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Unraveling the Dynamics of Derivative-Based Hedging

Does it Impact the Cost of Debt?

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Abstract

Title: Unraveling the Dynamics of Derivative-based Hedging: Does it Impact the Cost of Debt?

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Key words: Cost of debt, yield spread, hedging, IR, FX, CM, derivative-based hedging

Purpose: To investigate whether a firm's hedging activities have an impact on the cost of debt. Moreover, the study aims to investigate any differences between the three categories of risk: foreign exchange rate risks (FX), interest rate risks (IR) and commodity price risks (CM) as well as the sources of benefit from hedging.

Methodology: The study is conducted on a panel data set, and the utilized econometric approach includes pooled OLS, fixed effects, and an interaction term to test the moderating effect of market imperfections. The dependent variable is yield spreads on corporate bonds, and the main explanatory variables are hedging of interest rates, currencies, commodity prices, or the total extent of hedging activities. The sensitivity of the results is tested through several robustness tests.

Theoretical perspectives: The theoretical perspectives include Miller and Modigliani Ideal Capital Markets, Financial Distress, Agency theory, and Information Asymmetry.

Empirical foundation: The study consists of a sample of 1007 firm year observations on 186 non-financial, European firms with publicly traded bonds from the time period 2017-2022.

Conclusion: The study finds that the nominal amount of hedging is statistically significant, reducing the yield spread with 8 bps, implying a negative relationship to cost of debt. Furthermore, when studying the three categories of risk, the results indicate that IR hedge significantly reduces the yield spread while no such findings can be concluded for FX hedging or CM hedging.

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Table of Contents

1. Introduction..1
1.1 Background..1
1.2 Problem Discussion..2
1.3 Purpose, Contribution, and Findings..3
1.4 Outline..4
2. Literature Review and Hypothesis Development..5
2.1 Theoretical Literature..5
2.1.1 Miller & Modigliani and Perfect Capital Markets..5
2.1.2 Market Imperfections..5
2.1.2.1 Financial Distress Costs..5
2.1.2.2 Agency Costs..6
2.1.2.3 Information Asymmetry..7
2.2 Empirical Literature..8
2.2.1 Hedging..8
2.2.2 Hedging and the Cost of Debt..9
2.2.3 Hedging in Europe..10
2.3 Hypothesis Development..10
2.3.1 Hedging and the Cost of Debt..10
2.3.2 Understanding the Sources of Benefit from Hedging..11
3. Data and Sample Description..13
3.1 Sample Description..13
3.2 Dependent Variable: Cost of Debt..14
3.3 Explanatory Variables: Hedging, Control and Moderating variables..16
3.3.1 Hedging Variables..16
3.3.2 Control Variables..17
3.3.2.1 Firm Characteristics..18
3.3.2.2 Bond Characteristics..19
3.3.2.3 Macroeconomic Environment..20
3.3.3 Moderating Variables..20
3.4 Summary Statistics..21
3.4.1 Correlation Analysis..25
4. Methodology..27
4.1 Econometric Design..27

4.1.1 Multivariate Analysis 27
4.1.2 Modeling Choices 29
4.1.2.1 Fixed- and Random Effects 29
4.1.2.2 Endogeneity 30
4.1.1.3 Heteroskedasticity 32
4.2 Robustness 32
5. Empirical Results & Analysis 33
5.1 Multivariate Analysis 33
5.1.1 Hedging and the Cost of Debt 33
5.1.2 The Three Categories of Risk 35
5.1.3 Control Variables 36
5.1.4 The Moderating Effect of Market Imperfections 38
5.1.4.1 Financial Distress Costs 38
5.1.4.2 Agency Costs 41
5.1.4.3 Information Asymmetry 43
5.2 Robustness Tests 44
6. Conclusion 46
Bibliography 48
Appendix 53

List of Tables

Table 1, Bond Observations Distributed over Year, Industry, and Country....................15
Table 2, Summary Statistics..22
Table 3, Hedging by Industry and Country 24
Table 4, Pairwise Correlation 26
Table 5, POLS Total Hedging..34
Table 6, POLS IR/FX/CM...37
Table 7, Financial Distress 40
Table 8, Agency Costs..42
Table 9, Information Asymmetry..44
Table 10, Variable Definition..54
Table 11, Hausman Test..55
Table 12, White's Test 55
Table 13, Robustness tests Total Hedging 56
Table 14, Logged Yield Spread and Z-Spread IR, FX, and CM Hedging........................57
Table 15, Lagged IR, FX, and CM Hedging...58

1. Introduction

1.1 Background

For a long time, the vast majority of corporate managers viewed various risks faced by their respective company in isolation. Typically, risks were viewed independently, not putting emphasis in understanding interdependencies and correlations between different risks (Harrington and Niehaus, 2002). Even if today's globalized world and well-developed financial markets offer great opportunities for corporations, it also introduces various risks that if left unattended might prove costly. Such include price risks which revolve around changes in different market-based parameters, including foreign exchange rates (FX), interest rates (IR), and commodity prices (CM).

One way for managers to protect themselves from these price movements could be by the use of hedging. Hedging can take several forms but is typically divided into three groups. First, operational hedging, which aims to protect against financial risk exposures by means of non-financial instruments. A second type of hedging is natural hedging, where risk managers seek to mitigate risk by investing in assets whose performance is negatively correlated. Lastly, derivative-based hedging, which the name suggests, uses various financial derivatives in order to handle risk exposure (Hoberg & Moon, 2017). These include products such as futures, forwards, swaps, and options which are intended to reduce the volatility of cash flow and earnings. The global market for derivatives amounted to well over an astonishing $700 trillion in mid-2023 (ISDA, 2023).

Stulz (2022) strongly advocates for the use of derivative-based hedging as an efficient tool in order to mitigate and eliminate the realization of costly lower-tail outcomes. However, it is not obvious that this responsibility lies with the firm. Some investors might prefer the current risk level in the firm's operations and therefore are hesitant towards entering into costly and time-consuming hedging contracts when they can just as well diversify on their own (Nocco & Stulz, 2006). This debate leads us to question whether firms are indeed better off hedging their risk exposures or not, which both theory and research has attempted to answer.

1.2 Problem Discussion

Miller and Modigliani (1958) pioneered the field of corporate finance with their groundbreaking paper on financial policy irrelevance. More specifically, their work has served as a roadmap for subsequent researchers in the field of capital structure and today, 66 years later, is still widely cited and used in academia. At its essence, their theory is centered around the notion of ideal capital markets. Such markets have no costs related to either the choice of financing, or bankruptcy costs. This would imply that firm value and investors are indifferent in the choice of financial policy, including active risk management, seeing as any financing decisions can be replicated by the investors themselves (Miller & Modigliani. 1958).

However, markets are rarely perfect, and the costs inherent in failing to adequately address market imperfections create the need for active risk management. Neglecting these imperfections will, ceteris paribus, impact firm value and thus affect investors. Examples of market imperfections include distress costs, agency costs, and information asymmetry. Their implications can be altered either by operational changes or by entering into financial contracts (Hoberg & Moon, 2017)[1]. One such financial contract is hedging. Existing literature mainly revolves around how hedging directly, or indirectly, by mitigating or reducing the aforementioned imperfections, can increase firm value (see e.g., Carter, Rogers & Simkins, 2008; Jin & Jorion, 2006; Nelson, Moffitt & Affleck-Graves., 2005; Panaretou, 2014).

Furthermore, a few studies have tried to empirically prove the effects hedging has on the cost of debt and the explanations behind these. Chen and King (2014) studied the impact hedging has on public debt and found proof that hedging indeed leads to lower yield spreads for non-financial firms. The findings were attributed to reduced risk of financial distress, decreased agency costs, and reduced information asymmetry. Furthermore, a moderating effect of these market imperfections on the relationship between hedging and cost of debt was found (Chen & King, 2014). A somewhat similar study was conducted by Campello, Lin, Ma, and Zou (2011) but instead of proxying for cost of debt through public debt, the authors used spreads on bank loans. They prove that a one standard-deviation increase in hedging intensity results in a reduction of 54 bps in loan spreads, relative to the average spread of 189 bps.

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[1] From this point onwards, derivative-based hedging is always referred to as hedging, while operational- or natural hedging will always be specified whenever discussed.

Given the limited amount of research on the topic of hedging and the cost of debt, as well as the somewhat outdated studies, there is a need for further research on the topic. Both Campello et al. (2011) and Chen and King (2014) conducted their studies on the North American market between the years 1996-2002 and 1994-2009. To extend the current research in the field, there is an argument to be made that there is a need for a similar study with more recent data on a different geographic region. To this end, this study hopes to contribute by studying the years 2017-2022 focusing on non-financial, European firms. The European market can be considered rather homogenous since most countries within the continent rely on the same general company laws, as well as formal regulation and soft law, including abiding by the same standards and codes (Riksbanken, 2022). The common regulatory framework is one of the most significant areas where the EU (European Union) has attempted to create harmonizing financial regulations. Examples include The Markets in Financial Instruments Directive (MiFID) and the Central Securities Depositories Regulation (CSDR) which in short aims to increase consumer protection as well as improve financial market transparency (Finansinspektionen, 2021; Finansinspektionen, 2023).

1.3 Purpose, Contribution, and Findings

The purpose of this study is to determine how a firm's hedging activities impact the cost of debt, measured as the yield spread between government debt and a firm's outstanding bonds. Moreover, the study aims to investigate any differences between the three categories of risk: foreign exchange risks (FX), interest rate risks (IR) and commodity risks (CM). The study wishes to answer the following research questions:

- How does the total extent of hedging activities, as well as the specific hedging of IR, FX, and CM risks, impact the cost of debt?
- What are the sources of benefit for firms that engage in derivative-based hedging?

While many of the previous studies have been conducted on the U.S. market, this paper hopes to contribute by being the first to test if the extent of hedging has an impact on the cost of debt for non-financial European firms. Additionally, almost a decade has passed since the last extensive study on the relationship between hedging and the cost of debt, and this paper intends to fill the void with data on a more recent period.

In order to fulfill the purpose of this study, pooled OLS (POLS) regression analysis was used to test the hypotheses on a sample of 186 non-financial public European firms across 17 different countries. The findings suggest that hedging, and more specifically hedging interest rate risks, significantly reduces the cost of debt. The results prove robust to alternative model specifications. Furthermore, the results indicate that sources of benefit from hedging includes decreased risk of financial distress costs and reduced information asymmetry. This study could constitute the basis for well-informed decisions on the topic of hedging and the findings might prove useful to firms considering whether to engage in derivative-based hedging or are hesitant towards which risk category they should hedge.

1.4 Outline

The following chapters of this paper are outlined as follows. Chapter 2 provides a thorough explanation of the theoretic frameworks, a walk-through of previous literature on hedging and the development of the hypotheses. Chapter 3 delves into the data and sample description, outlining the dependent and explanatory variables as well as providing summary statistics. Chapter 4 describes the chosen methodology where focus is on the econometric design and robustness tests. Chapter 5 discusses the empirical findings, and chapter 6 concludes this paper.

2. Literature Review and Hypothesis Development

This chapter begins with a theoretical overview of why hedging might be a preferable way for firms to manage their risk exposures, stemming from different market imperfections present in today's financial markets. Drawing from these imperfections, the chapter is followed by an empirical review of previous literature on the topic, providing evidence on the benefits from hedging. Based on previous findings and the theoretical framework, this chapter ends with the development of seven hypotheses.

2.1 Theoretical Literature

2.1.1 Miller & Modigliani and Perfect Capital Markets

In a world with perfect capital markets, there are no costs related to either the choice of financing, or bankruptcy (Miller & Modigliani, 1958). Therefore, financing decisions, including any risk management activities, would be irrelevant since investors could replicate these on their own. This implies that firms are indifferent in how it chooses to finance its business.

2.1.2 Market Imperfections

However, research tells us that markets are rarely perfect (see Jensen & Meckling, 1976; Myers, 1977; Smith & Stulz, 1985). Market imperfections are to a high degree present, and since there are costs linked to these, firms can manage them in various ways, either by entering into contracts or by altering its operations, mitigating the effects. Some of these imperfections will be discussed below.

2.1.2.1 Financial Distress Costs

An example of the aforementioned market imperfections are costs related to financial distress, potentially eroding firm value in an imperfect market. Such costs tend to be high when earnings and cash flows are volatile, increasing the probability of default (Myers, 1984). Myers defines financial distress costs as legal and administrative costs of bankruptcy, including moral hazard, monitoring, and contracting costs. Even if firms manage to avoid default, these costs may very well erode firm value. The author argues that without such costs, there would be no need for creditors to impose costly debt covenants on their borrowers. Jensen and Meckling (1976) highlighted financial distress costs in their work, discussing how firms may refrain from further debt due to the wide array of costs that comes with it. Smith and Stulz (1985) extend on the topic and argue that such costs may arise when firms experience financial difficulties, and if left unattended it may result in bankruptcy. The authors argued that hedging can serve as a mechanism to mitigate the risk of financial distress and reduce the likelihood of bankruptcy. By hedging against adverse movements, firms can stabilize their cash flows and financial performance, thereby reducing the probability of experiencing severe financial distress.

2.1.2.2 Agency Costs

Agency costs have been the subject of countless research in the last decades, trying to understand the principal-agent problem prevalent in most firms. Myers (1977) was among the first to discuss the issue, and in short, principal-agent problems arise due to divergent interests between managers (agent) and owners (principal). Moreover, Myers studied in detail the topic of underinvestment, specifically examining how a firm's investment decisions are affected by different sources of financing. He argued that credit rationing in the form of sufficient access to capital or concerns regarding current debt levels may lead to firms foregoing NPV-positive investment opportunities. Traditional finance theory suggests that the value of a firm equals the present value of all future cash flows which indicates that foregone value creating projects have a direct impact on the value of the firm (Myers, 1977). Despite value creating investment opportunities, managers might be reluctant to undertake these, mainly due to fear of the consequences of adding additional debt. For instance, increased debt may very well impact firms' financials and lead to poor firm performance, negatively impacting management compensation or job security (Myers, 1977). However, hedging alleviates this problem by reducing the probability of poor outcomes occurring (Chen & King, 2014). Similar to Chen and King (2014), Froot, Scharfstein, and Stein (1993) argued that hedging can be used as an efficient tool for firms in order to avoid underinvestment problems. More predictable cash flows eliminate uncertainty resulting in creditors being more confident in the borrower's ability to repay its debt obligations.

Another important aspect of the principal-agent relationship revolves around risk-shifting where Jensen and Meckling (1976) can be considered pioneers. Risk-shifting suggests that firms (especially distressed firms close to default) try to benefit equity holders at the expense of debt holders by investing in high-risk projects. If the investment proves successful, the shareholders benefit, whereas creditors bear the risk if the opposite occurs. Hedging might be a preferable way to mitigate such risk-shifting problems since it reduces the risk of financial distress and the volatility of both earnings and cash flow (Giambona, Graham, Harvey & Bodnar, 2018). Campbell and Kracaw (1990) find similar results, illustrating how risk-shifting is closely related to the observed risk in the firm. When the incentive for firms to substitute towards riskier assets increases, so does the observable risk, resulting in higher costs of debt. Moreover, the authors argue that whenever observable and unobservable risks are perfectly positively correlated, any increases (decreases) in observable risk create incentives which lead to increases (decreases) in unobservable risk. Therefore, by entering into a hedging contract, a firm may protect itself from observable risks which might reduce agency costs, ultimately benefiting both the firm and its debt holders.

2.1.2.3 Information Asymmetry

Here, emphasis is put on describing costs in the manager-stakeholder relationship, typically characterized by one part (usually the manager) having superior information. Akerlof (1970) paper on the topic of information asymmetry has been widely cited in the last decades. It highlights the problems inherent in the aforementioned manager-stakeholder relationship and is illustrated with a scene from a car dealership containing both high-quality cars known as peaches and low-quality cars known as lemons. Because buyers are unable to accurately assess the true value of a used car, they are only willing to pay an average price of the two, which is driven down by the presence of potential lemons. Consequently, sellers of high-quality cars are less likely to sell at this price, leading to a situation where only lower-quality cars dominate the market. Akerlof argues that when sellers have more information about the quality of their products than buyers do, it leads to situations where only low-quality products (lemons) tend to be traded, undermining the efficiency of the market. Since the introduction of Akerlof (1970) market of lemons, information asymmetry has been a dominating explanatory theory in various streams of corporate finance. Extensive information asymmetry results in the less informed party imposing costs to protect itself from any uncertainty. These include costs linked to monitoring, adverse selection, and signaling to mention a few.

The impact asymmetric information has on the bond and equity markets has been covered extensively by previous literature. For instance, Yu (2004) finds that perceived quality of accounting information correlates with lower yield spreads. When stakeholders perceive a lack of transparency, it may signal hidden, negative news about a company, which should be reflected in the credit terms, referred to as a ‘Transparency spread’. Additionally, DaDalt, Gay, and Nam (2002) provides evidence that both the use of derivatives and the extent of derivatives usage is associated with lower asymmetric information by reducing volatility in earnings and cash flow. This reduction should lead to lower monitoring costs from debt holders, resulting in more generous credit terms. Furthermore, debt holders should be less inclined to impose costly covenants when designing contracting terms, thereby providing the borrower with greater operational flexibility.

2.2 Empirical Literature

2.2.1 Hedging

The topic of hedging has been widely cited and has been the subject for countless research articles throughout the years. Petersen and Thiagarajan (2000), compare two firms who operate within the same industry. Both firms manage their risk using vastly different hedging strategies. One firm aggressively uses derivatives in order to hedge while the other limits its hedging activities to purely operational alternatives, not using derivatives. They find that compensation structure has a large part to play in terms of incentives of the managers and how they choose to manage risk. The firm that actively hedges using derivatives is primarily managed by the founders who hold a significant portion of equity. Their compensation is therefore linked to stock values, which means that they prefer smoothness in earnings and cash flow streams. On the contrary, the managers of the firm that prefers operational alternatives over the use of derivatives, own a small fraction of equity meaning that their compensation is tied to different profitability measures.

Nevertheless, previous literature has mainly focused on how hedging, in the presence of market imperfections, can influence firm value. Examples include Nelson et al. (2005) and Panaretou (2014) who investigated how firms engaging in derivative-based hedging impact firm value. Both papers find that these firms outperform their peers. Furthermore, Carter et al. (2008) studied the U.S. airline industry and found that in general, airline industry investment opportunities correlate positively with jet fuel costs, while higher fuel costs are consistent with lower cash flow. The study found that hedging jet fuel is positively related to firm value since it allowed firms to capitalize on the aforementioned investment opportunities. Jin and Jorion (2006) conducted a similar study, but instead chose to analyze 119 U.S. oil and gas producers.

They manage to verify that hedging reduces the firm's stock price sensitivity to oil and gas prices.

More recent studies like Giambona et al. (2018) extend on previous literature. In their survey data of over 1100 risk managers across the globe, they find that 90% of risk managers in non-financial firms' hedge, using either financial or operational hedging alternatives. The most popular reasons are to increase expected cash flows, as well as smoothing earnings and pleasing stakeholders' expectations. The authors find that from a sample of 609 foreign firms, 59% of non-financial firms indicate that financial derivatives are a part of their risk management. Their findings show that from the various risks faced, non-financial firms mostly hedge their foreign exchange risk. Approximately 70% of respondents hedge their FX risks and the most common reasons among non-financial firms was either that it was a part of the firm's pricing strategy or that they had borrowed in foreign currencies. Hedging interest rate risk is slightly behind in popularity but is a close second. For commodity risks, the number was around 40% which the authors attribute to differences among industries in the extent of commodity price risk faced by firms. Interestingly, operational hedging is more popular than financial. However, for some forms of financial risk, such as FX, IR, and CM, firms tend to prefer a mix of both operational and derivative-based methods.

2.2.2 Hedging and the Cost of Debt

A few papers have studied the relationship between hedging and the cost of debt. Chen and King (2014) empirically studied the impact hedging has on public debt for U.S. firms between 1994-2009 through a binary hedging variable and found significant proof that hedging resulted in lower spreads. The authors chose to investigate the use of derivatives to hedge three types of risk: IR, FX, and CM. When looking at differences between firms, investment-grade rated firms that hedge showed a difference in yield spread amounting to 19,2 bps, while the effect was even greater for speculative-grade firms, having a yield spread of 45,2 bps lower than the non-hedging counterpart. The results can be attributed to reduced risk of bankruptcy, decreased agency costs, and reduced information asymmetry. Furthermore, the authors find that these imperfections have a moderating effect on the relationship between hedging and the cost of debt.

Campello et al. (2011) instead studied the spread on bank loans and, using both binary and continuous hedging variables, found comparable results. The authors found that a one-standard-deviation increase in hedging intensity was associated with a reduction of about 54 bps in loan spreads, relative to the average spread of 189 bps. Moreover, the study also proves that firms that hedge are less likely to have restricting covenants in their contracts. They prove that hedging activities limit the number of possible outcomes which results in better access to external funding. Like Chen and King (2014), the effect is larger for firms with a higher probability of facing financial distress costs and more severe agency costs than for those who do not. Lastly, they argue that hedging mitigates the risk for all stakeholders involved, including creditors, borrowers, and shareholders.

2.2.3 Hedging in Europe

Panaretou (2014) chose to study the British market, analyzing how hedging impacts firm performance for a sample of large, non-financial firms. She found that hedging IR and FX risks are more common than hedging CM risks. Moreover, her findings show that hedging premium is statistically significant for IR and FX hedging, while she finds no evidence that CM hedging significantly impacts firm value.

Giambona et al. (2018) compared North American to foreign firms and found that both groups are equally exposed to IR risks, approximately 75% of respondents. The same pattern can be found when comparing CM risks. For both regions, an estimated 35% of respondents perceive such risks. The largest discrepancy between North American firms and their foreign counterparts can be found in FX risks. Approximately 50% of North American respondents claim that they are exposed to such risks. The corresponding number for foreign firms is just below 80%, indicating that firms in the two regions perceive FX risks differently.

2.3 Hypothesis Development

2.3.1 Hedging and the Cost of Debt

As previously mentioned, some of the stronger arguments for firms to engage in financial hedging include reduced volatility of cash flow and earnings, consequently reducing costs linked to market imperfections (Campello et al., 2011; Chen & King, 2014; DaDalt et al., 2002; Froot et al., 1993; Smith and Stulz 1985). Greater predictability should satisfy bondholders since a reduction in uncertainty increases the likelihood of the issuer repaying its debt obligations. Decreasing the risk for costly lower-tail outcomes increases predictability for the firm and consequently, its creditors. All else equal, this should lower the required rate of return from lenders, negatively impacting the yield spread.

Decreasing the volatility of cash flow and earnings is usually done by hedging one of the three categories of risk: IR, FX, and/or CM. Since all of them are intended to protect against different market-based risks and ultimately increase predictability, they are expected to show a negative relationship with the cost of debt. Previous literature (see Campello et al., 2011; Chen & King, 2014) find considerable evidence that these are associated with lower spreads. However, Panaretou's (2014) results are somewhat conflicting, finding significance for FX and IR, but not for CM hedging, when regressing on firm performance.

Giambona et al. (2018) finds that foreign firms are more prone to hedge FX risks than their North American counterparts. This is an interesting observation since other studies prove that FX hedging is negatively associated with yield spread, which could impact the results. Since this study investigates a new geographic market, it is relevant to speculate on potential differences from the findings in previous studies. However, this does not change the fact that the expectations of the relationship between hedging and the cost of debt are similar to the aforementioned studies.

Drawing on previous literature and the above reasoning, the following hypotheses have been formulated:

H1: Hedging reduces the Cost of Debt

$H1_A$: IR hedging is associated with a negative impact on the Cost of Debt

$H1_B$: FX hedging is associated with a negative impact on the Cost of Debt

$H1_C$: CM hedging is associated with a negative impact on the Cost of Debt

2.3.2 Understanding the Sources of Benefit from Hedging

As previously mentioned, hedging can serve as a tool to mitigate costs of financial distress as well as increase debt capacity (Campello et al., 2011; Chen & King, 2014; Smith and Stulz; 1985). The source of benefit from hedging is the possibility to reduce cash flow volatility and consequently, reduce the probability of experiencing distress. Thus, firms facing larger risk of financial distress costs are expected to benefit more from hedging compared to their non-distressed counterparts.

Furthermore, theoretically and empirically, firms experiencing a larger extent of agency costs should benefit more from hedging (Campello et al. 2011; Chen & King, 2014; Froot et al., 1993). Froot et al. (1993) argue that hedging may help alleviate Myer's (1977) agency cost of underinvestment through reducing the probability of bad investment outcomes as well as increasing the predictability of cash flows, allowing for more debt capacity. Additionally, hedging may be a tool for firms to combat the Jensen and Meckling (1976) described risk-shifting (Campello et al., 2011; Chen & King, 2014). By reducing the asset and earnings volatility, as well as reducing the possibility to substitute the current assets for more risky ones, hedging activities may be seen as beneficial for creditors (Campello et al., 2011; Chen & King, 2014). To summarize, the source of benefit in hedging for firms from an agency cost perspective is the possibility to reduce risk-shifting and mitigate the underinvestment problem, which is beneficial to creditors. Therefore, hedging is hypothesized to be more valuable for firms facing severe agency costs.

Since the introduction of Akerlof (1970) market of lemons, information asymmetry has been a dominating explanatory theory in various streams of corporate finance. Hedging is no different, and information asymmetries impact asset prices through a firm's disclosures influencing investors' expectations on future cash flows (Chen & King, 2014; Yu, 2004;). As such, seeing as derivatives increase the transparency of a firm's cash flow streams (Chen & King, 2014; DaDalt et al., 2002), bondholders should demand a lower return for firms engaging in hedging activities due to lower monitoring costs as well as a reduction in the Yu (2004) described 'Transparency spread'. Hence, hedging is hypothesized to be more valuable for firms facing more information asymmetry.

In conclusion, the exploration and theoretical understanding of sources of benefit from hedging will involve examining the moderating effect of three market imperfections on the relationship between hedging and the cost of debt. Drawing on the theoretical framework, the following hypotheses have been formulated:

H2: Hedging is more valuable for firms with a higher risk of financial distress

H3: Hedging is more valuable for firms facing high agency costs

H4: Hedging is more valuable for firms with a high degree of information asymmetry

3. Data and Sample Description

3.1 Sample Description

The sample of this study is constituents on the STOXX Europe 600 index between the years 2017-2022. The index covers around 90% of the free-float market capitalization of the European stock market across 17 European countries, and consequently, includes the largest public firms around Europe (STOXX Ltd., 2023). Benefitting from the large market capitalization of the firms, a vast majority reports in accordance with IFRS 9 rule on Hedge Accounting, and thus in detail, disclose information on their hedging activities. The process on how hedging data is gathered is further described in 3.3.1 *Hedging Variables* but it follows the standards set up by previous literature (see Campello et al., 2011; Chen & King, 2014; Panaretou, 2014). Furthermore, in line with previous literature as well as the purpose of the study, all financial institutions and insurance companies were excluded from the sample due to these firms usually acting as counterpart in hedging contracts. This left us with ≈ 440 firms in the index. Only firms who either A) reports the nominal amount of outstanding derivatives or B) have no outstanding derivative contracts at year end were included in the final sample. The final dataset includes hedging data over 1323 firm-years, across 222 firms.

Bond data was gathered through the *Refinitiv Eikon* database, but given the structure of our data, we were only able to include currently active bonds.[2] This comes with the disadvantage of potentially having a less accurate approximation for the cost of debt in the earlier years of our study since bonds have matured. However, since we are interested in the weighted average yield at the year-level, coupled with the fact that we are researching large firms who generally have several outstanding bonds, the impact is considered negligible. Nonetheless, a total of 3946 bond observations were gathered, but after removing bonds with missing data, as well as perpetual and securitized bonds following previous research (Chen & King, 2014), the sample included a total of 2849 bond-level observations. Table 1 reports bond observations distributed over year, country, and industry.

[2] Currently active refers to bonds active as of 2024-04-22, the date when the data was gathered.

Subsequently, the hedging and bond data was matched at the year-level, and after removing firm observations that had no outstanding bonds or were missing control variables, we ended up with our final sample of 186 firms and 1007 firm-year observations.

3.2 Dependent Variable: Cost of Debt

The dependent variable of the study is cost of debt, which measures the cost to the firm of borrowing funds to finance its operations (Damodaran, 2006). The cost of debt should reflect the default risk that lenders perceive in the firm, and as it increases, lenders will charge higher spreads (excess of the risk-free rate). Further, Damodaran (2006) mentions two common estimation methods of the cost of debt, namely the YTM (yield to maturity) or the credit rating. The YTM reflects the required rate of return from bondholders, and thus serves as a good indication of how the market perceives the riskiness of the firm. Following Damodaran (2006) and previous research in the field (Chen & King, 2014), this study will measure the cost of debt through the *Yield Spread*. The data on *Yield Spread* is based on *Refinitiv Eikon*'s benchmark spread, which is the spread between the yield of a bond and a related government security with similar maturity. Chen & King (2014) adopts an estimation method where the yield spread is estimated by the difference between the YTM on a corporate bond at each bond transaction with the yield of a Treasury security that has a modified duration within two months of the corporate bond. For a given bond in a given year, a weighted average spread is then calculated using total transaction volume as the weight. Lastly, at the firm-year level, the total amount outstanding is used to compute a weighted average yield-spread for a given firm.

Given the data availability and scope of this thesis, our estimation method follows a similar approach but with the difference of only calculating the weighted average yield spread at the firm-year level, and not including the bond-level transactional weighted yield spread. Worth considering is that the estimation method used comes with the disadvantage of not being as accurate as the method deployed by Chen and King (2014), however, it has the advantage of being more consistent, efficient, and simplistic.

Table 1, Bond Observations Distributed over Year, Industry, and Country

Panel A: Year			Panel B: Industry			Panel C: Country		
	Freq.	**Percent**		**Freq.**	**Percent**		**Freq.**	**Percent**
2017	1040	36.50%	**Agriculture, Mining, and Construction**	135	4.74%	**Austria**	16	.56%
2018	303	10.64%	**Manufacturing**	1254	44.02%	**Belgium**	76	2.67%
2019	354	12.43%	**Transportation**	33	1.16%	**Denmark**	37	1.30%
2020	424	14.88%	**Communications and Utilities**	525	18.43%	**Finland**	30	1.05%
2021	347	12.18%	**Wholesales and Retails**	418	14.67%	**France**	499	17.51%
2022	381	13.37%	**Real Estate**	95	3.33%	**Germany**	663	23.27%
			Services and Public Administration	167	5.86%	**Ireland**	29	1.02%
			Oil and Gas	222	7.79%	**Italy**	202	7.09%
						Luxembourg	10	0.35%
						Netherlands	41	1.44%
						Norway	25	0.88%
						Portugal	19	.67%
						Spain	161	5.65%
						Sweden	121	4.25%
						Switzerland	256	8.99%
						U.K.	664	23.31%
Total	**2849**	**100.00%**		**2849**	**100.00%**		**2849**	**100.00%**

Table 1 reports the bond observations distributed over Year, Industry, and Country. As one can note in Panel A, 2017 has the largest percentage of bond issuance which can be attributed to the fact that 2017 also includes all bonds issued in prior years. Furthermore, in Panel B we note that Manufacturing is the industry with the highest percentage of bond issuance, which is expected, seeing as this is the industry most firms in our sample belong to. Finally, as illustrated in Panel C, the country with the most bond issuance is the U.K., closely followed by Germany. This is also in line with what is expected given our sample distribution.

To increase the robustness of our results, we will deploy two alternative measures for the *Yield Spread*. Firstly, the natural logarithm of *Yield Spread* will be used to mitigate potential skewness in the data, following Campello et al.'s (2011) methodology of logging loan spread. Secondly, the Z-spread, or the Zero-Volatility spread, will be employed as a novel variable. The Z-spread is less commonly used in literature, but Klein and Stellner (2014) were among the first to use the metric in their study on corporate bonds and sovereign credit risk. Simply described, the Z-spread is an alternative to the nominal yield spread to quantify the additional risk a corporate bond has to the risk-free equivalent. Technically speaking, it is the constant spread that, when added to the yield at each instance along the spot rate Treasury curve where there is a cash flow, makes the price of a security equal to the present value of its cash flow. Klein and Stellner (2014) argue that there are several advantages of using the Z-spread instead of the nominal yield spread, including the fact that the Z-spread encompasses more information on the term-structure of interest rates and is less biased than the conventional yield spread.

3.3 Explanatory Variables: Hedging, Control and Moderating variables

3.3.1 Hedging Variables

Following the discussion in 3.1 *Sample Description*, a vast majority of the sample discloses their hedging activities in accordance with IFRS 9 rule on Hedge Accounting. This facilitated a fast and standardized process of collecting the data on hedging, seeing as the data needed to be hand collected from each firm's Annual Report, Universal Registration Document, or 10-K filing.[3] Specifically, for each firm at year t, the derivative usage is found by applying a keyword search including, but not limited to, the following words: *Hedge, Derivative, Currency Swap, Exchange Forward, Interest Rate Swap, Commodity, Nominal, Notional,* and *Contractual Amount*. Upon identifying a relevant keyword, the results are analyzed to ascertain whether the instrument is related to a FX, IR, or CM hedge. As a final step, the total outstanding nominal amount for each category of derivative instrument classified as for non-trading purposes is recorded for the firm.

[3] Depending on where a firm is headquartered, or which stock exchange it is listed on, they have different regulations on what filing is required. For example, common for French companies is the filing of a Universal Registration Document, and some firms in the sample are cross-listed in the U.S., and thus file a 10-K.

Previous studies have followed a similar approach in the data gathering process (see Campello et al., 2011; Chen & King, 2014; Panaretou, 2014), however, proxying for hedging activities have differed. Chen & King (2014) uses only binary hedging variables, while Campello et al. (2011) and Panaretou (2014), apart from binary variables, also includes continuous hedging variables. Consistent in all papers is that derivative usage for hedging purposes is broken down into three categories to each distinctively manage their respective risk: *IR*, *FX*, and *CM*.

This paper has adopted the methodology of Campello et al. (2011) and Panaretou (2014), using both a binary and continuous variable for each individual risk category, as well as the total amount. However, as seen in Table 2, 94% of our sample hedges some risk exposure[4], suggesting a low variability in the dummy variable, limiting its discriminatory power in explaining the relationship with the cost of debt. The individual risk categories suffer from the same issue, with the exception of commodity hedgers which equals 41% of the sample. To ensure consistency, this paper will only use a continuous variable to proxy for the total amount and each category of risk hedging activities in all regressions.[5] The variables are denoted *Total Hedging*, *IR Hedging*, *FX Hedging*, and *CM Hedging* for the remainder of the paper. The variables are constructed in a similar manner to Campello et al. (2011) and Panaretou (2014) by scaling the outstanding nominal amount of hedging contracts at the end of the fiscal year to the total assets of the firm.

3.3.2 Control Variables

To control for effects on the cost of debt, various control variables have been included in each regression. The variables have been meticulously chosen based on previous literature and can be grouped into three distinct categories: firm-specific controls, bond controls, and macroeconomic controls. A summary of all variables and their predicted relationship to the *Yield Spread* is found in Table 10 in the appendix.

[4] Comparing this figure to Campello et al's (2011) 50.1% and Chen & King's (2014) 53% one can note that the papers' samples have a much larger degree of variability in their dummies, enabling meaningful usage of a binary variable.
[5] Worth mentioning however, is that the dummy variables will still be used to describe and discuss country- and industry differences, as well as comparing the sample with other studies.

3.3.2.1 Firm Characteristics

To begin with, this study uses controls for various previously empirically found firm-specific determinants on the cost of debt (see Campello et al., 2011; Chen & King, 2014). Firstly, *Firm Size*, proxied by the logarithm of a firm's total assets as at the end of the fiscal year, is included in all regressions. We predict the variable to have a negative effect on the *Yield Spread*, since larger firms should have more liquid bonds and better access to capital markets. Previous empirical findings suggest this relationship to hold (Campello et al., 2011; Chen & King, 2014).

Furthermore, as a proxy for the riskiness of a firm, the variable *Leverage* is included. Leverage is calculated following Campello et al. (2011) and is defined as the book value of total debt over the book value of total assets, rather than the Chen & King (2014) used proxy which is book value of total debt over the market value of assets. The choice was due to data availability. However, the prediction regarding the variable is the same, that more risky firms (higher leveraged) should have a higher cost of debt which is in line with previous empirical findings. Somewhat similar to *Leverage*, we also include *Altman Z-score*, *Interest Coverage*, and *Credit Rating* as proxies for credit risk following previous literature. Given the fact that a higher Z-score means a firm is further away from default, and that *Interest Coverage* is defined as EBITDA divided by interest expenses, we expect both *Altman Z-score* and *Interest Coverage* to be negatively related to yield spreads. The same relationship is anticipated for *Credit Rating* and here, previous literature has either chosen to include a dummy for each credit rating (Campello et al., 2011) or assign a value to each rating to transform it to a numerical scale (Chen & King, 2014). This study follows the latter approach and uses Moody's credit rating scale, where for example, an Aaa rating equals 22, Aa1 equals 21, and so on.

Moreover, a firm's profitability is expected to negatively impact the *Yield Spread* due to perceived higher degree of stability and lower credit risk. Following Campello et al. (2011) and Chen and King (2014), we proxy for *Profitability* by using EBITDA over total assets. Previous literature also suggests that firms with an ample amount of growth opportunities have a larger incentive to engage in risk-shifting behavior which should increase the cost of debt. However, findings are somewhat conflicted, with a possible explanation for the opposite relationship being that a high *Market-to-Book (MTB)* could indicate that there are more claimable assets in the case of default (Chen & King, 2014). Therefore, to control for these effects, the variable

MTB is added to all models, and is defined as market value of equity plus the book value of debt divided by total assets following Campello et al. (2011).

Furthermore, to capture a firm's asset risk, *Earnings volatility*, defined as the standard deviation of the first difference in EBITDA scaled by total assets over a four-year period, is included in the regression. Higher asset risk should increase the cost of debt which is supported by Chen and King's (2014) results. Related to a firm's asset risk, *Tangibility*, proxied by net PP&E over total assets following the same approach as Campello et al. (2011), is also included in all regressions. More tangible assets provide firms with larger collateral capacity and are usually less prone to informational asymmetric relationships. Therefore, we anticipate a negative relationship between tangibility and the cost of debt. Lastly, the variable *Private debt ratio (PDR)* is calculated for all firms, which is the private debt over total assets. Private debt is calculated based on Chen and King's (2014) approach and is the book value of total debt subtracted by the face value of commercial papers, notes, subordinated debt, and debentures divided by total assets. A higher private debt ratio is expected to increase the cost of debt due to the lower credit hierarchy of notes, subordinated debt, and commercial paper and potentially lower recovery rates of public debt (Chen & King, 2014).

3.3.2.2 Bond Characteristics

Apart from the aforementioned controls for firm-specific characteristics, three control variables for bond characteristics are included. Firstly, following Campello et al. (2011) the natural logarithm of days to maturity is in all regressions to proxy for the *Maturity*. Longer maturities are anticipated to increase the *Yield Spread* due to the higher risk of a change in interest rates for bonds with longer maturity (Chen & King, 2014). The second control variable is the logarithm of the *Issue Amount*. While it has not been found to be significant in previous empirical studies (see Campello et al., 2011) it is still included to capture potential diverse effects on *Yield Spreads*. Finally, *Coupon*, defined as the coupon rate in percent, is included to proxy for any tax benefits yielded (Chen & King, 2014). Previous empirical research has found the relationship to be positive, and we expect similar findings.

3.3.2.3 Macroeconomic Environment

Lastly, to control for the systematic risk in the bond market, a similar approach as Campello et al. (2011) and Chen & King (2014) is adopted. We proxy for the prevailing credit market conditions by including the variable *Market Credit Premium*, which is the spread between high-quality (Aaa rated) and medium-quality (Baa rated) corporate bonds. Furthermore, to proxy for term structures' effect on yield spreads, the variable *Term spread* is constructed. The variable is calculated as the spread between 1-year and 10-year AAA-rated Euro Area Central Government bonds. Literature suggests that credit spreads tend to increase in recessions while term spread decreases, and vice versa in a bullish market (Campello et al., 2011). Thus, we expect *Market Credit Premium* to be positively related to the *Yield Spread* while *Term Spread* to be negatively related.

3.3.3 Moderating Variables

To test *H2-H4*, distress costs, agency costs, and information asymmetries need to be proxied for. The hypotheses will be assessed through separate regressions with the introduction of interaction terms between *Total Hedging* and the proxy for the respective expected source of benefit, following a similar method to previous literature (Campello et al., 2011; Chen & King, 2014).

To begin with, based on the hypothesis development in *2.3.2*, we aim to test if firms facing a larger risk of financial distress have a greater benefit from engaging in hedging activities. To this end, we will follow Chen & King (2014) approach and interact *Credit Rating* and *Leverage* with *Total Hedging* in separate regressions. To further increase the robustness of our inference about the hypothesis, the alternative proxy of a *Speculative* dummy will be included, which equals one if a firm has a credit rating below investment grade (Moody's Baa3).

To proxy for the severity of agency costs a firm face, we will adopt three alternative measures. Firstly, following the method of Campello et al. (2011) we will use *MTB* as a proxy for a firm's likelihood to engage in risk-shifting activities. The rationale, as proposed by the authors, is that firms with a more ample amount of growth opportunities are more likely to substitute (invest) their current assets for more risky ones. In addition to *MTB*, regressions with an interaction term between hedging and *Earnings Volatility* and *Interest Coverage* will be run, respectively.

The proxies are used by Chen & King (2014) and are more related to the agency cost of underinvestment seeing as they seek to capture a firm's ability to raise financing as well as the predictability of cash flows.

Lastly, to test *H4* regarding differences in hedging benefit stemming from information asymmetries, two proxies based on analysts' estimates will be employed. The proxies are commonly used in the literature to measure the extent of information asymmetry a firm face (Chen & King, 2014). *Normalized Forecasts Error* is one of the measures, and it is calculated as the difference between the three-month analyst consensus on earnings per share (EPS) before the end of a fiscal year subtracted by the actual EPS divided by the actual EPS. The alternative measure is *Forecasts Dispersion* and it is the standard deviation of all earnings forecasts three-months before the end of a fiscal year.

3.4 Summary Statistics

Summary statistics are reported in Table 2 and are broken down by industry and country in Table 3. Similar to Campello (2011) and most of previous literature, the variables have been winsorized at the 1st and 99th percentiles. This results in the elimination of extreme values that could otherwise potentially skew the results. This stands in contrast to Chen and King (2014) who instead winsorized the 5th and 95th percentiles. We argue that such a decision could result in loss of valuable data points, that even outliers contribute with useful information and therefore choose to follow most of the previous literature.

As one can note from the table, the average (median) yield spread is 137.26 (117.51) bps with a minimum spread of 47.79 bps and a maximum of 449.92 bps. These figures are significantly different from those in previous studies. For instance, Chen and King (2014) found an average yield spread of 359 basis points, ranging from -524 to 1348 bps. One possible explanation for this discrepancy lies in sample differences. Chen & King's sample includes firms of various sizes, while our sample consists of the largest public companies in Europe. Larger and more mature firms are often less volatile, which should result in more generous credit terms. This is also reflected in the average credit rating, with our sample having, on average, a credit rating score of 15 (equivalent to Baa1) compared to Chen & King's 9.34 (equivalent to B1/Ba3). Similarly, a higher credit rating should coincide with lower yield spreads.

Table 2, Summary Statistics

	Mean	Median	Max	Min	SD	N
Yield Spread (bps)	137.26	117.51	449.92	47.79	72.71	1007
Z-spread (bps)	103.02	86.88	251.41	26.2	61.31	1007
Hedging	.94	1	1.00	0	.23	1007
Total Hedging (for Hedgers)	.20	.15	.60	.0	.17	950
IR Hedge	.78	1	1.00	0	.42	1007
IR Hedging (for Hedgers)	.08	.05	0.08	0	.28	782
FX Hedge	.85	1	1.00	0	.35	1007
FX Hedging (for Hedgers)	.12	.07	0.13	0	.45	860
CM Hedge	.41	0	1.00	0	.49	1007
CM Hedging (for Hedgers)	.02	.01	0.02	0	.07	414
Total Assets (Million €)	45218.98	24033	191337.26	3954.76	50854.5	1007
Leverage	.31	.31	0.54	.12	.12	1007
Interest Coverage	15.98	11.62	53.91	2.7	12.98	1007
Altman's Z-score	1.84	1.76	4.77	0	1.45	1007
Profitability	.1	.09	0.20	.02	.05	1007
MTB	1.3	1.04	3.27	.48	.78	1007
PDR	.11	.08	0.30	.01	.08	1007
Tangibility	.28	.23	0.76	.03	.2	1007
Earnings Volatility	.02	.01	0.05	0	.01	1007
Coupon (%)	2.38	2.23	4.79	.75	1.13	1007
Maturity (in Days)	3102.03	2812	5822.26	1307.89	1291.41	1007
Principal (Million €)	5989.4	2186.9	30421.84	250	8230.86	1007
Credit Rating	14.98	15	22.00	7	2.26	1007
Market Credit Premium	.92	.92	1.47	.52	.34	1007
Term Spread	.54	.46	1.25	.09	.39	1007
Speculative dummy	.1	0	1.00	0	.3	1007
Normalized Forecasts Error	-.01	-.01	0.26	-.2	.1	1007
Forecasts Dispersion	.24	.12	1.18	.01	.31	1007

Table 2 reports summary statistics of Yield Spread, Z-spread, all dummy and continuous hedging variables, and controls for determinants of the Yield Spread for the sample of 1007 firm-year observations. For variable definitions, see Table 10.

From the binary variable *Hedging*, one can tell that in 94% of the 1007 firm-year observations, at least one hedging contract is outstanding at year end. Furthermore, 78% of the sample hedges IR exposures, 85% hedges FX, and lastly, 41% hedges CM exposures. The derivative usage across the different risk categories is consistent with previous literature (see Campello et al., 2011; Chen & King, 2014; Giambona et al., 2018; Panaretou, 2014). It has been documented that the amount of IR and FX hedgers are similar, whereas CM hedgers are far less, attributed to industry differences (Giambona et al., 2018). The continuous variables, *Total Hedging, IR Hedging, FX Hedging*, and *CM Hedging* are for hedgers 20%, 8%, 12%, and 2% of total assets on average, respectively. These averages are somewhat smaller than what has been found by earlier studies (see Campello et al., 2011; Panaretou, 2014), potentially explained by differences in sample selection, where our study is conducted on larger firms who have larger balance sheets', possibly impacting the proxies.

To enable comparisons between different industries' propensity to hedge, a one- or two-digit SIC code is used to group all firms into eight different industries, following the same approach as Chen & King (2014). Table 3 provides an overview of the industry classification and statistics on industry-level hedging. As one can note from the table, Oil and Gas as well as Transportation are the two industries where hedging is the most common. Here, 100% of the firms hedge in one way or another. Firms in the Services and Public Administration industry have the lowest propensity to hedge, with an average of 11% of total assets, but 83% of the firms use some hedging instrument. When comparing various industries with the three types of hedging, one can tell that in Wholesales and Retails, 99% of firms engage in FX hedging. Quite surprisingly, this suggests that firms operating in this industry most likely face the most material FX risks. In terms of IR and CM hedging, Oil and Gas is at the top with 92% and 97%. It makes sense that actors in this industry enter into CM hedges since their financial performance depends heavily on price fluctuations in oil and gas.

As can be seen in Table 3, there are differences in hedging behavior between countries. From our firm sample, Danish firms hedge the most in relation to their total assets (36% on average), while The Netherlands hedge the least (7% on average). If one were to take a deeper look at the three categories of risk, firms in Belgium hedge IR the most in relation to total assets (15% on average) while Ireland, The Netherlands and Switzerland use it the least (3% on average).[6] For FX hedging, the corresponding numbers are Denmark, 21% and Belgium, 3%. Lastly, Portugal hedge CM risk the most (5% on average) and Belgium, Germany, Netherlands, Norway, and Sweden hedge the least (rounded off to 0.0% on average). The number of data points on each country varies greatly which results in the numbers not being entirely comparable, however still providing interesting insights and generally follows a distribution that was expected given the size of each country's economies.

[6] Worth pointing out is that Luxembourg is excluded from all comparisons due to few and zero hedging observations, rendering the extensiveness of hedging activities to be 0 for all categories of risk.

Table 3, Hedging by Industry and Country

Panel A: Industry	SIC	Freq.	Percent	Hedge	Total Hedging	IR	IR Hedging	FX	FX Hedging	CM	CM Hedging
Agriculture, Mining, and Construction	0-1	47	1.69%	1	.26	.82	.01	1	.05	.65	.03
Manufacturing	2-3	446	1.69%	1	.24	.82	.15	.53	.03	.35	0
Transportation	40-47	42	1.99%	1	.36	.85	.08	1	.21	.65	.04
Communications and Utilities	48-49	182	4.87%	.98	.28	.69	.05	.98	.2	.37	.01
Wholesales and Retails	5	101	17.18%	.94	.15	.77	.06	.93	.08	.47	.01
Real Estate	6	57	5.66%	.88	.17	.88	.14	.4	.01	0	0
Services and Public Administration	7-9	96	15.69%	.98	.18	.8	.06	.92	.11	.48	.00
Oil and Gas	13 or 29	36	2.38%	1	.16	1	.03	1	.12	.75	.01
Panel B: Country		**Freq.**	**Percent**	**Hedge**	**Total Hedging**	**IR**	**IR Hedging**	**FX**	**FX Hedging**	**CM**	**CM Hedging**
Austria		17	1.69%	1	.26	.82	.01	1	.05	.65	.03
Belgium		17	1.69%	1	.24	.82	.15	.53	.03	.35	0
Denmark		20	1.99%	1	.36	.85	.08	1	.21	.65	.04
Finland		49	4.87%	.98	.28	.69	.05	.98	.2	.37	.01
France		173	17.18%	.94	.15	.77	.06	.93	.08	.47	.01
Germany		158	15.69%	.98	.18	.8	.06	.92	.11	.48	.00
Ireland		24	2.38%	1	.16	1	.03	1	.12	.75	.01
Italy		65	6.45%	.91	.22	.91	.06	.66	.11	.49	.02
Luxembourg		6	.60%	0	0	0	0	0	0	0	0
Netherlands		31	3.08%	.97	.07	.39	.03	.97	.05	.03	.00
Norway		21	2.09%	.95	.14	.57	.08	.67	.05	.05	.00
Portugal		6	.60%	1	.24	1	.12	1	.07	1	.05
Spain		54	5.36%	.89	.12	.78	.06	.83	.05	.28	.01
Sweden		85	8.44%	.98	.22	.82	.08	.75	.13	.4	.00
Switzerland		92	9.14%	.8	.14	.46	.03	.8	.07	.35	.01
U.K.		189	18.77%	.99	.21	.93	.1	.85	.1	.37	.01
Austria		17	1.69%	1	.26	.82	.01	1	.05	.65	.03
Total		**1007**	**100.00**	94%	.18	78%	.07	85%	.1	41%	.01

Panel A in Table 3 reports the mean hedging behavior among the sample grouped by industry. We adopt a one- or two-digit SIC code to form eight different industry groups. In Panel B, the mean hedging behavior is instead broken down by country. As previously mentioned, our study includes sample firms domiciled in 17 different countries.

3.4.1 Correlation Analysis

Table 4 reports the pairwise correlation coefficient for each of the variables. One can note that similar to our predictions, *Total Hedging* has a significant, negative relationship with *Yield Spread*. However, surprisingly, none of the individual risk categories has a correlation coefficient which is significant. Nonetheless, most control variables display a correlation in line with previous empirical studies, with the exception for *Leverage*, *Tangibility*, *Term Spread*, *Normalized Forecasts Error*, and *Forecasts Dispersion* exhibiting an insignificant relationship. Interestingly, *Maturity* has a significant, negative correlation coefficient with *Yield Spread* which goes against predictions regarding the economic relationship, where longer maturities should increase the sensitivity of changes in interest rates, increasing the yield (Chen & King, 2014).

From an econometric standpoint, considering the issue of multicollinearity, Dormann et al.'s (2013) proposed rule of thumb, which suggests dropping all variables exceeding a correlation coefficient of 0.7 or higher, has been applied. No variables exceed this threshold, except for *Firm Size* and *Issue Amount* which has a correlation coefficient of 0.825, significant at the one-percent level. Economically, the correlation makes sense, seeing as the natural logarithm of outstanding principals on bonds should coincide with the size of the firm (proxied by the natural logarithm of total assets). Hence, *Issue Amount* is dropped from all regressions to ensure reliable estimates, and this approach follows Chen & King's (2014) methodology who does not proxy for *Issue Amount* unlike Campello et al. (2011) who includes it in all regression.[7] Worth noting is that while *Total Hedging* and *FX Hedging* exceeds the 0.7 threshold, these variables are not used in the same regressions, and thus, none of the variables have to be dropped. Furthermore, quite intuitively, *Total Hedging* should be positively correlated with the hedging of the individual risk categories given the definition of the variable.

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[7] Regressions using *Issue Amount* instead of *Firm Size* were tested for each of the models and the results are very similar, and our inference of the hypotheses does not change. For brevity, these results are however, not reported or discussed in this paper.

Table 4, Pairwise Correlation

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)
(1) Yield Spread	1.00																						
(2) Total Hedging	-0.078**	1.00																					
(3) FX Hedging	-0.04	0.752***	1.00																				
(4) IR Hedging	-0.02	0.522***	0.03	1.00																			
(5) CM Hedging	-0.03	0.327***	0.154***	0.03	1.00																		
(6) Firm Size	-0.134***	-0.093***	-0.097***	-0.04	0.128***	1.00																	
(7) Leverage	0.04	-0.074**	-0.245***	0.246***	-0.182***	-0.061*	1.00																
(8) Interest Coverage	-0.171***	0.04	0.095***	-0.077**	-0.04	-0.03	-0.341***	1.00															
(9) Altman's Z-Score	-0.169***	-0.070**	0.106***	-0.203***	-0.148***	-0.236***	-0.316***	0.526***	1.00														
(10) Profitability	-0.158***	-0.04	0.01	-0.125***	0.01	-0.117***	0.02	0.520***	0.569***	1.00													
(11) MTB	-0.238***	-0.04	0.05	-0.074**	-0.137***	-0.304***	0.061*	0.359***	0.641***	0.533***	1.00												
(12) PDR	0.074**	0.01	-0.107***	0.181***	-0.070**	-0.171***	0.544***	-0.158***	-0.260***	-0.139***	-0.05	1.00											
(13) Tangibility	0.03	0.063**	-0.086***	0.137***	0.240***	-0.096***	0.194***	-0.112***	-0.256***	-0.01	-0.160***	0.258***	1.00										
(14) Earnings Volatility	0.072**	0.073**	0.093***	-0.083***	0.175***	-0.00	-0.198***	0.111***	0.123***	0.065**	0.02	0.05	0.093***	1.00									
(15) Coupon	0.409***	-0.02	-0.02	0.03	0.093***	0.214***	-0.059*	-0.171***	-0.097***	0.05	-0.181***	-0.132***	0.105***	0.112***	1.00								
(16) Maturity (Days)	-0.080**	-0.135***	-0.146***	-0.04	0.062*	0.471***	0.01	-0.213***	-0.190***	-0.02	-0.114***	-0.240***	0.02	-0.157***	0.382***	1.00							
(17) Issue Amount	-0.121***	-0.133***	-0.151***	-0.05	0.04	0.825***	0.161***	-0.132***	-0.204***	-0.02	-0.188***	-0.205***	-0.086***	-0.056*	0.218***	0.441***	1.00						
(18) Credit Rating	-0.396***	-0.01	-0.01	0.01	-0.088***	0.268***	-0.110***	0.277***	0.225***	0.200***	0.168***	-0.170***	-0.01	-0.111***	-0.126***	0.179***	0.237***	1.00					
(19) Market Credit Premium	0.371***	-0.02	0.03	-0.01	0.02	0.01	-0.04	0.055*	0.02	0.086***	-0.094***	-0.02	-0.02	0.04	0.04	-0.126***	0.02	0.04	1.00				
(20) Term Spread	-0.04	0.03	0.02	0.02	-0.01	-0.02	-0.104***	0.03	0.03	0.085***	-0.01	-0.169***	0.00	-0.091***	0.162***	0.380***	-0.179***	0.060*	-0.278***	1.00			
(21) Speculative	0.371***	0.01	-0.03	0.01	0.074**	-0.170***	0.05	-0.167***	-0.163***	-0.083***	-0.141***	0.095***	-0.02	0.03	0.121***	-0.141***	-0.136***	-0.607***	-0.00	-0.04	1.00		
(22) Normalized Forecasts Error	0.02	0.05	0.063**	-0.02	0.054*	-0.056*	0.03	-0.071**	0.03	-0.056*	0.059*	0.03	-0.00	-0.00	-0.05	0.01	-0.04	0.00	0.063**	0.02	0.00	1.00	
(23) Forecasts Dispersion	0.03	0.04	0.01	0.02	0.115***	0.02	-0.061*	0.172***	0.070**	0.03	0.128***	0.098***	0.02	0.174***	-0.03	-0.159***	-0.04	-0.02	0.01	-0.111***	0.088***	0.04	1.00

*Table 4 reports the pairwise correlation for all variables. For variable definitions, see Table 10. Note that Firm Size and Issue Amount has a correlation coefficient of 0.825, and following the discussion, this variable is thus dropped for all regressions. *, **, and *** denotes significance levels of 10%, 5%, and 1% respectively.*

4. Methodology

4.1 Econometric Design

As we seek to study the relationship between a firm's cost of debt and hedging activities, a multiple regression analysis on panel data will be used to test all hypotheses. The models will be estimated through a pooled OLS (POLS) following common practice in the field (see Campello et al., 2011; Chen & King, 2014; DaDalt et al., 2002; Panaretou, 2014), as well as econometric standards (Woolridge, 2016).

A disadvantage with a simple POLS is that the estimates do not consider the panel data setting, but instead all observations are pooled over time, units, and groups (Woolridge, 2016). To increase reliability and reduce the risk of model misspecifications, various econometric techniques have been deployed by previous researchers, including clustering standard errors, utilizing fixed effects (FE) and/or random effects (RE), as well as using industry and year dummies (Campello et al., 2011; Chen & King, 2014; DaDalt et al., 2002; Panaretou, 2014). These modeling choices will be further discussed as the chapter progresses.

4.1.1 Multivariate Analysis

In answering *H1*, where the relationship between a firm's cost of debt and the extent of hedging activities is of interest, model (1) is employed. Model (1) adopts *Yield Spread* as the dependent variable and *Total Hedging* as the main explanatory variable to proxy for a firm's hedging activities. Additionally, to test $H1_A$ - $H1_C$, *Total Hedging* is replaced by each category of risk separately. For model (1) through (4), controls are added gradually in a three-step process. In the simplest model, only firm-and bond controls are included. In the second step, controls for systematic risk factors in the bond market are added. In the last and final step, industry- and year-effects are controlled for by introducing dummy variables. For a full variable list, see Table 10 in the appendix. After gradually adding controls, we arrive at our main model (1), followed by the subsequent models (2 - 4) for each category of risk. Note that the macroeconomic controls, *Market Credit Premium* and *Term Spread*, are omitted from the models when year controls are introduced. This is due to multicollinearity since the variables are the same for each firm in a given year, and the systematic risk in the bond market the aforementioned variables aim to proxy for is now captured by the year dummies.

(1)

$$Yield\ Spread_{i,t} = a + \beta_1 Total\ Hedging_{i,t} + \beta_2 Firm\ controls_{i,t} + \beta_3 Bond\ controls_{i,t} + \beta_4 Industry_{i,t} + \beta_5 Year_t + \mu_i$$

(2)

$$Yield\ Spread_{i,t} = a + \beta_1 IR\ Hedging_{i,t} + \beta_2 Firm\ controls_{i,t} + \beta_3 Bond\ controls_{i,t} + \beta_4 Industry_{i,t} + \beta_5 Year_t + \mu_i$$

(3)

$$Yield\ Spread_{i,t} = a + \beta_1 FX\ Hedging_{i,t} + \beta_2 Firm\ controls_{i,t} + \beta_3 Bond\ controls_{i,t} + \beta_4 Industry_{i,t} + \beta_5 Year_t + \mu_i$$

(4)

$$Yield\ Spread_{i,t} = a + \beta_1 CM\ Hedging_{i,t} + \beta_2 Firm\ controls_{i,t} + \beta_3 Bond\ controls_{i,t} + \beta_4 Industry_{i,t} + \beta_5 Year_t + \mu_i$$

To test the moderating effect of various market imperfections on the relationship between firms' cost of debt and extent of hedging activities following *H2 - H4*, models (5 - 7) was constructed. The models are built upon model (1) with *Total Hedging* as the main explanatory variable rather than the individual risk category but differ from each other depending on the market imperfection. Model (5) encompasses an interaction term, capturing the moderating effect of *Financial Distress* on hedging and the cost of debt, model (6) introduces *Agency Costs*, and lastly, model (7) includes the degree of *Information Asymmetry*. The complete list of alternative proxies for the imperfections is discussed in 3.3.3 *Moderating Variables*.

(5)

$$Yield\ Spread_{i,t} = a + \beta_1 Total\ Hedging_{i,t} + \beta_2 Financial\ Distress_{i,t} + \beta_3 Total\ Hedging_{i,t}\ x\ Financial\ Distress_{i,t} + \beta_4 Firm\ Controls_{i,t} + \beta_5 Bond\ controls_{i,t} + \beta_6 Industry_{i,t} + \beta_7 Year_t + \mu_i$$

(6)

$$Yield\ Spread_{i,t} = \quad a + \beta_1 Total\ Hedging_{i,t} + \beta_2 Agency\ Costs_{i,t}$$
$$+\beta_3 Total\ Hedging_{i,t}\ x\ Agency\ Costs_{i,t} + \beta_4 Firm\ Controls_{i,t}$$
$$+ \beta_5 Bond\ controls_{i,t} + \beta_6 Industry_{i,t} + \beta_7 Year_t + \mu_i$$

(7)

$$Yield\ Spread_{i,t} = \quad a + \beta_1 Total\ Hedging_{i,t} + \beta_2 Information\ Asymmetry_{i,t}$$
$$+\beta_3 Total\ Hedging_{i,t}\ x\ Information\ Asymmetry_{\ i,t} + \beta_4 Firm\ Controls_{i,t}$$
$$+ \beta_5 Bond\ controls_{i,t} + \beta_6 Industry_{i,t} + \beta_7 Year_t + \mu_i$$

4.1.2 Modeling Choices

4.1.2.1 Fixed- and Random Effects

Considering the panel data setting faced by researchers within the field of hedging (Campello et al., 2011; Chen & King, 2014; DaDalt et al., 2002; Panaretou, 2014), most researchers have opted to, apart from utilizing a POLS, include a firm-or industry fixed effects model to increase the reliability of the results. This is done to satisfy the condition of uncorrelated error terms and explanatory variables in order for the OLS-estimators to be consistent and unbiased. In a panel data setting, the error term is commonly referred to as the composite error, consisting of two parts; the idiosyncratic error, $u_{i,t}$, which is unobserved factors that vary over time, and unobserved factors that are constant over time, referred to as unobserved heterogeneity, a_i.

A common solution to deal with the idiosyncratic errors correlated over time is to use clustered standard errors. In previous studies, clustering has been done by firm (Campello et al., 2011; Panaretou, 2014) as well as by firm and year (Chen & King, 2014). Given our smaller time dimension (6), clustering by time may give rise to problems related to the inference of our hypotheses stemming from the use of limiting distributions (Panaretou, 2014). Thus, we will utilize standard errors clustered by firm in all our regression and use year dummies to account for the time effect in line with Panaretou (2014).

To ensure consistent estimators in regard to unobserved heterogeneity, utilizing a FE or RE model is common in corporate financial studies. In our study, unobserved heterogeneity could potentially be an issue due to unobserved effects, such as the availability of underwriters/counterparts for bonds and hedging contracts, impacting the error term while being correlated with the extent of hedging. As previously mentioned, previous researchers in the field of hedging have opted for a FE model (Campello et al., 2011; Chen & King, 2014; Panaretou, 2014), where the unobserved factor(s) $a_i$is removed. On the contrary, a RE model does not remove the unobserved factor(s) but only considers it when estimating the standard errors. We have followed previous literature and used firm-fixed effects in our main model (1) to increase the robustness regarding the inference of *H1*.[8] However, to justify the use of a FE over RE model, a Hausman test, where the rejection of the null indicates the preference of a FE due to the correlation between the unobserved effects and explanatory variables being non-zero, were used.[9] Nonetheless, for transparency, model (1) was also tested with RE, and the results are reported but not considered in the inference of *H1*.

4.1.2.2 Endogeneity

The assumption of exogeneity, the opposite of endogeneity, needs to be satisfied for models to estimate consistent and unbiased results of the estimators (Roberts & Withed, 2012). For the exogeneity assumption to hold, the explanatory variables must not be endogenous to the error term, and thus, are independent of the unobserved heterogeneity. Common causes of endogeneity include measurement errors, omitted variable bias, and reverse casualties (Roberts & Withed, 2012).

Customary in corporate finance research is the use of proxies to capture unobservable or difficult-to-quantify variables (Roberts & Whited, 2012). However, inefficient proxies may give rise to the aforementioned measurement errors if they are inconsistent with the true variable of interest, possibly exacerbating endogeneity issues in models. Nonetheless, we rely on proxies from previous research, and assume that no measurement errors are systematically impacting the correlation with the explanatory variables. Furthermore, to deal with other

[8] Only a fixed- and random effects model for the variable *Total Hedging* is reported and discussed in this paper for briefness. However, models for each individual risk category (IR/FX/CM) were tested with a fixed- and random effect, and the results can be sent upon request.

[9] The results for the Hausman test are reported in Table 11. As one can note, the null is rejected, and the test serves as further support that fixed effects are favored over random effects.

potential presence of endogeneity in our model, we included lagged explanatory variables, supplemental to the FE and RE regressions. The use of FE and RE help alleviate omitted variable biases by either removing the time-invariant factor or measuring changes within groups over time. Additionally, Chen & King (2014) argue that a benefit with lagging variables is that a firm's hedging previous year is less likely to correlate with unobserved factors. Due to trading in the public bond market, efficient markets should mean that bond prices, and consequently, the yield spread, is reflected by the firm's current performance (Chen & King, 2014). Moreover, lagging all explanatory variables may help mitigate reverse casualties, stemming from the possibility that firms with a lower cost of financing may have better access or have greater incentives to hedge (Chen & King, 2014). However, yield spread at time t should not affect a firm's hedging activities at time $t-1$. As a result, models (1 - 4) were run using a one-year lag on hedging and each risk category as well as all other explanatory variables to increase the robustness of our inferences.

Lastly, previous literature studying the relationship of hedging and the cost of debt has employed an instrumental variable (IV) regression to address the issue of endogeneity (Campello et al., 2011; Chen & King, 2014). Empirical research has found evidence that there is a tax-based incentive for firms to hedge, while bondholders should be irrelevant to a firm's tax obligations. Consequently, a tax-based instrument should fulfill the criteria of being exogenous to the error term while having a non-zero correlation with hedging (Chen & King, 2014). The aforementioned papers utilize Graham and Smith's (1999) model to estimate a measure of the potential tax incentives based on a reduction in the taxable income. However, the model requires the researcher to scour annual reports for the necessary data and is based on the U.S. tax system. Based on the limited scope of this paper, coupled with the fact that this paper studies a completely different tax regime(s), the instrument was not relevant to consider. Nonetheless, an alternative instrument, net operating loss carryforwards (NOLs), was discussed and used as a robustness test by Chen & King (2014). The authors found the F-statistic to be below the Wooldridge (2016) suggested critical value of 10 when using NOLs, indicating that NOLs is an inefficient and weak instrument for hedging.[10]

[10] A regression using tax loss carryforwards as an instrument for *Total Hedging* was conducted, and while NOLs were significant at a five-percent level in the first stage of the regression, the F-statistic (5.65) were below the critical value of 10. The results are available upon request, but they are in line with previous findings and provide further evidence that NOLs are a weak instrument for hedging activities.

4.1.1.3 Heteroskedasticity

The assumption of homoscedasticity is a necessary assumption for OLS to provide consistent estimates and refers to when the variance in the error term is independent of the explanatory variable. If the assumption is violated and the error terms are heteroskedastic, OLS is no longer the best linear unbiased estimator. To test for the presence of heteroskedastic error terms, a White's test was employed on the main model (1). The null was rejected, implying that the residuals do not follow a homoscedastic distribution.[11] As such, to address and satisfy the assumption of homoscedasticity, all models will use robust standard errors, similar to previous literature (Campello et al., 2011; Chen & King, 2014; DaDalt et al., 2002; Panaretou, 2014). More specifically, these will be clustered by firm following the discussion in 4.1.2.1 *Fixed- and Random Effects*.

4.2 Robustness

Apart from clustering standard errors and gradually introducing control variables, robustness in *H1* and $H1_A$-$H1_C$ will be achieved by using two alternative measures for the cost of debt. As discussed in 3.2 *Dependent Variable: Cost of Debt*, one model will use the natural logarithm of *Yield Spread* to mitigate any skewness in the data following Campello et al. (2011). Furthermore, the *Z-spread* will be used on the foundation of Klein and Stellner (2014) described advantage of the measurement being less biased and incorporating more information on the term-structure of interest rates than the *Yield Spread*.

[11] The results for the White's test are reported in Table 12, and the null is rejected at a one-percent level.

5. Empirical Results & Analysis

This chapter starts by attempting to answer hypotheses *H1* and $H1_A$-$H1_C$, followed by a general discussion of the control variables. Furthermore, we attempt to understand the sources of benefit from hedging by answering *H2-H4*. Lastly, the robustness tests are discussed.

5.1 Multivariate Analysis

5.1.1 Hedging and the Cost of Debt

As can be seen in Table 5, *Total Hedging* is statistically significant at the one-percent level in model (1 & 1.1) where we control for firm- and bond characteristics, as well as the systematic risk in the bond market. However, in model (1.2) when year and industry dummies are added, the significance level drops slightly but remains at a five-percent level. The results are conclusive and suggest that there is a negative relationship between the extent of a firm's hedging activities and the cost of debt. The coefficient from model (1.2) is -40.14, meaning that the average hedger has about an 8 bps (0.2*-40.14) lower spread compared to the non-hedging counterpart. This is the equivalent of a 6% reduction relative to the mean spread of 137 bps, indicating an economic impact. While the results are much in line with previous findings, the economic impact of hedging is less compared to that of Campello et al. (2011) who find that the average hedger reduces their loan spread by 29%. Nonetheless, the null of *H1* is rejected at the five-percent level, asserting that there is a negative relationship between hedging and the cost of debt. The rejection affirms theoretical and empirical findings that hedging does indeed impact the credit terms offered by the bondholders. Possible theoretical explanations include that hedging may reduce costs of financial distress (Smith & Stulz, 1985), mitigate the underinvestment problem or reduce incentives to engage in risk-shifting (Campbell and Kracaw, 1990; Froot et al., 1993; Giambona et al., 2018), and/or reduce information asymmetries (DaDalt et al., 2002).

In Table 13 in the appendix, model (1.3 & 1.4) reports the results from using a FE and RE model. In the FE model, the statistical significance of *Total Hedging* remains significant at the five-percent level, strengthening our rejection of the null. Furthermore, the RE model estimates a coefficient of similar significance, however, recall that the Hausman test indicated that a FE-model is preferable. As such, the results from the RE model are not considered in our rejection, but nonetheless, our inference on *H1* proves robust at the five-percent level when accounting for firm-fixed effects.[12]

Table 5, POLS Total Hedging

	Model 1	Model 1.1	Model 1.2
Total Hedging	-50.355***	-44.792***	-40.141**
	(16.216)	(16.114)	(15.782)
Firm Size	-12.244***	-11.261***	-10.783***
	(3.676)	(3.793)	(3.866)
Leverage	50.211	52.547*	46.855
	(32.152)	(31.410)	(30.956)
Interest Coverage	0.507	0.527*	0.434
	(0.312)	(0.296)	(0.273)
Altman's Z-score	-1.154	-1.101	2.549
	(2.787)	(2.749)	(2.945)
Profitability	-183.740**	-299.836***	-242.343***
	(89.262)	(89.222)	(85.606)
MTB	-15.369***	-7.285	-8.274
	(5.213)	(4.945)	(5.261)
PDR	-8.589	0.671	9.143
	(43.262)	(42.586)	(44.053)
Tangibility	-24.834	-17.758	-40.752**
	(17.752)	(17.229)	(17.003)
Earnings Volatility	43.439	41.923	23.697
	(210.790)	(207.944)	(223.747)
Coupon (%)	30.365***	28.294***	29.627***
	(3.745)	(3.770)	(3.662)
Maturity (Days)	-22.726***	-14.730*	-12.417
	(7.728)	(8.471)	(8.814)
Credit Rating	-7.226***	-8.362***	-9.048***
	(1.587)	(1.627)	(1.613)
Market Credit Premium		81.147***	
		(4.729)	
Term Spread		12.223**	
		(4.894)	
Intercept	510.649***	373.837***	450.998***
	(68.353)	(68.414)	(67.131)
Observations	1007	1007	1007
Adjusted R-squared	0.374	0.496	0.549
Standard errors	Clustered	Clustered	Clustered
Method	POLS	POLS	POLS
Industry dummies	No	No	Yes
Year Dummies	No	No	Yes

*Table 5 reports the results from a POLS regression, gradually introducing control variables to the main model (1). The dependent variable is Yield Spread. In the first step, only firm- and bond controls are present. In model (1.1) systematic risk factors in the bond market are controlled for. In the final model (1.2), industry and year-dummies are introduced. Note that Market Credit Premium and Term Spread are omitted when introducing year dummies in model (1.2) due to multicollinearity. Clustered robust standard errors by firm are reported in parenthesis. *, **, and *** denotes significance levels of 10%, 5%, and 1%, respectively.*

[12] While a firm-fixed effects model indirectly accounts for country-level unobserved heterogeneity, models including country dummies were tested for each hedging variable and the inference of the hypotheses are very similar. For brevity, these are not reported in the paper but can be sent upon request.

5.1.2 The Three Categories of Risk

Illustrated in Table 6, *IR Hedging* is statistically significant at the five-percent level while gradually adding controls to models (2 - 2.2). The results are in line with Campello et al. (2011), who found a significant, negative relationship between a continuous IR hedging variable and the cost of debt. Chen & King (2014) found further evidence for this relationship, albeit, by using a dummy variable approach. The estimated coefficient is -84.33, implying that a one-standard-deviation in outstanding IR hedging contracts to total assets, reduces the spread by ≈ 24 bps (0.28*84.33) for hedgers. This indicates economic significance, and thus, we reject $H1_A$ at the five-percent level and conclude that hedging interest rates decreases the cost of debt.

The estimates for model (3 - 3.2) are found in Table 6, where the main explanatory variable is *FX Hedging*. Previous researchers have found a significant relationship between FX hedging and cost of debt, measured as both a continuous and dummy variable (see Campello et al., 2011; Chen & King, 2014). Quite unanticipatedly, *FX Hedging* is weakly statistically significant in the simplest model, and as further controls are added gradually, it loses its significance when controlling for industry- and year effects. A possible explanation for our conflicting findings lies in the different geographical regions, with creditors' expectations in the euro-area potentially being that firms hedge their currency exposure. Thus, investors do not assign a 'hedging discount' to the yield spread but might charge a premium for the firms' not hedging FX exposures. The notion of this idea is supported by Panaretou (2014) finding that U.K. firms that hedge FX exposures significantly increase firm performance. Further support is found in the differences in samples, with 85% of the firms in our sample hedging FX risk while the equivalent is 26.9% and 27.3% in Chen & King (2014) and Campello et al.'s (2011) sample, respectively. The large sample difference is in line with Giambona et al. (2018) findings, who surveyed managers and discovered large discrepancies in the amount of material FX risk is faced by North American vs foreign firms.

An alternative explanation related to the above might be that risk-averse managers excessively use FX derivatives in our sample, leading to a risk appetite that diverges from that of the firm's stakeholders. This is supported by Petersen and Thiagarajan (2000) who found that the extent of derivative usage is closely related to management's compensation structure. By introducing overly extensive FX hedging programs, firms may impact their own capacity to repay debt obligations through paying high transaction costs and allocating extensive resources.

Nonetheless, the results do not allow us to reject the null of $H1_B$, and we find no evidence that FX hedging significantly impacts the cost of debt.

Lastly, Table 6 reports the coefficients for models (4 - 4.2) where *CM Hedging* serves as the variable of interest. The variable is insignificant, but as more controls are added, and eventually dummies are included for year and industry, the model estimates a significant coefficient at the ten-percent level. A one-standard-deviation increase in the CM hedging of a firm reduces the spread by about 19 bps (0.07*270.25). There is economic significance, and the results are in line with the dummy approximation by Chen & King (2014). However, given the weak significance and robustness of our results, the null of $H1_C$ cannot be rejected. Consequently, we do not find strong support that hedging commodity risk reduces the cost of debt. A similar conclusion was made by Panaretou (2014) who studied the effect of a continuous CM hedging variable on firm performance but found no significant result.

5.1.3 Control Variables

Similar to previous literature (see Campello et al., 2011; Chen & King, 2014), the variables *Profitability, Credit Rating, Coupon*, *Market Credit Premium* and *Firm Size* are generally significant at the one-percent level and in line with predictions. An explanation for each variable's relationship with the cost of debt is provided in 3.3.2 *Control Variables* and will therefore not be further discussed in this section. The significance level of the variables *Tangibility*, *Leverage* and *MTB* vary slightly between regressions but mostly follow expectations and previous literature. The latter two will be further discussed in 5.1.4 *The Moderating Effect of Market Imperfections*, but *Tangibility* is in most cases only found to be a significant determinant of *Yield Spread* when controlling for industry effects.[13] Intuitively, this makes sense, because industries vary significantly in underlying asset structures. By controlling for industry, the model captures within-industry differences, providing a more accurate depiction of the relationship.

[13] For reference, see Table 5 & 6. As one can note, as control variables are gradually added, and eventually industry effects are controlled for, Tangibility is significant at a five-percent level in the regressions.

Table 6, POLS IR/FX/CM

	Model 2	Model 2.1	Model 2.2	Model 3	Model 3.1	Model 3.2	Model 4	Model 4.1	Model 4.2
Total Hedging									
IR Hedging	-77.877**	-79.445**	-84.331**						
	(35.931)	(35.150)	(34.063)						
FX Hedging				-36.370*	-39.471*	-25.649			
				(21.641)	(22.200)	(22.542)			
CM Hedging							-236.891	-243.215	-270.253*
							(167.110)	(166.690)	(162.451)
Firm Size	-11.989***	-11.122***	-10.219***	-11.737***	-10.931***	-10.105***	-10.820***	-10.064***	-9.327**
	(3.624)	(3.743)	(3.770)	(3.629)	(3.770)	(3.823)	(3.628)	(3.763)	(3.795)
Leverage	71.266**	72.955**	66.594**	47.895	48.343	42.735	45.083	45.841	34.711
	(32.744)	(32.258)	(32.126)	(33.972)	(32.980)	(32.297)	(32.361)	(31.451)	(30.479)
Interest Coverage	0.546*	0.573*	0.477*	0.463	0.489*	0.391	0.429	0.458	0.358
	(0.312)	(0.296)	(0.273)	(0.311)	(0.293)	(0.271)	(0.312)	(0.293)	(0.266)
Altman's Z-score	-0.509	-0.611	3.124	-0.128	-0.238	3.607	-0.651	-0.757	2.950
	(2.857)	(2.844)	(2.959)	(2.776)	(2.752)	(2.927)	(2.755)	(2.738)	(2.871)
Profitability	-207.352**	-325.049***	-253.418***	-182.361**	-299.326***	-238.906***	-161.114*	-276.772***	-216.516**
	(88.569)	(88.831)	(85.814)	(87.027)	(86.711)	(84.784)	(89.239)	(88.525)	(86.544)
MTB	-15.623***	-7.417	-8.550	-15.333***	-7.112	-8.297	-15.424***	-7.311	-7.980
	(5.355)	(5.052)	(5.380)	(5.231)	(4.936)	(5.323)	(5.421)	(5.122)	(5.346)
PDR	-6.519	2.549	13.084	-6.813	2.168	13.408	-6.962	1.915	12.178
	(43.816)	(43.136)	(44.249)	(43.545)	(42.806)	(44.479)	(44.229)	(43.490)	(45.011)
Tangibility	-24.432	-17.115	-40.159**	-27.305	-20.136	-42.046**	-20.578	-13.211	-36.228**
	(17.965)	(17.447)	(17.037)	(17.592)	(17.102)	(17.165)	(18.420)	(17.953)	(17.333)
Earnings Volatility	-9.193	-7.773	-10.999	21.226	23.368	15.800	44.035	45.055	30.258
	(209.929)	(206.355)	(222.087)	(211.561)	(208.127)	(226.015)	(216.351)	(212.618)	(228.922)
Coupon (%)	30.811***	28.767***	30.306***	30.239***	28.197***	29.486***	29.874***	27.830***	29.313***
	(3.778)	(3.816)	(3.689)	(3.753)	(3.789)	(3.681)	(3.698)	(3.738)	(3.615)
Maturity (Days)	-21.275***	-13.346	-11.619	-21.637***	-13.579	-11.086	-20.520***	-12.009	-10.186
	(7.570)	(8.383)	(8.796)	(7.786)	(8.598)	(8.876)	(7.626)	(8.525)	(8.898)
Credit Rating	-7.148***	-8.264***	-9.060***	-7.411***	-8.531***	-9.247***	-7.694***	-8.817***	-9.546***
	(1.604)	(1.640)	(1.611)	(1.623)	(1.658)	(1.630)	(1.641)	(1.672)	(1.643)
Market Credit Premium		82.024***			82.085***			81.801***	
		(4.730)			(4.787)			(4.769)	
Term Spread		12.029**			11.530**			10.624**	
		(4.911)			(4.990)			(5.056)	
	484.770***	350.045***	435.551***	494.423***	360.115***	431.896***	477.791***	340.779***	420.716***
	(65.399)	(66.166)	(66.918)	(68.598)	(68.524)	(67.380)	(64.677)	(65.674)	(66.676)
Observations	1007	1007	1007	1007	1007	1007	1007	1007	1007
Adjusted R-squared	0.367	0.493	0.549	0.364	0.490	0.543	0.364	0.489	0.545
Standard errors	Clustered	Clustered	Clustered	Clustered	Clustered	Clustered	Clustered	Clustered	Clustered
Method	POLS	POLS	POLS	POLS	POLS	POLS	POLS	POLS	POLS
Industry dummies	No	No	Yes	No	No	Yes	No	No	Yes
Year Dummies	No	No	Yes	No	No	Yes	No	No	Yes

*Table 6 reports the results for the POLS regressions with the three categories of risk: IR, FX and CM hedging when gradually introducing control variables to models (2), (3) and (4). The dependent variable is Yield Spread. In the first step, only firm- and bond controls are present. In model (2.1), (3.1), and (4.1) systematic risk factors in the bond market are controlled for. In the final models (2.2), (3.2,) and (4.2), industry and year-dummies are introduced, and the systematic risk factors are omitted. Clustered robust standard errors by firm are reported in parenthesis. *, **, and *** denotes significance levels of 10%, 5%, and 1%, respectively.*

However, quite surprisingly *Interest Coverage* is not found to have a clear-cut relationship with the cost of debt. The significance level varies, with most models estimating insignificant coefficients, while a FE-model estimates a coefficient that is significant at a one-percent level. Interestingly, we generally find a positive relationship between *Interest Coverage* and the cost of debt, which stands in contrast to previous empirical findings (see Chen & King, 2014). *Interest Coverage* proxies for credit risk, and there is no direct economic explanation to why a reduced (increased) credit risk (*Interest Coverage*) would increase yield spreads. The results could be attributed to our sample, with the average *Interest Coverage* being significantly higher compared to previous studies.[14] Alternatively, the proxy could capture something else than the credit risk, potentially distorting the results. Moreover, *Term Spread* is found to positively impact spreads similar to Chen & King (2014), but against predictions and the findings of Campello et al. (2011). A potential explanation could be that bondholders may require a higher return if increased term spreads indicate higher expected future interest rates, implying a lower expected value of a firm's assets (Chen & King, 2014). Lastly, the determinants *Altman's Z-score*, *Earnings Volatility*, *PDR*, and *Maturity* are insignificant in the vast majority of regressions.

5.1.4 The Moderating Effect of Market Imperfections

The following three chapters will discuss the results from interacting *Total Hedging* with proxies for risk of financial distress, agency costs, and information asymmetry. Focus will be put on the moderating effect, but worth noting is that the statistical significance of *Total Hedging* and the control variables is generally in line with the results presented in the previous chapter.

5.1.4.1 Financial Distress Costs

To test *H4*, whether a firm's financial risk level has a moderating effect on the relationship between hedging and cost of debt through reducing the risk of financial distress, three alternative proxies were used to form interaction terms. The results are reported in Table 7, and in model (5.1) where *Leverage* was used as a proxy, the coefficient for the interaction term follows our prediction, being negative. This suggests that as a firm increases its leverage, the larger the benefit is from reducing cash flow volatility through hedging, however, the

[14] Comparing our average (median) interest coverage of 15.98 (11.62) with Chen & King's (2014) 9.18 (5.82) there is a noteworthy difference in the samples.

interaction term lacks statistical significance. Nonetheless, *Leverage* is significant at the ten-percent level and follows previous literature by having a positive relationship with the cost of debt, explained by increased default risk (Campello et al., 2011; Chen & King, 2014).

Model (5.2) was instead estimated with an interaction term formed between *Credit Rating* and *Total Hedging*. We would like to remind the reader that the credit rating has been transformed to a numerical scale as discussed in 3.3.2.1 *Firm Characteristics*. As seen in Table 7, *Total Hedging* and *Credit Rating* are both highly significant and follow earlier predictions, while the interaction term is significant at the five-percent level. The coefficient reads 7.92, meaning that a rating downgrade from e.g. A1 to A2 for an average hedger reduces the increase in the cost of debt by 1.6 bps (0.2*7.92) compared to non-hedgers, holding the extent of hedging constant. The positive coefficient of the interaction term provides statistically and economically significant support for *H4*, indicating that firms at a larger risk of facing financial distress (lower *Credit Rating*) benefit more from hedging, and follows previous findings (Campello et al., 2011; Chen & King, 2014).

Lastly, the results for model (5.3) are reported in Table 7, where the interaction term is constructed using the *Speculative* dummy. The dummy is highly significant and positive, suggesting that being a 'speculative grade' company increases the cost of debt by 59 bps, which is in line with previous literature (Chen & King, 2014). Moreover, the interaction term is negative with some economic weight, albeit of weak statistical significance. Nonetheless, the results are in line with previous findings (Chen & King, 2014) and provide a weaker statistical support for the inference of *H4* made in the previous paragraph. To sum up, the inference regarding *H4* depends on the proxy used, but the null is rejected, asserting that firms' facing a higher risk of financial distress moderates the relationship between hedging and cost of debt.

Table 7, Financial Distress

	Model 5.1	Model 5.2	Model 5.3
Total Hedging	-14.502	-171.694***	-25.458*
	(44.696)	(60.191)	(14.656)
Leverage	80.245*	50.326	41.934
	(42.045)	(30.516)	(30.784)
Hedging x Leverage	-187.474		
	(146.766)		
Credit Rating	-8.799***	-10.502***	-6.074***
	(1.612)	(1.596)	(1.433)
Hedging x Credit Rating		7.917**	
		(3.314)	
Speculative			59.023***
			(17.109)
Hedging x Speculative			-101.945*
			(58.111)
Firm Size	-10.567***	-10.074***	-9.545***
	(3.874)	(3.766)	(3.593)
Interest Coverage	0.432	0.448	0.401
	(0.266)	(0.272)	(0.265)
Altman's Z-score	2.421	2.784	3.099
	(2.955)	(2.925)	(2.748)
Profitability	-250.209***	-223.708***	-240.846***
	(86.028)	(85.738)	(80.801)
MTB	-8.088	-8.750*	-7.982*
	(5.280)	(5.145)	(4.752)
PDR	9.218	15.255	21.984
	(44.107)	(43.043)	(42.611)
Tangibility	-41.002**	-39.523**	-37.285**
	(17.105)	(16.993)	(17.049)
Earnings Volatility	34.678	2.604	84.393
	(221.181)	(218.861)	(211.044)
Coupon (%)	30.021***	29.202***	28.507***
	(3.632)	(3.633)	(3.579)
Maturity (Days)	-13.091	-11.064	-10.800
	(8.780)	(8.636)	(8.109)
Intercept	440.206***	454.375***	377.420***
	(68.221)	(65.106)	(67.219)
Observations	1007	1007	1007
Adjusted R-squared	0.551	0.555	0.572
Standard errors	Clustered	Clustered	Clustered
Method	POLS	POLS	POLS
Industry dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes

*Table 7 reports the results from interacting a proxy for risk of financial distress with Total Hedging using POLS. Model 5.1 interacts Leverage, 5.2 Credit Rating, and 5.3 the Speculative dummy. The dependent variable is Yield Spread. Clustered robust standard errors by firm are reported in parenthesis. *, **, and *** denotes significance levels of 10%, 5%, and 1%, respectively.*

5.1.4.2 Agency Costs

In order to test *H5*, models (6.1 - 6.3) were estimated using three different proxies for the severity of agency problems faced by a firm. Quite surprisingly, and against previous research (see Campello et al., 2011; Chen & King, 2014), our models did not estimate any statistically significant coefficients for the interaction terms as shown in Table 8. Proxying for agency costs by using *MTB*, Campello et al. (2011) found a negative coefficient for the interaction term which supports the theory that hedging may help alleviate risk-shifting behavior.

Theoretically, this could be explained by hedging reducing asset and cash flow volatility, as well as reducing the degree of observable risk following the argument by Campbell and Kracaw (1990). Furthermore, Chen & King (2014) found statistical support that *Interest Coverage* and *Earnings Volatility* has a moderating effect on the relationship through mitigating the underinvestment problem. The findings support Froot et al. (1993) argument that by engaging in hedging activities, firms can reduce the probability of bad investment outcomes and increase the predictability of cash flows, reducing agency costs of underinvestment.

While the direction of the coefficients our models estimated generally follow that of previous literature, no statistical significance was found. In the case of model (6.1), where *MTB* is used to form an interaction term, a potential explanation for the inconclusive results could be that *MTB* captures the amount of claimable assets over book assets for creditors, rather than the amount of growth opportunities. If this were the case, *MTB* should decrease the cost of debt, and there is no theoretical or empirical support for any moderating effect if *MTB* does not accurately proxy for risk-shifting. Lastly, the non-significant results could also be attributed to differences in sample selection, since the variables used to test the moderating effect of agency costs have not been significant determinants of cost of debt in most of our previous regressions (see e.g., Table 5 and 6).

Table 8, Agency Costs

	Model 6.1	Model 6.2	Model 6.3
Total Hedging	-50.211*	-30.815	-46.167**
	(30.248)	(21.476)	(22.462)
MTB	-9.741	-8.072	-8.134
	(6.638)	(5.264)	(5.262)
Hedging x MTB	7.050		
	(15.893)		
Earnings Volatility	15.539	131.632	24.328
	(228.474)	(301.428)	(223.322)
Hedging x Earnings Volatility		-425.710	
		(767.829)	
Interest Coverage	0.444	0.414	0.341
	(0.275)	(0.274)	(0.334)
Hedging x Interest Coverage			0.326
			(0.662)
Firm Size	-10.881***	-10.859***	-10.817***
	(3.875)	(3.853)	(3.884)
Leverage	48.375	46.649	46.691
	(31.232)	(30.994)	(30.969)
Altman's Z-score	2.526	2.510	2.507
	(2.948)	(2.934)	(2.940)
Profitability	-246.118***	-241.075***	-241.405***
	(85.990)	(85.435)	(85.602)
PDR	8.018	8.986	8.417
	(44.035)	(43.981)	(44.290)
Tangibility	-40.727**	-41.252**	-40.626**
	(17.015)	(16.924)	(17.039)
Coupon (%)	29.665***	29.681***	29.618***
	(3.660)	(3.653)	(3.672)
Maturity (Days)	-12.377	-12.708	-12.520
	(8.833)	(8.897)	(8.794)
Credit Rating	-9.028***	-9.030***	-9.013***
	(1.621)	(1.622)	(1.612)
Intercept	452.869***	452.203***	452.846***
	(66.612)	(67.380)	(66.910)
Observations	1007	1007	1007
Adjusted R-squared	0.550	0.550	0.549
Standard errors	Clustered	Clustered	Clustered
Method	POLS	POLS	POLS
Industry dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes

*Table 8 reports the results from interacting a proxy for agency costs with Total Hedging using POLS. Model 6.1 interacts MTB, 5.2 Earnings Volatility, and 5.3 Interest Coverage. The dependent variable is Yield Spread. Clustered robust standard errors by firm are reported in parenthesis. *, **, and *** denotes significance levels of 10%, 5%, and 1%, respectively.*

5.1.4.3 Information Asymmetry

Models (7.1 & 7.2) were constructed to test *H6*, where the degree of information asymmetry firms' faces is hypothesized to experience a larger benefit of hedging. To this end, two proxies based on analysts' forecasts are used, and in the first model with *Normalized Forecasts Error* no significant results are found. However, when using the alternative measure *Forecasts Dispersion*, we find significant support for our hypothesis. As seen in Table 9, the coefficient for *Forecasts Dispersion* is 17.2 bps and significant at the ten-percent level. The results are less significant, but in line with previous studies (Chen & King, 2014).

A theoretical explanation for the relationship lies in the increased monitor costs (DaDalt et al., 2002) as well as the 'Transparency spread' charged by bondholders (Yu, 2004). In the same table, one can note that the interaction term is significant at a five-percent level and indicates a negative moderating effect. This suggests that hedging is more valuable for firms facing more severe information asymmetries. Holding hedging constant, a one standard deviation increase in *Forecasts Dispersion* for the average hedger increases the cost of debt by 0.7 bps (0.31* 0.2*-11.13) less than the non-hedging counterpart.

The results should be interpreted with caution, seeing as the two measures yielded vastly different results. Nonetheless, the estimates from model (7.2) seem to indicate that by engaging in hedging activities, bondholders demand lower returns due to decreased monitoring costs (Dadalt et al., 2002). This is motivated by reduced volatility- and increased transparency of cash flows, generating more favorable credit terms (Chen & King, 2014; DaDalt et al., 2002). A possible joint explanation is the Yu (2004) defined 'Transparency Spread' for opaque firms, where a reduction in information asymmetry from hedging should result in a lower spread charged by bondholders. To conclude, given the mixed results, but the rather strong significance in model (7.2), we cannot fully reject the null but partly assert that information asymmetry has some moderating effect.

Table 9, Information Asymmetry

	Model 7.1	Model 7.2
Total Hedging	-41.128***	-33.757**
	(15.560)	(15.524)
Normalized Forecasts Error	25.431	
	(37.129)	
Hedging x Normalized Forecasts Error	-140.688	
	(203.975)	
Forecasts Dispersion		17.176*
		(9.619)
Hedging x Forecasts Dispersion		-11.129**
		(4.727)
Firm Size	-10.880***	-10.514***
	(3.846)	(3.882)
Leverage	45.543	42.468
	(31.145)	(30.610)
Interest Coverage	0.420	0.346
	(0.276)	(0.273)
Altman's Z-score	2.463	2.151
	(2.928)	(2.788)
Profitability	-238.484***	-230.289***
	(85.986)	(82.635)
MTB	-8.385	-7.003
	(5.165)	(5.174)
PDR	8.059	5.403
	(44.018)	(43.757)
Tangibility	-40.871**	-38.803**
	(16.975)	(16.750)
Earnings Volatility	29.901	4.938
	(222.206)	(219.410)
Coupon (%)	29.606***	29.823***
	(3.666)	(3.708)
Maturity (Days)	-12.840	-11.656
	(8.803)	(8.832)
Credit Rating	-8.975***	-9.141***
	(1.598)	(1.581)
Intercept	454.928***	439.215***
	(66.477)	(65.891)
Observations	1007	1007
Adjusted R-squared	0.550	0.556
Standard errors	Clustered	Clustered
Method	POLS	POLS
Industry dummies	Yes	Yes
Year dummies	Yes	Yes

*Table 9 reports the result from interacting proxies for risk of information asymmetry using POLS. Model 7.1 interacts Analysts' Normalized Forecast Error and 7.2 Forecast Dispersion. The dependent variable is Yield Spread. Clustered robust standard errors by firm are reported in parenthesis. *, **, and *** denotes significance levels of 10%, 5%, and 1%, respectively.*

5.2 Robustness Tests

To increase the robustness regarding the inference of our hypothesis, several robustness tests have been conducted as discussed in chapter 4 *Methodology*. These include (1) clustering standard errors by firm, (2) gradually adding controls, (3) using a FE and RE model, (4) logging *Yield Spread*, (5) employing *Z-spread* as an alternative measure for the cost of debt, and (6) lagging all explanatory variables. The latter three will now be discussed, seeing as the first half was covered earlier in this chapter.

To begin with, models (1.5 & 2.3 - 4.3), reported in Table 13 & 14, are identical to models (1.2 - 4.2) but all variables are now regressed on the natural logarithm of *Yield Spread.* As shown in the output, the statistical significance of *Total Hedging* remains robust at the five-percent level, even when the dependent variable is in its logarithmic form. Additionally, the economic significance remains impactful, with the average hedger having (-0.208* 0.2) 4.2% lower cost of debt. Worth mentioning is that the significance of *IR Hedging* and *FX Hedging* are unaffected by logging *Yield Spread*, but *CM Hedging* loses its prior weak significance.

Furthermore, models (1.6 & 2.4 - 4.4) are regressed on the alternative measure of *Z-Spread* with the same controls as previous models, and the output is reported in Table 13 & 14. *Total Hedging* proves robust, and the statistical significance is increased to the one-percent level. Interestingly, the economic significance is enhanced, with an average hedger reducing the Z-spread by (0.2 * -41.94) 8.4 bps, or approximately 8% of the average Z-spread. Therefore, our acceptance of *H1* in favor of the null remains robust, despite choosing an alternative measure for the cost of debt. Moreover, model (2.4) strengthens the robustness of $H1_A$, with *IR Hedging* remaining statistically significant at a five-percent level. Similar to *Total Hedging*, the economic significance has increased relative to the mean, with a one-standard-deviation increase in IR hedging reducing the spread by (0.28*-79.71) 22 bps among hedgers. Worth noting is that *CM Hedging* loses its weak statistical significance by using either of the alternative measures, while *FX Hedging* remains insignificant.

Lastly, models (1.7 & 2.5 - 4.5) were constructed to address concerns regarding endogenous variables, emanating from reverse casualties. To this end, all explanatory variables were lagged by one year and results are reported in Table 13 & 15. One can note that *Total Hedging* remains robust at the five-percent level, and our inference regarding *H1* is reinforced. The coefficients for *FX Hedging* and *CM Hedging* remain at the same significance level as the previous edition of the models (i.e., 3.2 & 4.2), and thus, the inference of the hypothesis is the same. However, model (2.4) estimated a coefficient of weaker significance for *IR Hedging*. This means that the rejection of $H1_A$'s null does not remain robust at a five-percent level.

6. Conclusion

To conclude, by proxying for firms' hedging activities through scaling the total nominal amount of hedging contracts at year-end by total assets, we find strong support for our hypothesis that hedging reduces the cost of debt. The effect is significant at a one-percent level, but when controlling for industry- and year effects, the significance level is slightly reduced to five percent. The inference of our first hypothesis remained robust at a five-percent level when using alternative measures for the cost of debt, lagging explanatory variables, and employing firm-fixed effects. The potential value proposition of hedging includes reduced risk of financial distress, mitigating the underinvestment problem, reduced incentives to risk-shift, and/or decreased information asymmetry.

When examining the impact of each category of risk, support is found for our hypothesis that hedging interest rate exposures have a significant, negative impact on the cost of debt. The inference proved robust at a five-percent level to alternative model specifications, except for lagging all explanatory variables by one year, where the significance slightly diminishes. While hedging currency and commodity price risk have a significant negative relationship with yield spreads in some models, the results are not robust, and thus we cannot conclude that hedging these risk exposures significantly reduces the cost of debt.

Furthermore, three hypotheses regarding market imperfections' moderating effect were tested in order to understand the sources of benefit from hedging. Support is found that for firms facing a higher risk of financial distress, proxied through credit ratings, hedging is more valuable. This solidifies the notion that hedging can serve as a tool to reduce cash flow volatility, and consequently, the expected costs of financial distress are decreased. However, using market-to-book, earnings volatility, and interest coverage as proxies for the severity of agency costs faced by firms, no moderating effect is found. The results are not in line with previous research in the area, and the inconclusive results can partly be attributed to the use of inadequate proxies or sample selection. Lastly, we find some support that firms facing more severe information asymmetries benefit more from hedging, depending on the proxy used. Specifically, when measuring with analysts' forecasts dispersion, significant evidence is found that hedging decreases monitoring costs as well as reduces the 'Transparency Spread' charged by bondholders, ultimately reducing the cost of debt.

To summarize, by looking at 186 non-financial public European firms, this study has provided additional insights into the relationship between hedging and the cost of debt. Through using a novel dataset over firms' hedging activities, we are, to our knowledge, the first to find support that hedging negatively impacts the cost of debt in the European market. However, the study encompasses a few limitations future research should consider. First, our sample selection, including only large, public firms in approximately half of the countries in Europe, may not reflect the true relationship between hedging and the cost of debt in the region. As such, suggestions for future research could include studying a sample consisting of firms with larger disparities in terms of size, country of domicile, as well as including non-public firms. Secondly, while the focus of this study has been purely on derivative-based hedging, operational hedging is highly relevant to consider for future researchers since this is the most common type of hedging according to earlier papers. Studying hedge effectiveness by comparing the distinct types of hedging and its impact on the cost of debt is something that would be valuable for both academia and corporations. While this is certainly intriguing, it would however, require survey data to accurately measure the extensiveness of operational hedging.

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Appendix

Table 10, Variable Definition

Variable Name	Definition	Prediction (+/-)
Yield Spread	YTM – risk-free rate	**N/A**
Z-spread	Alternative measure to the yield spread	
(IR, FX, or CM) Hedging dummy	=1 if outstanding (IR, FX, or CM) hedging contract at year t	**N/A**
Total Hedging	Nominal amount of total hedging instruments/Total Assets	-
IR Hedging	Nominal amount of IR hedge/Total Assets	-
FX Hedging	Nominal amount of FX hedge/Total Assets	-
CM Hedging	Nominal amount of CM hedge /Total Assets	-
	Firm Specific Control Variables	
Firm Size	Log(Total Assets)	-
Leverage	Total debt/Total Assets	+
Altman Z-score	Altman (1968) Z-score	-
Interest Coverage	EBITDA/Interest expenses	-
Credit Rating	Moody's credit rating transformed to a numerical scale where Aaa=22, Aa1=21,…, D=1	-
Profitability	EBITDA/Total Assets	-
MTB	(Market value of Equity + Total Debt)/ Total Assets	+/-
Earnings Volatility	First difference in EBITDA over a 4-year period/ Total Assets	+
Tangibility	Net PP&E/Total Assets	-
Private Debt Ratio	(Total debt- Commercial Papers- Notes- Subordinated debt- Debentures)/Total Assets	+
	Bond Specific Control Variables	
Maturity (Days)	Log(Maturity) (In days)	+
Issue Amount	Log(Principal)	+/-
Coupon (%)	Coupon rate in %	+
	Macroeconomic Control Variables	
Market Credit Premium	Spread on Baa and Aaa rated corporate bonds	+
Term spread	Spread on 1-year and 10-year AAA-rated Euro Area Central Government bonds	-
	Moderating variables	
Total Hedging x Leverage	Total Hedging*Leverage	-
Total Hedging x Credit Rating	Total Hedging * Credit Rating	+
Speculative	=1 if Credit Rating is below investment grade (Moody's Baa3)	+
Total Hedging x Speculative	Total Hedging * Speculative	-
Total Hedging x MTB	Total Hedging * MTB	-
Total Hedging x Earnings Volatility	Total Hedging * Earnings Volatility	-
Total Hedging x Interest Coverage	Total Hedging * Interest Coverage	+
Normalized Forecast Error	(Analysts' three-month prior estimated EPS- Actual EPS)/ Actual EPS	+
Total Hedging x Normalized Forecasts Error	Total Hedging * Normalized Forecasts Error	-
Forecasts Dispersion	Analsts' standard deviation of all earnings forecasts three-month before fiscal year end	+
Total Hedging x Forecasts Dispersion	Total Hedging * Forecasts Dispersion	-

Table 10 illustrates all firm, bond, and macroeconomic control variables used in the regression with the predicted relationship based on previous studies in the column to the right. Note that a hedging dummy variable is constructed for each risk category and hedging contract at year end, albeit its only use is for summary statistics.

Table 11, Hausman Test

	Coef.
Chi-square test value	71.94
P-value	0
Decision	Reject H0

Table 11 reports the results from the Hausman test on the main model (1), using Total Hedging as the main explanatory variable. As illustrated in the table, the null is rejected, further justifying the use of fixed-effects over random-effects.

Table 12, White's Test

H0: Homoskedasticity Ha: Unrestricted heteroskedasticity	Test value	P	Decision
Model 1 (main)	333	0.000	Reject H0

Table 12 presents the results from the White's test on the main model (1), using Total Hedging as the main explanatory variable. As illustrated in the table, the null is rejected, indicating that the residuals do not follow a homoscedastic distribution. Therefore, all models will use robust standard errors to satisfy the assumption of homoskedasticity.

Table 13, Robustness tests Total Hedging

	Model 1.3	Model 1.4	Model 1.5	Model 1.6	Model 1.7
Total Hedging	-35.261**	-39.022**	-0.208**	-41.940***	-37.885**
	(17.924)	(15.801)	(0.099)	(15.336)	(17.194)
Firm Size	9.500	-14.186***	-0.068***	-10.387***	-9.116**
	(7.574)	(4.245)	(0.024)	(3.745)	(3.981)
Leverage	60.369*	46.167	0.352*	50.142*	45.976
	(34.508)	(28.919)	(0.211)	(28.053)	(32.520)
Interest Coverage	0.684***	0.618***	0.001	0.447	0.185
	(0.222)	(0.226)	(0.002)	(0.279)	(0.280)
Altman's Z-score	2.339	0.225	0.020	2.395	1.956
	(3.397)	(2.919)	(0.019)	(2.719)	(3.030)
Profitability	-409.034***	-384.836***	-1.322**	-290.994***	-213.007***
	(70.941)	(81.616)	(0.516)	(83.973)	(74.129)
MTB	9.604*	-2.360	-0.077**	-4.722	-10.005**
	(5.734)	(4.752)	(0.035)	(5.019)	(4.991)
PDR	-0.794	7.176	0.076	6.063	14.124
	(38.770)	(37.626)	(0.277)	(41.620)	(42.379)
Tangibility	-24.399	-18.748	-0.204*	-31.083*	-38.254**
	(33.323)	(19.544)	(0.105)	(16.197)	(16.857)
Earnings Volatility	-23.124	-79.357	0.555	-10.031	34.350
	(144.369)	(221.361)	(1.366)	(223.018)	(225.784)
Coupon (%)	27.105***	28.844***	0.172***	38.970***	23.438***
	(2.562)	(4.350)	(0.020)	(3.678)	(3.467)
Maturity (Days)	21.253**	6.058	-0.035	-0..378	-15.988*
	(8.665)	(7.773)	(0.053)	(8.377)	(9.591)
Credit Rating	-5.038***	-7.273***	-0.062***	-7.921***	-8.540***
	(1.215)	(1.285)	(0.010)	(1.562)	(1.842)
Intercept	-66.254	347.036***	6.538***	275.138***	540.274***
	(105.128)	(66.047)	(0.400)	(65.363)	(72.425)
Observations	1007	1007	1007	1007	821
Adjusted R-squared	0.554	0.514	0.581	0.579	0.507
Standard errors	Clustered	Clustered	Clustered	Clustered	Clustered
Method	FE	RE	POLS	POLS	Lagged
Industry dummies	No	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes

*Table 13 reports the results from various alternative model specifications for the main model (1) with Total Hedging as the main explanatory variable. Model 1.3 reports results for firm-fixed effects while 1.4 reports random effects. Furthermore, presented in the table is Model 1.5 and 1.6, using the natural logarithm of Yield Spread and Z-spread as the dependent variable in POLS regressions. Lastly, model (1.7) is a POLS regression with all explanatory variables lagged by one year. Note that the lagging explanatory variables lead to a loss of 186 observations due to the last year-observation for each firm not being included in the regression. Clustered robust standard errors by firm are reported in parenthesis. *, **, and *** denotes significance levels of 10%, 5%, and 1%, respectively.*

Table 14, Logged Yield Spread and Z-Spread IR, FX, and CM Hedging

	Panel A: Logged Yield Spread			Panel B: Z-Spread		
	Model 2.3	Model 3.3	Model 4.3	Model 2.4	Model 3.4	Model 4.4
IR Hedging	-0.437**			-79.706**		
	(0.219)			(32.786)		
FX Hedging		-0.148			-32.758	
		(0.144)			(22.542)	
CM Hedging			-1.083			-243.765
			(1.123)			(157.657)
Firm Size	-0.017	-0.064***	-0.061**	-9.755***	-9.754***	-8.931**
	(0.034)	(0.024)	(0.024)	(3.666)	(3.708)	(3.685)
Leverage	0.621***	0.327	0.306	69.006**	44.397	39.486
	(0.234)	(0.219)	(0.208)	(29.465)	(29.278)	(27.975)
Interest Coverage	0.001	0.001	0.001	0.484*	0.400	0.373
	(0.002)	(0.002)	(0.002)	(0.278)	(0.275)	(0.273)
Altman's Z-score	0.023	0.025	0.023	3.075	3.428	2.952
	(0.020)	(0.019)	(0.019)	(2.759)	(2.707)	(2.715)
Profitability	-1.276**	-1.307**	-1.210**	-300.736***	-288.299***	-266.658***
	(0.511)	(0.512)	(0.527)	(84.641)	(82.574)	(84.878)
MTB	-0.076**	-0.077**	-0.076**	-5.014	-4.676	-4.502
	(0.035)	(0.035)	(0.035)	(5.167)	(5.066)	(5.138)
PDR	-0.116	0.098	0.095	10.328	10.251	9.575
	(0.285)	(0.279)	(0.283)	(41.934)	(41.943)	(42.670)
Tangibility	-0.204**	-0.211**	-0.187*	-30.620*	-32.508**	-27.141
	(0.103)	(0.106)	(0.107)	(16.303)	(16.336)	(16.454)
Earnings Volatility	0.258	0.519	0.560	-44.558	-16.073	-6.598
	(1.359)	(1.376)	(1.409)	(221.969)	(224.790)	(228.854)
Coupon (%)	0.181***	0.172***	0.171***	39.598***	38.822***	38.667***
	(0.020)	(0.020)	(0.020)	(3.735)	(3.695)	(3.652)
Maturity (Days)	-0.049	-0.028	-0.023	0.605	0.787	1.963
	(0.057)	(0.053)	(0.053)	(8.477)	(8.451)	(8.533)
Credit Rating	-0.060***	-0.063***	-0.064***	-7.962***	-8.106***	-8.413***
	(0.010)	(0.010)	(0.010)	(1.570)	(1.575)	(1.607)
Intercept	7.069***	6.446***	6.380***	257.409***	258.042***	243.338***
	(0.489)	(0.404)	(0.398)	(65.850)	(65.487)	(65.403)
Observations	1007	1007	1007	1007	1007	1007
Adjusted R-squared	0.584	0.577	0.577	0.578	0.574	0.574
Standard errors	Clustered	Clustered	Clustered	Clustered	Clustered	Clustered
Method	POLS	POLS	POLS	POLS	POLS	POLS
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes

*Table 14 reports the results from POLS regressions for IR, FX, and CM hedging using alternative measures for the cost of debt. Panel A presents the output for using the natural logarithm of Yield Spread, while Panel B reports the model for using Z-spread as the dependent variable. Clustered robust standard errors by firm are reported in parenthesis. *, **, and *** denotes significance levels of 10%, 5%, and 1% respectively.*

Table 15, Lagged IR, FX, and CM Hedging

	Model 2.5	Model 3.5	Model 4.5
IR Hedging	-68.955*		
	(38.062)		
FX Hedging		-13.187	
		(24.283)	
CM Hedging			-306.719*
			(174.678)
Firm Size	-8.636**	-8.411**	-7.783**
	(3.876)	(3.952)	(3.936)
Leverage	64.158*	45.403	33.141
	(34.392)	(33.731)	(31.947)
Interest Coverage	0.242	0.170	0.137
	(0.289)	(0.285)	(0.276)
Altman's Z-score	2.534	3.102	2.178
	(3.030)	(2.998)	(2.893)
Profitability	-219.259***	-207.249***	-189.572**
	(75.162)	(74.621)	(74.677)
MTB	-10.492**	-10.304**	-9.651*
	(5.152)	(5.142)	(5.124)
PDR	18.545	19.484	17.614
	(42.747)	(43.003)	(43.148)
Tangibility	-38.360**	-39.327**	-32.852*
	(17.059)	(17.174)	(17.316)
Earnings Volatility	-3.986	7.201	15.808
	(225.166)	(228.363)	(227.730)
Coupon (%)	24.074***	23.301***	23.206***
	(3.516)	(3.500)	(3.454)
Maturity (Days)	-14.802	-13.906	-13.663
	(9.574)	(9.676)	(9.570)
Credit Rating	-8.593***	-8.839***	-9.151***
	(1.845)	(1.862)	(1.867)
Intercept	522.918***	515.982***	513.101***
	(71.859)	(72.474)	(70.517)
Observations	821	821	821
Adjusted R-squared	0.506	0.501	0.505
Standard errors	Clustered	Clustered	Clustered
Method	Lagged	Lagged	Lagged
Industry dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes

*Table 15 reports results from a POLS regression for each risk category, IR, FX, and CM hedging, with all explanatory variables lagged by one year Note that the lagging explanatory variables leads to a loss of 186 observations due to the last year-observation for each firm not being included in the regression. Clustered robust standard errors by firm are reported in parenthesis. *, **, and *** denotes significance levels of 10%, 5%, and 1%, respectively.*