are not consistent with the findings of Tessema and Deumes (2018). These authors suggested that the use of derivatives may increase earnings volatility due to the specific criteria of accounting standards for hedging. According to accounting standards, if the measurement criteria for hedging are not met, the fair value of derivatives should be recognized in the period's results, which may lead to greater earnings instability. However, the results found in this study indicate an inverse relationship between derivatives held for speculative/trading purposes and earnings volatility. This can be explained by the fact that derivatives can also be used for financial protection purposes without recourse to hedge accounting standards.

The results of the study indicated that the control variables, FXExp (exposure to exchange rate fluctuations) and Frevenue (company's non-domestic revenue), have significant relationships with the dependent variables. These variables have statistically significant coefficients and a positive relationship with earnings volatility, which is consistent with the findings of Phua et al. (2021) regarding the impact of external risks, such as business and financial risks, on earnings stability.

The variable Debt has an inverse relationship with earnings volatility, which is consistent with previous studies by Beneda (2013) and Abdel-khalik & Chen (2015). This suggested that leverage helps to minimize financial difficulties. On the other hand, the Revenue variable did not show a significant relationship with earnings volatility, contrary to the findings of Zhang (2009). However, Tessema and Deumes (2018) observed an inverse relationship between profitability and earnings smoothing. For Dividends, the results were mixed. In some models, dividends showed a positive and significant relationship with the dependent variable, while in other models the relationship became negative after scaling earnings volatility by total assets. This is different from the findings of Choi et al. (2015), who showed an inverse relationship between dividend payout and earnings volatility.

Two additional regressions were carried out to validate the main results obtained in the previous models (Table 8). After conducting the Hausman test (Appendix 3), it was found that the fixed effects model was more appropriate for estimating these models. The results estimated using the fixed effects method confirmed the statistical significance of the coefficients of the independent variables Derivative, FVH and FVS. Furthermore, there were no changes in the estimated signs of the coefficients of these variables compared to the previous models. Therefore, the previous conclusions are consistent and remain valid.

Table 8. Robustness Tests

	VolE		VolET	
FVH	-0.436	***	-0.522	***
	(-4.277)		(-3.392)	
FVS	-1.695	***	-2.052	***
	(-2.982)		(-2.808)	
Derivative	182.422.000	***	186.607.000	***
	(10.480)		(8.856)	
Debt	1.423		1.908	
	(0.900)		(1.037)	
FXExp	0.555	**	0.546	*
	(2.042)		(1.857)	
Frevenue	-0.012		-0.016	
	(-0.861)		(-0.984)	
Revenue	-0.010		-0.007	
	(-1.248)		(-0.784)	
Dividends	-156.724		-108.258	
	(-1.205)		(-0.665)	
R-square LSDV	64.90%		66.13%	
Observations	156		156	
F-statistic	12.336		10.816	
P-value(F)	<0.001		<0.001	

Note: ***, ** and * indicate significance at the 1%, 5% and 10% levels (two-tailed).

4.4. Part 2 - Descriptive statistics

The variables used in the second part of this study were characterised by calculating descriptive statistics. The same statistics carried out in the first part of the research were repeated in this second part. Table 9 summarises the results obtained[2].

In order to examine the linear relationship between variables, the Pearson correlation coefficient was calculated. The results of this test showed that the strongest correlations between the independent and/or control variables are mainly related to the variables representing the use of derivatives, as can be seen in Table 10.

[2] Measurement of variables:

Variables measured in € thousand: CurrencyH, CurrencyS, InterestH, InterestS, CommoditesH, CommoditiesS;

Variables scaled by total assets: VolE_AT and VolET_AT;

Variables measured by percentage variation: RetS, Capex, Debt and Dividends;

Measurement of the other variables: Revenue - first difference and Asset - natural logarithm.

Table 9. Descriptive statistics - Part 2

Variable	Number of observations	Average	Median	Minimum	Maximum	Amplitude	Standard Deviation
VolET_AT	1,232	0	0	0	0.93	0.93	0.04
VolET	1,234	29,394	1,571	1	4,955,700.00	4,955,699.25	190,800.00
RetS	1,218	0	0	-1	24.00	24.94	0.84
CurrencyH	241	5,435	16	-41,522	385,980.00	427,502.00	34.523.00
CurrencyS	212	1,131	6	-21,994	57,346.00	79,340.00	6,877.70
InterestH	426	-12,024	-551	-691,330	185,460.00	876,790.00	56,842.00
InterestS	156	-1,564	-158	-33,563	26,941.00	60,504.00	5,840.90
CommoditiesH	132	-5,471	-39	-265,230	87,722.00	352,952.00	36,778.00
CommoditiesS	123	9,096	-1	-67,178	573,390.00	640,568.00	64,335.00
Revenue	1,217	19,899	1,289	-16,046,000	16,463,000.00	32,509,000.00	1,049,900.00
Asset	1,465	13	13	1	18.77	17.68	2.38
Capex	1,209	10	0	-1	8,685.00	8,686.00	260.87
Debt	1,376	14	0	-2,773	11,889.00	14,662.30	352.70
Dividends	649	4	0	-1	727.82	728.82	42.09

Table 10. Correlation of variables – Pearson

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	1.	11.	12.	13.	14.
1.VolET_AT	1.000													
2.VolET	.070*	1.000												
3.RetS	.020	-.008	1.000											
4.CurrencyH	-.232**	-.415**	.045	1.000										
5.CurrencyS	-.068	-.301**	.065	.194*	1.000									
6.InterestH	.047	.221**	-.002	.190*	.042	1.000								
7.InterestS	.136	.372**	-.053	-.007	-.296*	.770**	1.000							
8.CommoditiesH	.027	.069	.012	-.055	-.144	-.055	-.120	1.000						
9.CommoditiesS	-.095	-.090	-.090	.377**	-.208	-.018	.028	.387**	1.000					
1.Revenue	.017	.210**	-.010	-.403**	.152*	.055	.215**	.019	-.029	1.000				
11. Asset	-.082**	.269**	-.039	-.155*	-.123	-.021	.134	-.138	.053	-.008	1.000			
12. Capex	-.006	-.006	.016	.005	.034	.004	-.018	-.017	-.021	.001	.008	1.000		
13. Debt	.003	-.006	-.016	.019	.006	.004	.020	.012	-.024	.000	.000	-.002	1.000	
14. Dividends	.016	-.003	.068	.005	.023	.002	.075	.016	.036	.005	-.018	-.002	-.006	1.000

**. Correlation is significant at the .01 level (2-tailed).
*. Correlation is significant at the .05 level (2-tailed).

The variables CurrencyH and CurrencyS, representing derivative contracts related to exchange rates, showed a significant correlation with profit volatility (VolET). Similarly, the variables InterestH and InterestS, representing derivative contracts related to interest rates, are also correlated with profit volatility. This is evidence of a possible link between the use of these derivatives and the volatility of companies' earnings.

However, no significant correlations were found between the variables representing commodity prices and earnings volatility. Similarly, the variable representing stock returns did not show significant correlations with the variables related to derivatives. In summary, the results indicated that the use of derivatives related to exchange rates and interest rates may be associated with earnings volatility in companies, while derivatives related to commodity prices and stock returns do not show a significant correlation.

The VIF test was performed because of the strong and regular correlations between the variables, as shown by the Pearson correlation coefficient. The results of the VIF test can be found in Appendix 2 and showed that there was acceptable multicollinearity between the variables.

4.5. Part 2 - Estimated regression models

The estimated regression models are presented in Table 11. For the proposed models, diagnostic tests indicating which panel data model is most appropriate are provided in Appendix 3. To control for potential heteroskedasticity, all models were estimated with robust standard errors.

The empirical results showed contradictions with Hypothesis 4 proposed in this study for the variables related to derivatives used as hedging instruments, as not all the estimated coefficients exhibited an inverse relationship with the volatility of economic results. Among the estimated coefficients, only derivatives indexed to exchange rates demonstrated a negative relationship with the dependent variables representing earnings volatility.

It is also observed that the relationships between the coefficients of the underlying assets of speculative/trading derivatives and the volatility of results are different from those found for hedging derivatives. It is important to note, however, that these results do not contradict Hypothesis 5 of the study.

Table 11. Estimation results | Part 2

	VolET_AT		VolET		RetS	
CurrencyH	0.000	***	-0.293	***	0.000	***
	(-3.689)		(-2.872)		(2.742)	
CurrencyS	0.000	**	3.668	**	0.000	
	(2.177)		(2.185)		(-1.125)	
InterestH	0.000	***	1.212	***	0.000	**
	(2.963)		(3.948)		(2.224)	
InterestS	0.000		-6.623	**	0.000	***
	(-1.455)		(-2.395)		(-3.075)	
CommoditiesH	0.000	**	0.305	**	0.000	*
	(2.025)		(-2.100)		(1.918)	
CommoditiesS	0.000	***	-0.364		0.000	*
	(-2.912)		(-1.289)		(1.884)	
Asset	-0.001		9705.450			
	(-0.191)		(-0.407)			
Capex	0.000	***	0.545			
	(-2.878)		(1.127)			
Revenue	0.000	*	-0.030	*		
	(-1.911)		(-1.726)			
Dividends	0.000		903.115	*	0.001	**
	(-0.022)		(1.765)		(2.139)	
Debt					0.000	
					(-0.587)	
Crisis					-0.160	***
					(-4.424)	
R-square & R-square LSDV	39.06%		54.10%		4.44%	
Adjusted R-square	5.05%		33.62%		2.84%	
Observations	499		478		549	
F-statistic	163		1701		10	
P-value(F)	<0.001		<0.001		<0.001	

Note: ***, ** and * indicate significance at the 1%. 5%. and 10% levels (two-tailed).

The estimated coefficients for the variables representing hedging instruments are different from those found in the research by Abdel-khalik and Chen (2015). In the authors' study, the variable representing the cumulative value of cash flow hedge designations in other comprehensive income showed a negative relationship with earnings volatility. The results presented here also differ from those presented by Beneda (2013).

Indeed, the presence of positive coefficients for the interest rate and commodity variables can be attributed to the effects of mark-to-market, the volatility of the underlying assets and the hedging method used by the companies, such as cash flow hedges, fair value hedges and net investment hedges. However, it is important to note that the study did not specify the hedging method associated with each instrument analysed, which may have influenced the different estimated relationships between the coefficients representing the use of derivatives and the dependent variables.

The results obtained for the variables Interest S and Commodities S indicate that the coefficients of the variables representing derivatives used as speculative/trading instruments are inversely related to the volatility of the earnings. It is possible that the coefficients of the variables InterestS and CommoditiesS are because companies may not consider these derivatives as hedging instruments due to accounting restrictions. However, these instruments may have been acquired with the aim of protecting economic results.

The explanation provided by Lee (2019) regarding exposure to currency fluctuations due to foreign assets may be relevant to the estimated coefficient of the variable CurrencyS. Many firms in the sample have a structure similar to that of multinational corporations. The consolidation of financial statements in a multinational corporation, especially if there are subsidiaries that report their net income in foreign currency, may pose a currency risk to the organization. Speculative/trading derivatives may not be able to minimise this risk. In addition, some of these derivative transactions, even if considered as preventive measures against financial risks, may not consider the potential impact of the difference between the fair value of the derivative and the value of the underlying asset exposed to the financial risk.

The positive and statistically significant coefficients of the variables CurrencyH, InterestH, and CommoditiesH on market return (RetS) are consistent with the findings of Nguyen and Liu (2014), who found that the use of derivatives to mitigate currency risk is associated with better long-term performance of companies. These results supported Hypothesis 6 of this study, which posits a positive relationship between derivatives, measured as risk hedging instruments, and the market value of companies.

The statistically significant coefficients for the variable InterestS and its negative association with the market return (RetS) are similar to the results reported by Titova et al. (2020), who observed an inverse relationship between the market value of derivatives measured as trading instruments and organizational performance. However, for the CommoditiesS variable, the coefficients showed weak statistical significance and its relationship with market return (RetS) was positive.

The results showed a positive relationship between the use of derivatives to hedge currency and interest rate risks and companies' financial performance, as reflected in market returns. This suggests that the use of these derivatives can help companies to protect themselves against currency and interest rate fluctuations, leading to more favorable performance. However, the relationship between commodity derivatives and financial performance is less clear, suggesting that their effectiveness as hedging instruments may vary depending on commodity market conditions. These findings underlined the importance of proper risk management and hedging strategies tailored to each market context.

The estimated coefficients for the control variables, sales, and dividends, maintained the same significant relationships with the dependent variables as observed in the previous section. In addition, the estimated coefficient for the investment opportunity variable (Capex) showed a statistically significant negative relationship with earnings volatility, confirming the findings of Phua et al. (2021) but contrasting with the findings of Tessema and Deumes (2018). These results highlighted the importance of control variables in understanding the relationship between derivatives and earnings volatility, as well as the need to consider the impact of investment opportunities on firms' risk management and financial performance. Finally, the crisis variable (representing the year 2020) was found to have a negative relationship with stock returns.

An additional regression was run for the model where the dependent variable is stock returns (RetS). The model was first estimated using the pooled model, as the results of the diagnostic tests indicated that it was appropriate (Appendix 3). The regression was then re-estimated using the random effects model and the results are presented in Table 12. After carrying out robustness tests, it was found that all the results for the variables of interest remained consistent, confirming the previous findings.

Table 12. Robustness Tests

	RetS	
CurrencyH	0.000	***
	(2.875)	
CurrencyS	-0.000	
	(−1.337)	
InterestH	0.000	***
	(2.590)	
InterestS	-0.000	***
	(−3.061)	

	RetS	
CommoditiesH	0.000	**
	(2.308)	
CommoditiesS	0.000	*
	(1.901)	
Dividends	0.001	**
	(2.102)	
Debt	0.000	
	(0.697)	
Crisis	-0.159	***
	(−4.439)	
Between variance	0.24%	
Within variance	10.28%	
Theta used for quasi-demeaning	4.85%	
Observations	549	
F-statistic	91.614	
P-value(F)	<0.001	

Note: ***, **, and * indicate significance at the 1%, 5% and 10% levels (two-tailed).

Conclusions

The main objective of this study was to analyze the risk management strategies adopted by non-financial companies in regions with less efficient financial markets, with a particular focus on Portuguese and Spanish companies. The study aimed to understand how these companies deal with the lack of liquidity and the limited availability of underlying assets to hedge risk, and how these strategies affected the variability of accounting earnings and expected shareholder returns.

The results of the first part of the study showed a positive relationship between the indiscriminate use of derivatives and earnings volatility, measured by a binary variable. However, contrary to expectations, the estimated coefficients for derivatives measured as hedging instruments and speculative/trading instruments showed an inverse relationship with earnings volatility. Robustness tests confirmed these findings, as the estimated coefficients for the independent variables representing the use of derivatives remained unchanged.

These results may be due to misclassification or inadequate accounting treatment of derivatives by the sample companies. In the case of derivatives classified as speculative/trading, it is possible that they were acquired for risk management

purposes but did not meet the strict criteria to qualify as effective hedging instruments, leading to the observed inverse relationship with earnings volatility. With respect to derivatives designated as hedges, the relationship found is in line with expectations, as the results indicate a possible contribution of their use to the stability of accounting results. These results contribute to literature by providing insights into the risk management strategies of non-financial firms in regions with less efficient financial markets.

These findings help to understand how companies deal with earnings volatility and the challenges associated with the use of derivatives as hedging instruments or for speculative/trading purposes. This understanding can assist companies in making informed decisions and adopting more effective hedging strategies, taking into account the specificities of less developed financial markets. In addition, the results can help improve management practices and the appropriateness of accounting standards, benefiting both companies and standard setters operating in illiquid environments. This is because the valuation difficulties faced by these companies may lead to the misclassification of their derivatives for purposes other than those for which they were contracted, resulting in their subsequent accounting as non-hedging instruments.

The results of the second part of the study provide valuable insights on the relationship between derivatives and corporate stock returns, particularly when different underlying assets are taken into account. These results highlighted the importance of taking into account the nature of the underlying assets when examining the impact of derivatives. In particular, the results showed a positive association between the use of derivatives as hedging instruments and company stock returns, suggesting that these derivatives can potentially contribute to improved stock performance. Conversely, derivatives classified as speculative/trading instruments generally showed an inverse relationship with stock returns.

Assets such as interest rates and currencies have greater availability and liquidity for effective hedging, which may explain the positive relationship found between hedging derivatives and equity returns. On the other hand, commodity-related derivatives may face greater difficulties in hedging risk due to the limited availability and liquidity of these assets. This may explain the inverse relationship found for speculative/trading derivatives related to commodities.

These findings highlighted the importance of considering the nature of the underlying assets when analyzing the impact of derivatives, as different assets may have had different levels of availability and liquidity, thus affecting the effectiveness of risk hedging. Companies can use these insights to refine their financial strategies. By understanding the impact of derivatives on equity returns, they can tailor their

hedging and trading practices to their specific risk exposures and underlying assets. As a result, they can optimize their financial position and overall performance, potentially attracting more investors and stakeholders.

This lack of detailed and transparent data may have affected the depth of the analysis conducted, as companies did not disclose details of their overall risk management strategies. In addition, publicly available data may have been limited in scope and granularity, which may have affected the ability of the study to draw robust conclusions and generalize to the wider business landscape.

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APPENDICES

Appendix 1. Control Variables

Table 13. Control variables

Control variables - Equations 1, 2 and 3	
Debt(i,t) = (DEB(i,t)/DEB(i,t-1)) - 1	Annual variation of total debt of company i in period t
FXExp(i,t)	Cash impact of exchange rate fluctuations of company i in period t
Frevenue(i,t)	Foreign income of company i in period t
Revenue(i,t) = REV(i,t) - REV(i,t-1)	First difference of the data on the revenue of companies in the fiscal period
Dividends(i,t) = (DIV(i,t)/DIV(i,t-1))-1	Variation of dividends distributed from company *i* in period *t*.
Control variables - Equations 4 and 5	
Asset(i,t) = lnTA(i,t)	Logarithm of total assets of company *i* in period *t*
Capex(i,t) = (CAPEX(i,t)/CAPEX_(i,t-1)) -1	Annual change in capital expenditure of company i in period t
Revenue(i,t) = REV(i,t) - REV(i,t-1)	First difference of the data on the revenue of companies in the fiscal period
Dividends(i,t) = (DIV(i,t)/DIV(i,t-1))-1	Variation of dividends distributed from company *i* in period *t*
Debt(i,t) = (DEB(i,t)/DEB(i,t-1)) - 1	Annual variation of total debt of company i in period t
Crisis	Binary variable that assumes the value of 1 if the year is 2020, 0 otherwise

Appendix 2. Variance Inflation Factor Test

Table 14. Variance Inflation Factor Test | Part 1

Variable	VIF	Variable	VIF
FVH	1,180	FXExp	1,136
FVS	1,380	Frevenue	1,083
Derivative	1,017	Revenue	1,351
Debt	1,003	Dividends	1,003

Table 15. Variance Inflation Factor Test | Part 2

Variable	VolET_AT	VolET	RetS
CurrencyH	1,092	1,092	1,133
CurrencyS	1,537	1,537	1,082
InterestH	1,723	1,723	1,732
InterestS	1,908	1,908	1,662
CommoditiesH	1,104	1,104	1,012
CommoditiesS	1,132	1,132	1,054
Asset	1,079	1,079	
Capex	1,000	1,000	
Revenue	1,197	1,197	
Dividends	1,014	1,014	1,010
Debt			1,000
Crisis			1,009

Appendix 3. Diagnostic Tests - Panel Data Models

Table 16. Results of Diagnostic Statistical Tests

		Breusch-Pagan Test		Hausman Test		F-Test		
Dependent Variable		P-value	Results	P-value	Results	P-value	Results	Best-fit panel data model
Part 1	(VolE)	0,76	Pooled	0,00	Fixed Effects	0,42	Pooled	Pooled
	(VolET)	0,96	Pooled	0,00	Fixed Effects	0,24	Pooled	Pooled
	(VolE_AT)	0,52	Pooled	0,02	Fixed Effects	0,03	Fixed Effects	Fixed Effects
	(VolET_AT)	0,45	Pooled	0,00	Fixed Effects	0,00	Fixed Effects	Fixed Effects
Part 2	(VolE_AT)	0,16	Pooled	0,03	Fixed Effects	0,04	Fixed Effects	Fixed Effects
	(VolE_AT)	0,00	Random Effects	0,00	Fixed Effects	0,00	Fixed Effects	Fixed Effects
	(VolET_AT)	0,00	Random Effects	0,00	Fixed Effects	0,00	Fixed Effects	Fixed Effects
	(VolET)	0,16	Pooled	0,00	Fixed Effects	0,01	Fixed Effects	Fixed Effects
	(RetS)	0,79	Pooled	0,37	Random Effects	0,42	Pooled	Pooled

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