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To Hedge or not to Hedge:
An Empirical Analysis on the Determinants of Corporate Interest Rate Risk Management

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Abstract: Two theories explain why company size and leverage affect interest rate hedging: Economies of scale of derivatives usage and expected costs of financial distress. We test whether these determinants affect corporates in the decision to hedge interest rate risk with derivatives. Building on a new, hand-collected data set on interest rate swap usage of corporate constituents of the S&P 500, we find that firms' decisions to hedge are impacted by size and leverage. Differentiating between two kinds of exposures, relating to either rising or falling interest rates, we show that size affects the decision to use fixed-to-floating swaps, and leverage affects the decision to swap floating debt into fixed-rate debt. Our results also indicate differences in the determinants of the decision to hedge and the hedging extent.

Keywords: Interest Rate Risk Management, Interest Rate Hedging, Interest Rate Derivatives, Cash Flow Hedging, Fair Value Hedging

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1 Introduction

"[…] the coronavirus poses evolving risks to economic activity. In light of these risks and in support of achieving its maximum employment and price stability goals, the Federal Open Market Committee decided today to lower the target range for the federal funds rate […]" (Federal Reserve, 2020).

Facing disrupted financial markets, the Federal Reserve cut its benchmark interest rate to counter the threat to the economy from the coronavirus pandemic and set a new target range of 0% to 0.25% from a previous target range of 1% to 1.25% in March 2020. The cut was positive news for most businesses as the action made it cheaper to borrow for companies and consumers, helping to fuel economic growth. Falling interest rates lead to lower interest rate expenses for firms that carry floating-rate debt. At the same time, companies with fixed-rate debt suffer a loss in the fair value of their debt portfolio. Generally, firms are affected by fluctuating interest rates as it impacts their borrowing conditions and also affects their debt instruments by changing the amount of interest payments for floating-rate debt or the fair value of fixed-rate obligations.

Companies are exposed to market risks and can use corporate risk management to mitigate risks which are difficult to control or accurately forecast. The quote above exemplifies that interest rates continue to be subject to fluctuations and unexpected movements. Interest rate risk is one of the most important market risks, which companies can control by using interest rate swaps[1]. The rising importance of interest rate derivatives can be depicted by an almost sevenfold increase in the over-the-counter market for interest rate derivatives from USD 71.6 trillion to USD 495.1 trillion in the last twenty years (Bank for International Settlements, 2020).

Companies are exposed to interest rate risk if they own assets or liabilities that bear interest rate. Our analysis focuses on the liability side, as it carries the largest share of debt instruments for corporate firms. Fluctuations in interest rates impact the fair value or the interest payments of these instruments and ultimately affect a company's balance sheet or cash flow. This implies that interest rate risk can be divided into two kinds of risk. We define Cash

[1] The International Swaps and Derivatives Association (ISDA) defines an interest rate swap "as a transaction where one party agrees to make periodic payments to the counterparty of amounts accrued at one reference rate (e.g. a fixed rate) on the notional amount over a calculation period in exchange for payments by the other party accrued on the notional amount at another reference rate (e.g. a floating rate, such as LIBOR with a designated maturity equal to the length of the calculation period)" (ISDA, 2012).

Flow risk as the risk of a change in interest rates impacting a firm's cash flows, which could stem from fluctuating interest payments from floating-rate debt. Fair Value risk, on the other hand, represents the risk of changes in the fair value of a firm's debt instruments, which may affect its balance sheet. Thus, companies with Cash Flow risk are negatively affected by rising interest rates, while companies with Fair Value risk suffer when interest rates fall. Literature has only been able to provide ambiguous results on determinants of hedging for firms despite the topic's importance and has not explicitly differentiated Cash Flow and Fair Value risk.

Creating a data base from the constituents of the S&P 500, we examine hedging activities of 396 corporates by collecting information on whether and to what extent the companies use interest rate swaps. Because firms only report whether they hedge but do not consistently state whether they are exposed to interest rate risk, we need to develop a measure of interest rate risk exposure. To do so, we construct criteria for Cash Flow exposure and Fair Value exposure and classify the companies accordingly. For Cash Flow exposure, we follow Graham and Rogers (2002) and regress changes in operating income on changes in the 6-month Libor rate. For Fair Value exposure, we use a self-constructed criterion which relates to the companies' fixed-rate debt. We find that most companies in our sample are exposed to interest rate risk of some form. We continue by analyzing whether interest rate risk exposure prompts firms to use interest rate swaps. We find this to be the case for our developed classifications, as our results demonstrate the fraction of hedgers amongst exposed firms to be larger than amongst firms that are not exposed, for each type of interest rate risk. We use a sample consisting of firms that are exposed to interest rate risk in general, and reclassify it in two samples for Cash Flow risk and Fair Value risk, for the further analysis.

We then construct a research framework by identifying the economies of scales inherent in derivative usage and expected costs of financial distress as our main theories, which are complemented by proxies for economic rationales of Fair Value and Cash Flow hedging. Size and leverage are the main specifications resulting from our theoretical framework. Company-specific data is obtained to test the identified relationships.

We demonstrate a strong positive relationship between the size and the leverage of a company and its probability to hedge interest rate risk. Applying the theory on Cash Flow and Fair Value interest rate risk hedging separately shows that the size of a company significantly affects the decision to employ Fair Value hedging whereas leverage significantly affects the likelihood of exercising Cash Flow hedging.

The findings are consistent with the main assumptions raised in our theoretical framework. We argue that a company's size and amount of debt are both determinants that affect a firm's decision to use interest rate swaps. We claim that size is relevant for the hedging decision due to underlying economies of scale. Size is expected to be a particular dominant determinant for the decision to hedge Fair Value risk due to shareholder scrutiny and access to capital markets for fixed-rate bond issuances, which is more apparent for larger firms. We explain the importance of leverage in the implementation of interest rate risk management with costs of financial distress and costs of bankruptcy. We further argue that leverage affects the decision for Cash Flow hedging stronger than for Fair Value hedging, given the more prominent link between Cash Flow risk and the probability of financial distress. In our framework, we further account for potential interactions between the main determinants and supporting variables. We argue that profitability, growth opportunities and cash flow volatility affect the impact of leverage on the hedging decision. However, our findings do not identify any interactive relationships between those variables.

The decision to employ Cash Flow hedging and Fair Value hedging could be influenced by specific determinants that only apply to one type of interest rate risk. We study the rationales for Cash Flow and Fair Value hedging and identify the share of floating debt as a Cash Flow hedging specific determinant, and short-term assets and cyclicality as determinants for Fair Value hedging. Our results confirm that the share of floating debt positively affects the decision to engage in Cash Flow hedging but cannot confirm that short-term assets and cyclicality are drivers for the Fair Value hedging decision.

After using a dummy variable representing the hedging decision, we continue by examining the extent of hedging, using a continuous dependent variable. For this purpose, we apply our theoretical framework on the extent of hedging for companies with an existing interest rate risk management and demonstrate that the results are inherently different from our analysis which regards the probability to engage in hedging. Our results show a negative relationship between the size of a company and the extent of Cash Flow hedging and a negative relationship between a firm's leverage and its extent of Fair Value hedging. These results suggest that theories explaining the hedging decision may not work for the extent of hedging.

This study is the first contribution to look at the internal margin of hedging separately for Cash Flow and Fair Value hedging. Previous literature that tests the internal margin either only accounts for Cash Flow hedging (e.g. Carneiro and Sherris, 2008), subtracts the extent of Fair Value hedging from the extent of Cash Flow hedging (e.g. Bretscher et al, 2015) or does

not distinguish between the two forms of interest rate hedging at all (e.g. Belghitar et al, 2008). However, Fair Value hedging observes interest rate risk from a long-term view by focusing on increased balance sheet stability while Cash Flow hedging limits interest rate risk in the short-term and aims to reduce volatility in cash flows by providing certainty in near future interest expenses. Therefore, the differing objectives of both forms require testing for the determinants of Cash Flow and Fair Value hedging separately.

According to our framework, determinants for Fair Value hedging represent the economic rationales of duration matching and market cyclicality. Based on these rationales, we expect companies with a higher share of short-term assets and higher market cyclicality to be more likely to manage Fair Value risk. Notably, we do not find any empirical evidence for these assumptions, which indicates that this topic would benefit from a more detailed analysis for the determinants of Fair Value hedging in particular.

To the best of our knowledge, this is the first study that identifies and analyzes the determinants of Fair Value hedging. We thereby contribute not only by providing support for existing determinants in the current environment but also by offering new insights on underlying drivers of differing objectives in interest rate risk management.

The findings of this work are in line with previous studies on the impact of size and leverage on the hedging decision (e.g. Graham and Rogers, 2002). However, in contrast to these studies, this work divides interest rate risk into Cash Flow and Fair Value risk and demonstrates different objectives and results for the two differing risks. Furthermore, our study is not limited to the external margin of hedging but also explores the internal margin. To the best of our knowledge, our study is the only work so far with empirical evidence regarding the internal margin separately for Cash Flow and Fair Value hedging. The majority of existing studies was conducted in the 1990s and early 2000s (e.g. Bartram et al, 2009; Graham and Rogers, 2002; Stulz, 1996), when reporting risk management activities became mandatory in the US and Europe. Our study contributes to determine whether these the findings hold in the current environment.

The study is structured in the following way. In Section 2 we provide an overview of previous literature, and discuss existing results as well as possible research gaps. In Section 3 we construct the theoretical framework and develop our hypotheses which are tested in our analysis. Section 4 describes the methodology and includes our sample creation as well as our exposure analysis, followed by the variable and model selection to test the hypotheses. We

present and interpret our findings in Section 5. Section 6 concludes with a discussion of our results.

2 Literature Review

Corporate risk management and its qualitative and quantitative drivers are debated topics in the academic and non-academic fields. Corporates may choose to use financial or natural hedging to mitigate risks which are unable to be controlled or predicted. Derivatives are a conventional tool to hedge general market risks. The high level of possible customization of derivative products further allows firms to hedge different risks which can range from interest rate fluctuations and currency exchange rates to price risks in commodities, stocks or debt and natural phenomena.

Traditional economic theory suggests that corporate risk management is irrelevant for shareholders. A classic example is Modigliani and Miller's (1958) proposition, according to which corporate financing choices do not have an effect on company value, assuming perfect, frictionless markets. Corporate risk management can be classified as a part of a firm's financial decision and is thus considered irrelevant. However, assumptions under which hedging as a financing choice is insignificant do not hold in practice. Easing these theoretical assumptions, corporate hedging becomes important in the risk and capital management of the firm. Smith and Stulz (1985) have demonstrated in their theory of corporate hedging that imperfect capital markets can create conditions where corporate hedging becomes economically justified by adding value to the firm. They find that firms hedge to maximize value for three reasons namely taxes, costs of financial distress and managerial risk aversion.

Until the early 1990s, empirical research faced substantial hurdles in the use of such derivatives that were employed for corporate risk management and was confronted with a lack of reporting standards and concerns about confidentiality which declared hedging strategies as insider information. The introduction of legal obligations to report the details of hedging instruments allowed researchers to gather data for empirical analyses on this matter, while differences in the scope of derivative usage reporting and the need for manual searches in annual reports still impose challenges.

Theories on corporate risk management have typically been tested with a bivariate dummy variable indicating whether the company uses financial derivatives[2] to hedge risks

[2] By definition, "financial derivatives are financial instruments that are linked to a specific financial instrument or indicator or commodity, and through which specific financial risks can be traded in financial markets in their own right; their value derives from the price of the underlying item (i.e. the reference price) and, unlike debt instruments, no principal amount is advanced to be repaid and no investment income accrues" (OECD, 2004).

(Allayannis and Weston, 2001). Yet, some studies have also employed notional amounts as a proxy for a firm's extent of hedging (Tufano, 1996). Generally, studies tend to focus on specific kinds of risks or risk practices and test specified theories when assessing corporate risk management. Researchers have considered different risks such as foreign currency risk (Allayannis and Weston, 2002), interest rate risk (Bartram et al, 2009) or commodity price risk (Géczy et al, 2006).

We identify the economies of scale effect and the costs of financial distress and bankruptcy as our main theories, which have been addressed by the following studies.

Carneiro and Sherris (2008) explain the economies of scale inherent in derivative usage, as the initial implementation costs present a hurdle for small companies to engage in interest rate hedging. However, literature provides mixed predictions about the direction of the effect of company size on the hedging decision. Aretz and Bartram (2010) show that most studies expect a negative size effect, stating an increased need for hedging for small firms because of more opaque organizational structures. Therefore, the direction of the size effect could be different for the hedging decision per se and the amount of debt that is hedged (Graham and Rogers, 2002; Allayanis and Ofek, 2001).

Smith and Stulz (1985) argue that hedging can prevent costs of financial distress by reducing the probability of bankruptcy. Also, firms could benefit from increasing the price of new debt by including covenants in bond issues, which would guarantee bondholders that firms will hedge after the sale of debt. Graham and Rogers (2002) show that corporate risk management hence mitigates the risk of extreme scenarios such as financial distress and bankruptcy by reducing firm volatility and allowing the firm to carry more debt. Given that corporate hedging decreases costs of financial distress, firms with more leverage or higher probability of default should be incentivized to hedge.

Graham and Rogers (2002) test whether corporates respond to the incentive to increase debt capacity and the incentive to reduce expected tax liabilities by reducing the volatility of taxable income. They use a random selection of 469 corporate US firms in the fiscal year of 1995, after derivative disclosures became mandatory, and look at interest rate hedging and foreign exchange risk hedging separately. The hedging extent variable is defined as the difference between floating-to-fixed and fixed-to-floating swaps, divided by book assets. They find highly significant, positive effects of size and leverage for the hedging decision (dummy dependent variable) and the hedging extent (continuous dependent variable).

Our work relates to the aforementioned studies and adds to the ongoing debate through three channels. First, prior empirical results for the main theories are ambiguous. A majority of studies show a significant positive size effect on the hedging decision, however overall results are mixed and usually do not go in the predicted direction (Aretz and Bartram, 2010). Graham and Rogers (2002) and Allayanis and Ofek (2001) show that small firms with a risk management program hedge in a more extensive way. Several proxies have been used in previous literature to test the cost of financial distress theory, such as the interest coverage ratio, long-term debt and implied default probability. Bartram et al (2009), Graham and Rogers (2002) and Haushalter (2000) find strong positive correlations between leverage and corporate hedging, while the results of Rampini et al (2020) indicate a negative effect of leverage for financial institutions. We thus contribute by testing the size and leverage effects on a large, recent data sample with S&P 500 companies in the fiscal year 2019.

Second, there are differences between studies that use a dummy dependent variable and studies that use a continuous variable. Carneiro and Sherris (2008) and Graham and Rogers (2002) run tests for both dummy and continuous dependent variables. Most studies do not run separate tests, resulting in difficulties when comparing results (Aretz and Bartram, 2010). We test both dependent variables separately and refine the hedging extent analysis by looking at hedgers only to make possible differences visible.

Third, there is a lack of testing Cash Flow and Fair Value hedging determinants separately. None of the studies mentioned above runs separate tests for firms that engage in Fair Value hedging. We expand the traditional definition of interest hedging by distinguishing between Cash Flow and Fair Value hedging and account for potential differences.

Besides the aforementioned theories regarding economies of scale of derivative usage and expected costs of financial distress, literature also discusses theories about agency costs with the resulting underinvestment problem and corporate taxation. Information asymmetries between managers and bondholders can generate agency costs, which can be mitigated through hedging. Empirical research provides only weak evidence on the relation between information asymmetries and corporate risk management. Accordingly, the effect of institutional ownership and the number of analysts following a company is in the predicted direction for some studies (Dionne and Triki, 2005) but is significantly opposite for others (Graham and Rogers, 2002). Studies have shown that corporate risk management can mitigate underinvestment problems (Myers and Majluf, 1984; Myers, 1977). A company may choose to forego profitable investment projects if it is presented with a lack of internal funds in some states of nature due

to volatility in income. Hedging allows a firm to move internal funds into states where they may otherwise be scarce (Graham and Rogers, 2002). Hence, proxies for higher growth opportunities should be positively associated with corporate hedging. Quantifying valuable investment opportunities with the market-to-book ratio, several empirical studies find no effect on hedging (Allayannis and Ofek, 2001; Mian, 1996). Géczy et al (1997) define the measure of underinvestment costs as the product of the Market-to-book ratio and the debt ratio.

Smith and Stulz (1985) illustrate that cash flow volatility is costly for firms facing a convex tax function. Testing for tax convexity, most empirical studies use existing net operating loss carryforwards as a proxy for tax function convexity (Géczy et al, 1997; Nance et al, 1993). This variable implies that firms with existing net operating losses face tax convexity although Smith and Stulz's argument relies on a firm's future losses. Aretz and Bartram (2010) show that overall research provides ambiguous results for the convex tax curve theory.

3 Research Framework and Hypothesis Development

3.1 Definition and Differentiation of Interest Rate Risks

Firms are exposed to interest rate risk if they carry assets or liabilities which are subject to fluctuating interest rates. Interest rate exposure may come from the asset side but primarily stems from the liability side, as the latter typically carries more interest rate bearing instruments.

A company can influence the mix of floating and fixed debt in two ways. They can directly issue the preferred debt type, or they can use derivatives to achieve the preferred fixed-to-floating debt mix. While this work, in line with other mentioned studies (Aretz and Bartram, 2010), focuses on the determinants of derivative usage, it is worthwhile to mention the impact of preferences in debt issuances. However, companies may be unable to directly control the preferred rate type and are often restricted to a given market standard offering (Appadu, 2010).

Firms have two options to alter their debt structure and change their interest rate risk exposure by using financial derivatives (Appadu, 2010). Companies can either swap variable rates into fixed payments or vice versa. In this study, we use the terms Cash Flow hedging for floating-to-fixed swaps and interest rate locks. Engaging in Cash Flow hedging, a firm pays the fixed-rate leg of the swap and receives the floating-rate leg. Fair Value hedging refers to the use of fixed-to-floating swaps, where a company pays the floating-rate leg and receives the fixed-rate leg. These terms are largely consistent with the ASC 815 hedge accounting perspective[3] used in annual reports, although companies sometimes choose deviating classifications for accounting reasons.

Cash Flow hedging mitigates a company's Cash Flow risk exposure by reducing the volatility of a firm's free cash flows. A firm that has debt obligations at a floating rate is likely to be exposed to the variability of interest rates, which can cause volatility in cash flows and income. This exposure affects the company in the short-term, as it influences their near-term earnings. The firm can reduce this risk by converting an amount of existing floating-rate

[3] The Hedge accounting perspective under Accounting Standards Codification (ASC) Topic 815 (Financial Accounting Standards Board, 2017), "Derivatives and Hedging" aligns accounting for hedging activities with a company's risk management strategies and provides improved information about those strategies. The FASB first issued its comprehensive standard on the accounting for derivatives and hedging in 1998 and has revised it numerous times, including a significant amendment issued in August 2017. ASC 815 defines three different kinds of hedges: (1) Fair Value hedges, which hedge the exposure to variations in the fair value of liabilities (2) Cash Flow hedges, which hedge the exposure to changes in expected cash flows of liabilities (3) Hedges of net investment in foreign operations, which hedge the translation exposure to fluctuations in foreign exchange rates in other comprehensive income. The latter is only related to foreign exchange risk.

borrowings into fixed-rate debt by using a floating-to-fixed interest rate swap. Stabilizing capital in- and outflows, Cash Flow hedging thus protects the daily business of a company. Entering variable-to-fixed contracts may reduce the risk of getting into financial distress and thereby mitigates the expected cost of financial distress, as increased cash flow stability provides a company with a higher likelihood of honoring its debt obligations (Stulz, 1996). Company examples may be helpful to further illustrate the inherent differing objectives in firm-specific corporate risk management practices. Against this backdrop, Harley-Davidson (2020) explains in its annual report the decision to hedge its Cash Flow risk stating that it uses interest rate swaps and caps to reduce the impact of interest rate fluctuations on its debt.

Fluctuating interest rates change the net present value (NPV) of fixed-rate debt. In the long term, this causes changing nominal values for new debt issuances or duration mismatches. Companies may regard this as an issue if they must refinance their borrowings. For example, Nike (2019), Kellogg Company (2020) and Laboratory Corporation of America Holdings (2020) mention this rationale in their annual reports as a reason to engage in Fair Value hedging by entering fixed-to-floating swaps. Further, a company holding a significant amount of floating interest-rate bearing assets is incentivized to match these with its debt payments. Thus, if a company initially carries fixed-rate debt, a higher amount of short-term assets may lead to interest mismatches, given any changes in the interest rate. This provides an incentive to swap a portion of the debt to floating rate and is stated as such in several annual reports (e.g. IBM, 2020; Textron, 2020). Further, cyclical companies may enter Fair Value hedging as they should prefer to hold a large portion of floating-rate debt due to their positive exposure to the economic cycle. Hence, swapping fixed-rate to floating-rate debt serves as a natural hedge against economic cyclicality if interest rates move anticyclical (Chava and Purnanandam, 2007). To illustrate Fair Value exposure, 3M (2020) states in its annual report that it manages interest risk and expense by implementing a mix of fixed and floating-rate debt to balance both exposures through the use of Fair Value hedges associated with its long-term debt. They have, for instance, entered a fixed-to-floating swap in 2018 that converts a portion of fixed-rate medium-term notes into a floating-rate note “as a hedge of its exposure to changes in fair value that are attributable to interest rate risk” (3M, 2020).

Defining interest rate risk from both a Cash Flow and a Fair Value perspective implies that a company with debt is likely to be exposed to either or both kinds of interest rate risk, giving way for several options to address interest rate risks. A firm cannot reduce both Cash Flow and Fair Value interest rate risk simultaneously but is able to shift or balance the exposure

depending on its risk priorities and views. Accordingly, we observe in screened annual reports that firms aim for a company-specific ratio between fixed and floating-rate debt to balance both exposures. While the two directions of interest rate hedging seem to be exclusive, there are companies that control their floating and fixed debt balance by entering both fixed-to-floating and floating-to-fixed swaps. In its annual report Eli Lilly and Company (2020) addresses its interest rate risk exposures through a controlled risk management program which includes the use of derivatives with the objective to limit the impact of interest rate fluctuations on the fair value of their debt, earnings and cash flows. As all their long-term debt is tied to a fixed rate, they use Fair Value hedging by entering fixed-to-floating swaps "to achieve an acceptable balance between fixed- and floating-rate debt". Further, they are Cash Flow hedgers, having forward-starting interest rate swaps "as part of any anticipated future debt issuances in order to reduce the risk of cash flow volatility from future changes in interests" through which they will have fixed payments and receive the floating leg of the swap. This portrays that while both hedging strategies theoretically work in opposing directions, there are certain circumstances in which simultaneous Cash Flow and Fair Value hedging is compatible.

3.2 Size as a Determinant of Hedging

We argue that the size of a company influences a firm's interest rate hedging decision as hedging entails fixed costs, that are easier to pay for large companies due to economies of scale. We further state that the size effect should be particularly pronounced for Fair Value hedging.

Smaller companies tend to neither have the organizational structure (e.g., a treasury department) nor the experience or expertise to engage in interest rate hedging activities and are confronted with a large amount of fixed costs regarding the implementation and monitoring of a risk management program. Derivative markets are moreover subject to significant economies of scale in the structure of transaction costs, suggesting that large firms are more likely to hedge (Carneiro and Sherris, 2008). Hence, smaller companies may forego to hedge interest rate risks as the implied costs outweigh the benefits of hedging. Accordingly, Booth et al (1984) argue that hedging programs exhibit informational scale economies and that larger firms are thus more likely to hedge.

Following this rationale, size may be a strong determinant particularly for Fair Value hedging, given the easier access to the capital market and increased public scrutiny for large companies. It can be argued that larger companies are more likely to have long-term fixed-rate debt translating into a higher Fair Value exposure and are thus more inclined to conduct Fair

Value hedges. This is because long-term bonds are typically issued with underlying fixed interest rates in capital markets, while bank-based debt is typically distributed on a floating-rate basis (Appadu, 2010). Hence, corporates that have access to capital markets may be more inclined to conduct fixed-to-floating interest rate swaps. Generally, companies with high turnover or high total assets have the cash flow stability required to raise debt in capital markets and will be incentivized to do so as transactions costs in capital markets are more favorable compared to bank-based loans (Appadu, 2010). In addition, both shareholder and creditor scrutiny increase with size, further incentivizing companies to prevent fair value changes on their balance sheet. The larger a company the higher the focus on its balance sheet, as the firm will be subject to credit ratings and underlying ratios which are connected to its balance sheet. Larger companies may thus be more likely to be Fair Value Hedgers and to focus on mitigating volatility in their reported assets and liabilities. We expect that stable cash flows are important for all companies, independent of size and public scrutiny, and therefore the above theory is not applicable to Cash Flow hedgers.

From this argumentation we derive:

Hypothesis 1. There is a positive correlation between company size and the decision to employ interest rate risk management, which is particularly pronounced for Fair Value hedging activities compared to Cash Flow hedging.

3.3 Leverage as a Determinant of Hedging

Assuming that corporate risk management can lower the likelihood of bankruptcy and financial distress, we argue that companies with a higher leverage and thus a higher probability of such a scenario are more likely to hedge. We further state that the leverage effect should be stronger for Cash Flow hedging compared to Fair Value hedging.

Levered companies bear the risk that their cash flows are insufficient to hold covenants and to meet fixed-payment obligations on time and in full. Therefore, the higher the leverage the higher the risk of the scenario of financial distress. Once unable to honor its payment and covenant commitments, a firm is forced into bankruptcy, at which point creditors and shareholders attempt to recover their investments in the company which is often accompanied with a costly dispute about the distribution of the remaining firm value (Warner, 1977). These direct costs typically refer to administrative and accounting fees as well as legal costs. Besides the scenario of direct costs of financial distress, a company may also face indirect costs of bankruptcy if the market participants expect a default in the near-term future. Yet, Rampini et

al (2020) find that more financially constrained financial institutions hedge less as the costs of foregoing lending or cutting credit lines are higher than the costs of hedging. This scenario is not entirely applicable to corporates, since they do not face that decision. However, they still have to allocate their funds between hedging and other investment opportunities.

A firm with high leverage has higher payment obligations and should be more engaged in corporate interest rate hedging as it will have more difficulties to hold its commitments. Given the direct link of floating-rate debt to interest rate movements, this is especially the case for Cash Flow hedging. Higher payment obligations that are subject to volatility increase this effect as they raise the likelihood of default. Hence, leverage matters less for companies with fixed-rate debt. A firm borrowing at a floating rate, on the other hand, is likely to face exposure from the variability of interest rates, which can cause volatility in cash flows and earnings. Using interest rate swaps, the company can reduce the risk of financial distress and earnings volatility, converting floating-rate debt into long-term fixed-rate debt (Stulz, 1996; Titman, 1992). A highly leveraged firm with higher Cash Flow exposure is therefore more likely to engage in Cash Flow hedging and pay a fixed rate and receive floating-rate payments on its variable debt compared to a highly leveraged company with higher Fair Value exposure which will be less likely to swap its fixed-rate into floating-rate payments.

We thus derive the following hypothesis:

Hypothesis 2. Leverage has a positive effect on a company's decision to hedge interest rate risk while this effect is stronger for Cash Flow hedging than for Fair Value hedging.

3.4 Cash Flow Hedging Determinants

Firms with more floating-rate debt face a greater variability in their cash flows and are more likely to find themselves in financial distress. Cash Flow volatility may be subject to the variability in interest rate of the company's floating debt. Therefore, companies holding a large share of floating-rate debt should be at greater risk to face difficulties in meeting their payment obligations and are more likely to experience financial distress. Thus, firms with a large portion of floating-rate debt are expected to swap this position partially or entirely into fixed-rate debt, which, as a result, lowers the probability of the firm encountering financial distress. We therefore expect a positive relationship between the percentage of floating-rate debt and Cash Flow hedging.

3.5 Fair Value Hedging Determinants

Fair Value hedging through the use of fixed-to-floating interest rate swaps can minimize a company's interest rate exposure through long-term cash flow stabilization, matching assets and liabilities to a common interest rate, and linking cyclical earnings to interest rate expense.

A change in market interest rates will impact the fair market value of fixed-rate debt. Keeping the fair value of debt stable allows companies to avoid changes in notional values for new debt issuances and stabilizes cash flows in the long term. Accordingly, in the manual screening process of the annual reports we observe several companies which mention that they apply Fair Value hedging with the objective to maintain stable fair values on their debt instruments (e.g. Kellogg Company, 2020; Nike, 2019). This rationale is difficult to be translated into a concrete determinant for Fair Value hedging. A possible proxy that answers whether a firm intends to refinance the issued amount of debt could be measured by a company's target leverage. However, companies typically do not disclose information on refinancing policies and new debt issuances in advance.

A company typically aims to match the amount of debt tied to floating rates with the amount of cash and short-term investments. A firm's cash and short-term investments are by definition short-term and usually tied to variable interest rates. Thus, companies with more cash and short-term investments relative to debt, should seek to hold more floating-rate debt. This economic rationale is also reflected in several annual reports (e.g. IBM, 2020; Textron, 2020). Hence, the more financial assets a firm possesses relative to its size, the higher its incentive to swap existing fixed-rate borrowings into floating-rate debt. We thus use the share of short-term assets as a possible determinant for Fair Value hedging which should be reflected in a positive effect.

Another incentive to employ Fair Value hedging are correlations between interest rates and operating profits (Chava and Purnanandam, 2007). In a scenario where the correlation between interest expense and profits before interest and tax (EBIT) is positive, the effect on a company's earnings is partially offset. Thus, an increase in EBIT and in interest expenses causes both effects to neutralize each other, leading to a natural hedge and providing stability in a firm's cash flow. This incentivizes firms to issue floating-rate debt or to swap fixed-rate debt into floating-rate debt by engaging in Fair Value hedging. Exposure to economic cycles will thus be regarded as a potential determinant for Fair Value hedging which should result in a positive relationship between the two.

3.6 Interaction Effects on Leverage

It is important to account for potential relations between other characteristics and our main determinants. The structural parameter size is not particularly affected by any other company characteristic, because the economies of scales effect inherent in derivatives is not company specific. Therefore, interacting the size effect with other company specific determinants would not have an additional explanatory effect. However, potential interaction effects can be identified for leverage. Thus, we study the effect of leverage on the hedging decision in more detail and further contribute to the second hypothesis. We expect to find interaction terms between leverage and other company properties, namely profitability, growth opportunities and cash flow volatility.

Profitability and its Effect on Leverage

It is possible that high leverage can lead to default, particularly in combination with a low profitability. More profitable firms find it less difficult to cover financial obligations which should result in a lower need for corporate interest rate risk management, implying a lower probability of financial distress overall (Rogers, 2002). Vice versa, a highly leveraged company with a low profitability might run an even higher risk of insolvency. We therefore expect to see a negative effect of profitability on the hedging decision. However, there is evidence of a positive correlation for financial institutions between profitability and hedging, indicating that less profitable institutions cannot afford interest rate risk management (Rampini et al, 2020). While these findings have only been measured for financial institutions, the same argument could be applied to corporates under the aforementioned limitations. Hence, theory is unable to provide a clear effect of profitability on interest rate hedging and may reduce the assumed relationship between hedging and higher leverage or enforce it.

Growth opportunities and its Effect on Leverage

A company in a growth market should have more positive NPV project possibilities than a company in a mature market. Also, higher leverage increases the likelihood for a company to be forced to forego profitable projects due to a lack of available financing. The combination of high growth opportunities and high leverage should thus increase the likelihood for interest rate hedging. We follow conventions in literature and measure growth opportunities with the book-to-market proxy (MacKay and Moeller, 2007; Jin and Jorion, 2006; Allayannis and Weston, 2001). A lower book-to-market ratio implies a higher availability of positive NPV projects, indicating a higher incentive to hedge (Bartram et al, 2007). We thus expect higher

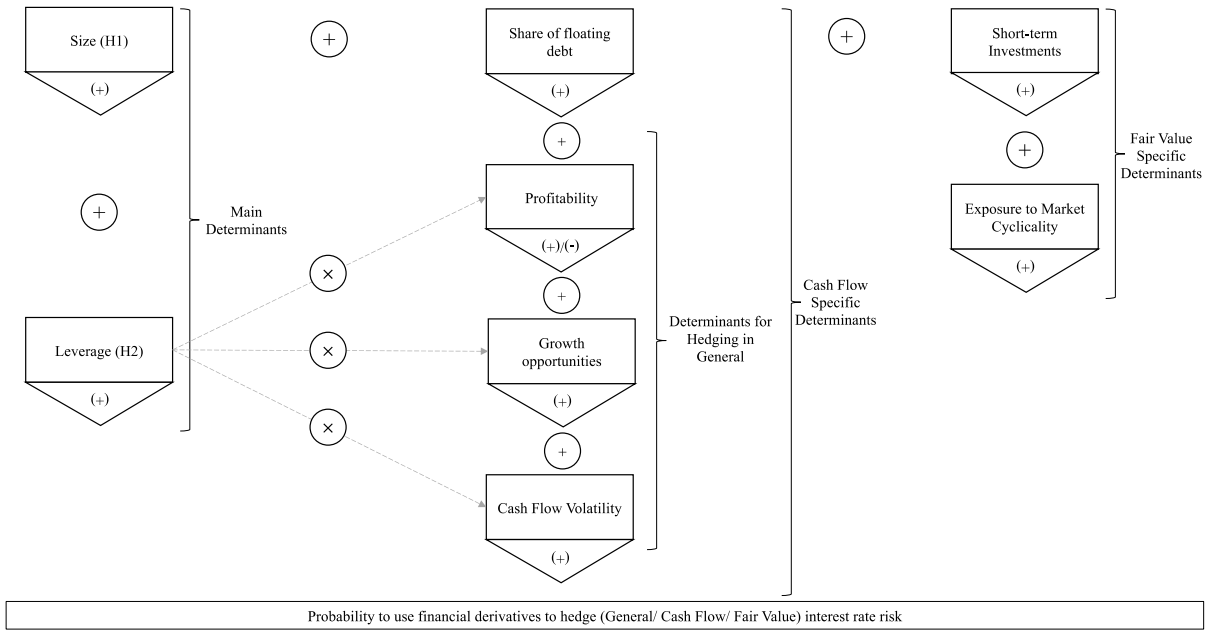
growth opportunities to enforce the positive effect of leverage on corporate interest rate risk management.

Cash Flow Volatility and its Effect on Leverage

Companies facing cash flow volatility in combination with a high leverage are incentivized to hedge to stabilize cash flows and to avoid cutbacks in investment. High-levered companies which experience cash flow constraints face a similar investment shortage as companies in growth markets and should be more inclined to hedge. Morellec and Smith (2007) argue that corporate hedging can also control free cash flow problems. Corporate risk management lowers the probability of cash flow fluctuation and thus reduces the costs of potential agency problems such as overinvestment and underinvestment. Yet, cash flow volatility by itself may not be a high concern for a firm, as it can rely on external financing to ensure liquidity. Increased leverage, however, may make external capital too costly and force a firm to cut back on their investment expenditures rather than turn to financial markets, thereby foregoing profitable projects. In fact, the empirical evidence suggests that higher cash flow volatility may lead to permanent cutbacks in investment (Minton and Schrand, 1999). Corporate hedging can ensure that firms have sufficient internal funds to finance their profitable investment opportunities without having to raise additional outside capital. Further, volatile cash flows increase the chance for a company being unable to meet its debt obligations while stable cash flows add certainty for the company and its creditors to hold its commitments. Thus, a company with high leverage and high cash flow volatility is more likely to enter a state of financial distress and should thus have a higher incentive to hedge compared to a firm with high leverage and low cash flow volatility.

In Figure 1 we include a consolidated view of our theoretical framework, summarizing all aforementioned determinants to be tested.

Figure 1:
Schematic Representation of the Determinants in Research Framework



This figure summarizes the established research framework. The main determinants Size and Leverage impact the probability of using financial derivatives, assuming that larger and more leveraged companies are more likely to hedge. The main determinants are tested for all three exposures and are included when analyzing the probability to hedge general interest rate, Cash Flow and Fair Value risk. In addition, we include profitability, growth opportunities, and income volatility as interaction terms on leverage. We expect that profitability, and a lack of growth opportunities mitigate the positive impact leverage has on hedging, while income volatility is expected to increase the hedging probability. The interaction variables as well as the share of floating-rate debt are further employed when looking at the probability to use Cash Flow hedging and can thus be classified as the Cash Flow specific determinants. Short-term investments and exposure to market cyclicality represent Fair Value specific determinants. The respective sign below shows that we expect the amount of short-term assets and cyclicality to be positively related to Fair Value hedging.

4 Data and Methodology

4.1 Construction of Hedging Data Base

Inherent in all studies that use variables for hedging decisions, the lack of data availability imposes certain challenges (Rampini et al, 2020). Therefore, we manually construct a database as the foundation of our analysis which includes the hedging activities and the amount of interest rate swaps used for Cash Flow and Fair Value hedging for all non-financial constituents in the S&P 500. The dataset includes which companies are exposed to Cash Flow risk, Fair Value risk and general interest rate risk, the hedging decision as a dummy variable for the respective risk, and further reports the extent of hedging for companies that use financial derivatives to mitigate interest rate risk. For the complete underlying data set, please refer to Table A.V in the appendix.

Focusing our analysis on the S&P 500 is appropriate for several reasons. First, the respective constituents typically carry debt and are thus exposed to fluctuating interest rates. Further, U.S. companies have traditionally been required to disclose derivative usage before the adoption of IFRS and report derivatives in a more standardized form (Carneiro and Sherris, 2008). The size of the index with around 500 companies ensures a sufficiently large sample. Finally, we are in line with previous studies in constructing a dataset based on information of large U.S. nonfinancial firms (e.g. Allayannis and Weston, 2001). This allows for better comparability between previous research and this study's results, as the latter contains the unique features of observing hedging behavior with current data and refining interest rate risk into two categories.

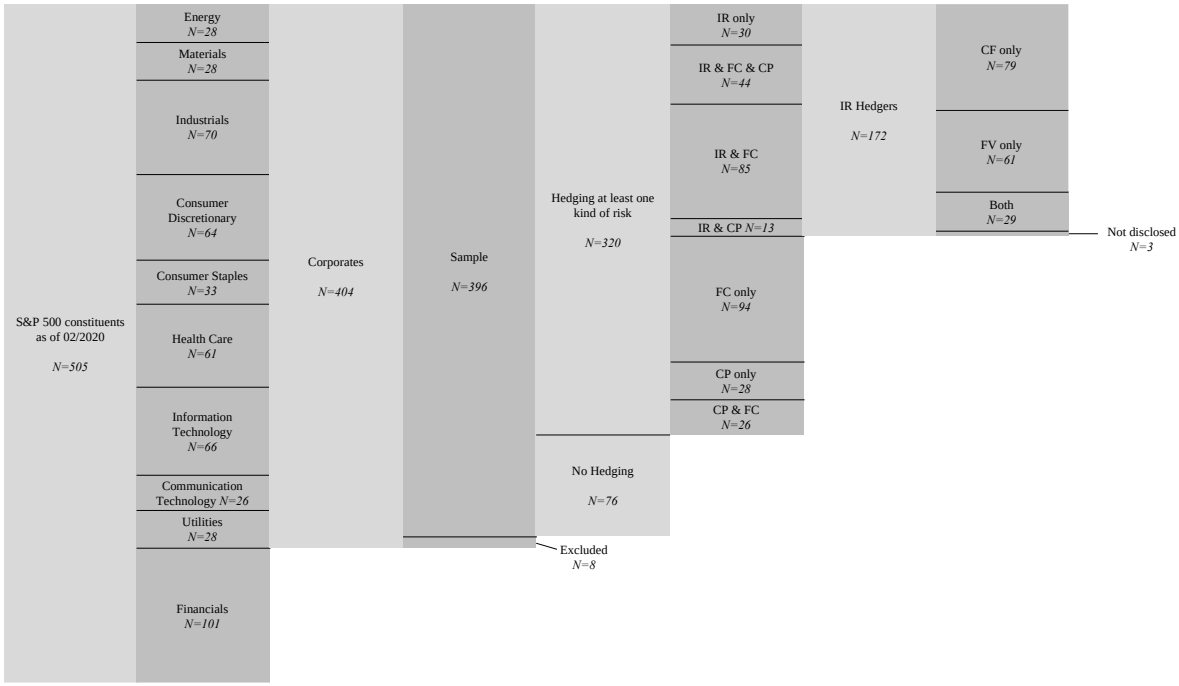
For the purpose of obtaining comparable data, we exclude all companies in the Global Industry Classification Standard (GICS) sector "Financials", where the link between derivatives usage and risk management is different than for corporates. Occasionally, studies, such as Allayanis and Weston (2001), also remove energy companies. However, we choose to include this sector, as the differences to other corporate industries are smaller for interest rate risk management than for other forms of hedging such as commodity price risk hedging.

To extract the firms' hedging decisions, we retrieve the 10-K reports of all non-financial S&P 500 companies from the EDGAR data base. We look at the fiscal year ending in the twelve months prior to February 29, 2020 and select the S&P 500 constituents as of that date to obtain the most recent data possible while excluding possible effects of the COVID-19 pandemic. During this process, we omit eight companies due to missingness of the 10-K form or because

they are owned by another constituent, which results in a total of 396 companies in our sample. We show in the stickiness analysis in Section 5.5.1 that focusing on one year does not distort our results.

Information regarding derivatives usage and risk management activities can usually be found in Item 7A and a corresponding section in the "Notes to Consolidated Financial Statements" in Item 8 of the firms' 10-K forms. These sections disclose insights on the companies' hedging activities regarding foreign currency, interest rate and commodity derivatives. A company holding derivatives for non-trading purposes is considered a hedger. Cash Flow hedging refers to holding floating-to-fixed interest rate swaps and forward starting interest rate locks, which both enable companies to pay the fixed-rate leg and receive the floating rate leg. Fair Value hedging alludes to companies holding fixed-to-floating swaps, where companies pay the floating-rate leg and receive the fixed-rate leg. Figure 2 summarizes the retrieved information.

Figure 2:
Sample Construction and Overview



This figure illustrates the sample construction and provides an overview of company classification. Included in the original sample are all constituents of the S&P 500 as of the end of February 2020, which can then be divided into different industries, using the GICS Sector classification. 101 Companies belonging to the GICS Sector Financials are excluded, as were eight corporate firms that were owned by another constituent or were missing 10-K reports. We further divide the sample into Corporates which hedge at least one of the three kinds of risk using derivatives (interest rate risk, foreign currency risk, commodity price risk) or none. We further sub-divide the companies with a corporate interest rate risk management into the kinds of risk they hedge. Looking at all companies that hedge interest rate risk, we further refine interest rate hedging into companies that do Cash Flow hedging and Fair Value hedging or both or do not disclose the kind of interest rate risk hedged. IR = Interest Rate, FC = Foreign Currency, CP = Commodity Price, CF = Cash Flow, FV = Fair Value.

For Cash Flow and Fair Value hedging, we also extract the notional amount of the debt that is swapped, separately for floating-to-fixed and fixed-to-floating swaps. This step does not take the notional amounts of forward starting swaps into account, since forwards refer to debt in the future and including them would be an inaccurate depiction of the currently hedged position. The following analysis focuses on interest rate risk management. Foreign currency and commodity price risk hedging will be used for comparison purposes only.

4.2 Risk Exposure Analysis

4.2.1 Classification of Firms into Risk Exposures

We divide the exposure to changing interest rates into three categories, Cash Flow exposure, Fair Value exposure and general interest rate risk exposure. A company carries Cash Flow exposure if interest rate fluctuations can affect its cash flows, either on an operating or on a total level. Fair Value exposure accounts for potential changes in the Fair Value of firm debt induced by fluctuations in interest rates. Finally, general interest rate exposure applies when a firm faces either Cash Flow or Fair Value exposure, or both.

We follow Graham and Rogers (2002) and determine whether a firm has ex-ante Cash Flow exposure, meaning that it is exposed prior to the hedging decision. Accordingly, we perform a univariate regression of changes in the six-month Libor rate on changes in the company's operating income following this model:

$$y_{i,t} = \alpha_{\mathrm{i}} + \beta_i x_t + \epsilon_{i,t} \tag{1}$$

where:
$y_{i,t}$ = Quarterly change in operating income for company i
α_{i} = Regression intercept
β_i = Regression coefficient for company i
x_t = Quarterly change in six-month Libor rate
$\epsilon_{i,t}$ = Error term for company i in quarter t

This approach addresses a possible endogeneity[4] problem since operating income does not include gains and losses from derivative usage. The regression is performed for all 396 firms in the sample for seven years on a quarterly basis. In line with Graham and Rogers (2002), a firm is classified to have Cash Flow exposure if one of the three following criteria is met:

[4] We define endogeneity according to Graham and Rogers (2002). Accordingly, endogeneity refers to the possibility of the explanatory variable being influenced by the explained variable, which can lead to reverse causality.

1) Negative, significant coefficient in regression
2) Positive, significant coefficient in regression and less than 50% of debt is floating
3) Unsignificant coefficient in regression and floating debt larger than zero

We define the coefficient to be significant if the p-value is smaller than 10%. Criterion 1 captures all companies where a rise in interest rates has a direct effect on cash flows. Criterion 2 adds companies where falling interest rates have a negative effect on cash flow, but floating debt is limited. This is because a large proportion of floating debt can offset the positive exposure and thus reduce interest rate risk. The third criterion includes companies with no significant exposure in the regression, but which carry floating-rate debt, as changing interest rates would influence the interest payments of their floating debt. Out of the 396 companies in our sample, 8, 20 and 218 firms are subject to criterion 1, 2 and 3 respectively, summing up to 246 companies with Cash Flow exposure. Alternatively, we examine a more simplified classification of Cash Flow exposure, considering all companies carrying floating-rate debt to be exposed to Cash Flow risk. This excludes 11 companies whose operating income is significantly affected by interest rates in the above regression. We therefore stick to our initial classification to Cash Flow exposure following the technique used by Graham and Rogers (2002).

Performing a regression for the determination of Fair Value exposure is challenging. While it would be consistent to follow the same logic as before and regress changes in the fair value of debt on changes in interest rates, companies typically do not disclose such information. Therefore, we decide to study the debt structure of the companies in our sample. We assume a company to be exposed to Fair Value risk if it carries non-floating debt. We are confident that this definition does not disregard companies with exposure, since almost all firms in our database hold non-floating debt. To account for the risk of this definition to be too inclusive, we alternatively test a higher cut off ratio of 40%, which yields to similar results in our analysis.[5] Therefore, we stick to our criterion and include all companies with non-floating debt, which amounts to 361 companies with Fair Value exposure.

We find a total of 389 firms in our sample with exposure to interest rate risk in general, either in the form of Cash Flow risk, Fair Value risk or both. This confirms our initial assumption that almost all S&P 500 companies carry interest rate risk in some form.

[5] We reference to the corresponding robustness test in Section 5.5.2.

4.2.2 Testing for Differences in Hedging Activity

We continue our exposure analysis by testing our assumption that companies exposed to changes in interest rates differ in their corporate risk management activities from companies that are not exposed. Testing for differences, we apply a two proportions test to account for the nature of the factor hedging activity as a dummy variable. We apply this test for each of the exposure categories defined above. Hence, the general interest rate risk exposure is tested for differences in the fraction of hedgers between companies that are classified as having interest rate risk exposure and companies that are classified as having none. Consequently, Cash Flow exposure and Fair Value exposure test for the usage of interest rate derivates hedging the respective exposure, by using floating-to-fixed interest rate swaps for Cash Flow exposure and fixed-to-floating swaps for Fair Value exposure. For example, in the Fair Value analysis, a company is then classified as a hedger if it implements fixed-to-floating swaps and considered a non-hedger if it has floating-to-fixed swaps only. The results for this analysis are discussed in Section 5.1.

4.3 Empirical Strategy

4.3.1 Variable Selection

To select the variables used in the further analysis, we are guided by previous literature (see e.g. the literature overview by Aretz and Bartram, 2010) and data availability. All data is as of February 29, 2020 and is extracted from EIKON, if not specified otherwise.

As a proxy for size, we use the book value of total assets and take the logarithm to control for skewness. This represents a consensus in literature (Aretz and Bartram, 2010). We proxy leverage by taking the ratio between the book value of debt and the book value of total assets. The profitability is measured by the net income after taxes divided by the book value of total assets (ROA). The book-to-market ratio serves as a proxy for growth opportunities and refers to the book value of equity divided by the result of number of shares multiplied by the price per share. We proxy the volatility of cash flows with the operating income to avoid potential endogeneity problems, since losses and gains from derivative usage are not included in operating income. The volatility of operating income is measured by taking the absolute value of the index of dispersion to account for negative means in the operating incomes of some companies in the sample. We take 40 quarters of operating income into account when calculating the volatility of operating income:

$$\text{Volatility}_{\text{Operating Income}} = \left| \frac{\sigma^2_{Operating\ Income}}{\mu_{Operating\ Income}} \right| \quad (2)$$

where: $\sigma^2_{Operating\ Income}$ = Variance of operating income for 40 quarters

$\mu_{Operating\ Income}$ = Mean of operating income for 40 quarters

Testing a variable specifically designed for companies carrying Cash Flow exposure, we use a company's ratio of floating-rate debt. We collect this information from Bloomberg.

We test for variables against the backdrop of Fair Value hedging rationales by using cash and short-term investments over assets as a proxy for short term assets and the 5-year monthly CAPM beta as a proxy for cyclicality.

The variable cash and short-term investments scaled by assets allows us to capture the earlier developed economic rationale that companies with a higher amount of short-term assets are more likely to benefit from floating-rate debt and should thus engage more in fixed-to-floating interest rate swaps than companies with a lower amount of short-term assets.

The 5-year monthly beta is employed to test for the rationale that cyclical companies are able to match the cyclicality of their earnings before interest and tax with changing interest expenses by keeping a higher amount of floating-rate debt which can be achieved through interest rate swaps.

To account for the possibility that company properties can vary significantly among industries which could affect the validity of the analysis, we employ industry dummy variables for each sector. We use the GICS for the industry breakdown. Our sample includes all sectors except of Financials, which is in line with our aforementioned reasoning regarding their ex-ante exclusion, and Real Estate, which did not apply to any constituent of the S&P 500 as of February 2020.

4.3.2 Differences between Hedgers and Non-Hedgers

Following Allayannis and Weston (2001), we start by studying the hedging determinants in a univariate analysis, testing if hedgers and non-hedgers vary significantly in the variables described above. We use two-sided t-tests to account for differences in means. The results for these difference tests are presented in Section 5.2.

4.3.3 Multivariate Analyses

Interest Rate Hedging in general

We propose a multivariate regression to test our hypotheses, taking into account the variables to be examined as well as control variables. We use three models to test for determinants of interest rate hedging in general. Model 1 includes the proxy variables for size and leverage and controls for industry differences. In Model 2, we add interaction terms which could affect the leverage variable, namely return on assets, book-to-market ratio and volatility of operating income.

We use a Probit model[6] to regress the determinants on the hedging decision. This allows to use the binary dependent dummy *hedging decision* as dependent variable in the following model:

$$Pr(Y = 1 \mid Size,\ Leverage,\ Z) = \Phi(\beta_0 + \beta_1 Size + \beta_2 Leverage + bZ) \quad (3)$$

where:

Pr = Probability

Y = Interest rate hedging dummy variable

$Size$ = Logarithm of book assets

$Leverage$ = Total debt over total assets

Φ = Cumulative distribution function

b = $k \times 1$ Vector for the respective other independent variables, where k is the number of independent variables and interaction terms in the particular model excluding the main variables size and leverage

Z = $1 \times k$ Vector for the respective other independent variables, where k is the number of independent variables and interaction terms in the particular model excluding the main variables size and leverage

For the analysis of interest rate hedging in general, the sample consists of all companies that are exposed to Cash Flow risk, Fair Value risk, or both. A firm is classified as hedger if it hedges any form of interest rate risk. The sample size depends on whether we analyze hedging in general, Cash Flow hedging or Fair Value hedging. We discuss the statistical power together with the regression results. The regression output for the general interest rate analysis is discussed in Section 5.3.1.

[6] If we perform Logit regressions, all significant results for the Logit regressions are also significant in the Probit regressions and have the same sign, and vice versa. We use the Probit model as it is standard in Finance literature.

Cash Flow Hedging

Next, we analyze Cash Flow hedging separately to observe important determinants for companies seeking to hedge their Cash Flow interest rate risk exposure. In addition to our main variables size and leverage, we include the variable share of floating-rate debt which we, based on our economic rationale development, assume to be particularly pronounced for Cash Flow hedgers.

The underlying sample used in the analysis of Cash Flow hedging consists of all companies that are exposed to Cash Flow risk. A firm is classified as hedger if it hedges Cash Flow risk or both Cash Flow and Fair Value risk.

We use a multivariate Probit regression for interest rate hedging in general specified in Equation 3 with the modification that the binary dependent variable Y equals Cash Flow hedging dummy variable. Model 3 tests the variables for size and leverage and controls for industry differences. In Model 4, we employ the additional variable of floating-rate debt as a percentage of total debt. Given the expected effect leverage has on Cash Flow hedging, we add interaction terms that may influence the leverage variable in Model 5. The empirical findings are presented and discussed in Section 5.3.2.

Fair Value Hedging

We further refine our analysis by looking solely on companies with Fair Value exposure. For the analysis of Fair Value hedging, the sample consists of all companies that are exposed to Fair Value risk. A firm is classified as a hedger if it hedges Fair Value risk or both Fair Value and Cash Flow risk.

Again, we change the dummy dependent variable Y which now is the Fair Value hedging dummy variable and apply our main variables size and leverage to the Fair Value framework in Model 6. We continue by testing the determinants cash and short-term assets scaled by total assets and 5-year monthly beta, which are both particularly relevant for Fair Value hedging, in Model 7 and Model 8 respectively. Model 9 comprises both determinants which have been observed singularly in the previous two models. We show our findings in Section 5.3.3.

For an overview of the explanatory variables and the underlying sample used in all models please refer to Table A.I in the appendix.

5 Empirical Results

We present our results in the following order. First, we validate our exposure criteria by testing for statistical significance in the hedging activities of exposed and not-exposed firms. We then test which firm characteristics differ between hedgers and non-hedgers. Third, we look at the multivariate results of the external margin of hedging with the hedging dummy as dependent variable. Fourth, we extend our analysis by using the internal margin of hedging as dependent variable. The tests for differences and the analyses with the dummy dependent variable follow the structure hedging in general, Cash Flow hedging, Fair Value hedging. The chapter ends with appropriate checks for robustness.

5.1 Validation of Exposure Specifications

Table 1:
Testing for differences in fraction of hedgers between exposed and non-exposed companies

	IR Risk General		Cash Flow Risk		Fair Value Risk	
	% of Hedgers	Number of IR Hedgers	% of Hedgers	Number of CF Hedgers	% of Hedgers	Number of FV Hedgers
Exposure	45.61	171 of 375	38.62	95 of 246	24.65	89 of 361
No Exposure	4.76	1 of 21	13.33	20 of 150	2.86	1 of 35
Chi square statistic	7.43***		27.70***		7.43***	

*This table depicts the tests for differences in the hedging decision between exposed and non-exposed companies for interest rate hedging in general, Cash Flow hedging and Fair Value hedging. The firms in the "Exposure" group are the firms that are exposed to the applicable risk in each of the three categories. The firms in the "No Exposure" group consist of the share of the 396 sample companies that are not exposed to the specified risk category. A company is classified as a hedger if it hedges the respective risk exposure. We calculate the fraction of hedgers for each of the groups (six in total). We then conduct a test of equal proportions (prop.test) to test for differences to account for the dummy nature of the hedging variable. The Chi square statistic quantifies the difference between the observed counts and accounts expected if there was no relationship at all in the population. *, ** or *** indicates that the difference in mean between companies with and without exposure are significantly different from zero at the 10%, 5%, or 1% level, respectively. IR = Interest Rate, CF = Cash Flow, FV = Fair Value.*

We start the presentation of our results by validating our exposure criteria and company classifications. As we can see from Table 1, there are significant differences for companies with interest rate risk exposure and its two sub-groups, namely Cash Flow and Fair Value risk exposure. Observing a p-value of 0.57%, the difference in hedging activity between firms with and without general interest rate risk exposure is highly significant. It is to be noted, that this is limited by the fact that the 'No Exposure' group only consists of 21 firms. Further, companies exposed to Cash Flow interest rate risk are significantly different in their hedging behavior from not-exposed firms with a p-value of 0.00%. Companies exposed to Fair Value interest

rate risk are different in their interest rate hedging management compared to companies with no such exposure with a p-value of 0.64%.

The results confirm the chosen exposure definitions, demonstrating significantly more hedging activities for exposed firms than for firms without exposure. The three groups of firms with general interest rate exposure, Cash Flow exposure and Fair Value exposure build the basis for the further analysis of hedging determinants.

5.2 Testing for Differences between Hedgers and Non-Hedgers

Table 2:
Tests for differences in means between Hedgers and Non-Hedgers

	IR hedging in general			Cash Flow hedging			Fair Value hedging		
	Hedgers	Non-Hedgers	t-stat	Hedgers	Non-Hedgers	t-stat	Hedgers	Non-Hedgers	t-stat
Log Assets	24.06	23.55	4.52***	23.92	23.89	0.26	24.44	23.64	6.13***
D/A	0.37	0.28	4.89***	0.41	0.30	3.58***	0.35	0.33	1.12
ROA (%)	6.56	7.15	-0.79	5.52	6.62	-1.32	7.26	6.57	0.92
Book-to-market	0.36	0.39	-0.81	0.38	0.41	-0.74	0.33	0.39	-1.41
Volatility of operating income (billion)	1.78	2.18	-0.50	2.09	2.47	-0.30	1.87	2.11	-0.27
Floating Share	0.16	0.14	0.93	0.26	0.21	1.46	0.09	0.13	-2.94***
Beta	1.01	1.09	-1.63	1.00	1.09	-1.35	0.98	1.06	-1.54
Cash scaled by assets	0.08	0.09	-1.04	0.07	0.09	-1.91*	0.10	0.10	0.37
Sample Size	171	204		88	156		89	269	

*This table depicts the tests for differences between hedgers and non-hedgers for interest rate hedging in general, Cash Flow hedging and Fair Value hedging. The samples of each column consist of hedgers / non-hedgers with the underlying exposure. Statistical significance is examined with Student's two-sided T-Test. *, ** or *** indicates that the difference in mean between hedgers and non-hedgers are significantly different from zero at the 10%, 5%, or 1% level, respectively. The grey values are not part of the further analysis as they are not backed by our theoretical framework and are included for the purpose of completeness.*

Before we test our hypotheses using multivariate regressions, we examine the possible determinants by comparing the means of hedgers and non-hedgers. This analysis allows for a more detailed understanding of the structural differences between hedgers and non-hedgers on a standalone basis but does not replace the multivariate tests that follow. Table 2 shows the results of the test for differences. There are early indications in favor of our hypotheses that size and leverage facilitate general interest rate hedging. Hedgers are significantly larger in size than non-hedgers for interest rate hedging in general and Fair Value hedging in particular, with no significant difference amongst companies with Cash Flow exposure. Companies that are

exposed to interest rate risk in general and Cash Flow interest rate risk are significantly more leveraged if they have an interest rate risk management in place, while no significant difference can be noted for Fair Value hedging. None of the variables that we expect to interact with leverage shows significant differences between hedgers and non-hedgers on a standalone basis for all three exposures. Other than expected, we do not see a significant difference in the share of floating debt for Cash Flow hedgers and non-hedgers. Surprisingly, the share of floating debt is only significantly different amongst hedgers and non-hedgers of Fair Value interest rate risk, which is not part of our theoretical framework but may be explained by preferences in debt structures of firms. The proxies for cyclicality and short-term assets show no significant differences for Fair Value exposure, however, firms with Cash Flow exposure that do not hedge have more cash.

We observe the general trend that the wider the exposure definition, the more variables are significantly different between hedgers and non-hedgers.[7] This could stem from the larger sample sizes for the broader exposures of all hedging forms and interest rate risk in general but could also indicate that a narrow exposure definition makes the specific determinants of hedging visible. We continue the discussion on the need for the different samples for interest rate hedging in general, Cash Flow hedging and Fair Value hedging in the further analysis.

To summarize, we see strong size and leverage effects and ambiguous results for the other variables on a standalone basis.

[7] This holds especially if we broaden the scope and compare the results for interest rate hedging with the differences tests for all companies in the sample, taking all kind of hedging into account, including foreign currency and commodity price risk hedging. The results for the differences test for the whole sample with all kinds of risk can be found in Table A.II in the appendix.

5.3 Regression Analysis: Hedging Decision

5.3.1 General Interest Rate Hedging

Table 3:
Multivariate Probit regression interest rate risk in general

	Model 1		Model 2	
	Coeff.	**z-value**	**Coeff.**	**z-value**
Intercept	-7.98***	-4.77	-7.77***	-4.41
Log Assets	0.31***	4.57	0.30***	4.20
D/A	1.90***	4.17	1.80**	2.09
ROA			0.23	0.10
Book-to-market			-0.39	-0.69
Volatility of operating income			0.00	-0.22
ROA × D/A			-1.22	-0.26
Book-to-market × D/A			1.61	0.97
Vol. of op. income × D/A			0.00	0.10
Industry Fixed Effects	Yes		Yes	
Observations	**375**		**375**	
AIC Score	**479.19**		**488.76**	

*This table shows the results from a Probit regression model. We regress on the binary variable Hedging yes/no for each company in our dataset with general interest rate risk exposure. The main company characteristics included are the Log of Assets (Log Assets) as well as the Debt-to-Assets (D/A) ratio. Interaction characteristics with leverage are Return on Assets with Debt/Assets, Book-to-market with Debt/Assets, and the Volatility of Operating Income with Debt/Assets. The volatility of operating income for each company is a variable equal to the absolute value of the index of dispersion of the firm's operating income from the last 40 quarters. To account for differences between industries we employ a dummy variable for each industry, which is 1 when the company is part of this particular GICS sector and 0 otherwise. Each company is assigned to one GICS sector. In the first model specification we only include the main characteristics Logarithm of Assets and Debt/Assets which serve as proxies for size and leverage, respectively. This specification tests our hypotheses of size and leverage effect on the hedging decision. Model 2 further controls for possible interaction terms with Debt/Assets and tests whether profitability, growth opportunities and volatility of operating income have any impact on the hedging decision in combination with leverage. We further report the number of observations in our dataset along with the Akaike information criteria (AIC Score) for each model. *, ** or *** indicates that the estimate is significantly different from zero at the 10%, 5%, or 1% level, respectively.*

We find support for our Hypotheses 1 and 2 in Table 3, which confirms that size and leverage are determinants for the decision to hedge interest rate risk, yielding both positive and highly significant coefficients in Model 1. This implies that larger and more leveraged companies increase the predicted probability of hedging interest rate risk respectively. The coefficients for size and leverage slightly decrease when we test for additional variables in Model 2. The statistical significance of the leverage coefficient decreases in Model 2, indicating that the interaction terms have some explanatory power without being significant. It can further be noted that the fit does not improve in Model 2.

We do not observe significant results for the interaction variables in Model 2. The interaction terms with leverage are expected to have a stronger effect for Cash Flow hedging, where the theory regarding leverage is particularly pronounced, which is tested in the following section.

The findings that company size and leverage have a positive effect on the hedging decision reinforce Hypotheses 1 and 2. We continue with our discussion of results by studying whether the leverage effect is especially pronounced for Cash Flow hedgers and the size effect is especially strong for Fair Value hedgers in the following sections.

5.3.2 Cash Flow Hedging

Table 4:
Multivariate Probit regression Cash Flow hedging

	Model 3		**Model 4**		**Model 5**	
	Coeff.	**z-value**	**Coeff.**	**z-value**	**Coeff.**	**z-value**
Intercept	-0.28	-0.14	-2.82	-1.27	-2.03	-0.82
Log Assets	0.00	-0.05	0.09	1.03	0.06	0.60
D/A	1.87***	3.27	2.12***	3.56	2.48**	1.97
Floating Share			1.06***	2.70	0.96**	2.38
ROA					-0.12	-0.03
Book-to-market					-0.08	-0.10
Volatility of operating income					0.00	0.42
ROA × D/A					-4.42	-0.53
Book-to-market × D/A					0.06	0.03
Vol. of op. income × D/A					0.00	-0.44
Industry Fixed Effects	Yes		Yes		Yes	
Observations	**244**		**244**		**244**	
AIC Score	**311.23**		**306.15**		**316.11**	

This table shows the results from a Probit regression model. We regress on the binary variable Cash Flow hedging yes/no for each company in our dataset with Cash Flow interest rate risk exposure. The main company characteristics included are the Log of Assets (Log Assets) as well as the Debt to Assets (D/A) ratio. The Cash Flow interest rate risk specific company characteristic is Floating Share which is the share of floating-rate debt from total debt. Interaction characteristics with leverage consist of Return on Assets, Book-to-market, and the Volatility of Operating Income. The volatility of operating income for each company is a variable equal to the absolute value of the index of dispersion of the firm's operating income from the last 40 quarters. To account for differences between industries we employ a dummy variable for each industry, which is 1 when the company is part of this particular GICS sector and 0 otherwise. Each company is assigned to one GICS sector. In Model 3 we only include the main characteristics Logarithm of Assets and Debt/Assets which serve as proxies for size and leverage, respectively. This specification tests our hypotheses of size and leverage effect on the decision to use fixed to floating-rate swaps. Model 4 tests the economic rationale of hedging Cash Flow risk. Model 5 further controls for possible interaction terms with Debt/Asset and tests whether profitability, growth opportunities and volatility of operating income have any impact on the Cash Flow hedging decision in combination with leverage.

*We further report the number of observations in our dataset along with the Akaike information criteria (AIC Score) for each model. *, ** or *** indicates that the estimate is significantly different from zero at the 10%, 5%, or 1% level, respectively.*

Table 4 shows that in Model 3 leverage has a significant effect on the decision to hedge Cash Flow risk by using floating-to-fixed swaps. The coefficient has the expected positive sign. We can observe that size is not significant in all three models in Table 4, which suggests that it is not a relevant determinant for Cash Flow hedging.

Including the share of floating debt in Model 4 yields a significant, positive effect. As expected, companies with a large share of floating-rate debt are more likely to hedge their Cash Flow risk.[8] Also, in Model 4, the fit improves, and the leverage coefficient increases. Similar to the general interest rate hedging analysis, the inclusion of leverage interaction terms in Model 5 does neither improve the model fit nor does it provide significant results. However, the interaction terms seem to partly explain the positive effect of the floating share, since the coefficient becomes smaller and less significant.

5.3.3 Fair Value Hedging

Table 5:
Multivariate Probit regression Fair Value hedging

	Model 6		**Model 7**		**Model 8**		**Model 9**	
	Coeff.	**z-value**	**Coeff.**	**z-value**	**Coeff.**	**z-value**	**Coeff.**	**z-value**
Intercept	-13.83***	-6.74	-13.73***	-6.69	-14.16***	-6.84	-14.08***	-6.80
Log Assets	0.51***	6.27	0.51***	6.28	0.52***	6.37	0.52***	6.39
D/A	0.49	1.10	0.48	1.08	0.52	1.18	0.51	1.16
Beta			-0.28	-1.14			-0.29	-1.19
Cash scaled by assets					1.03	1.29	1.06	1.34
Industry Fixed Effects	Yes		Yes		Yes		Yes	
Observations	**350**		**350**		**350**		**350**	
AIC Score	**351.61**		**352.33**		**351.95**		**352.55**	

This table shows the results from a Probit regression model. We regress on the binary variable Fair Value hedging yes/no for each company in our dataset with Fair Value interest rate risk exposure. The main company characteristics included are the Log of Assets (Log Assets) as well as the Debt to Assets (D/A) ratio. The Fair Value interest rate specific company characteristics are Beta which is based on the 5-year monthly beta and Cash scaled by Assets, which consists of cash and short-term assets divided by total assets. To account for differences between industries we employ a dummy variable for each industry, which is 1 when the company is part of this particular GICS sector and 0 otherwise. Each company is assigned to one GICS sector. In Model 6 we only

[8] Surprisingly, we did not see significant results in the test for differences for the floating share in the difference between means of hedgers and non-hedgers. However, performing a Wilcoxon-Mann-Whitney test to examine a difference in the medians of hedgers and non-hedgers, we observe statistically significant difference at the 5% level. This indicates that there is a stand-alone effect of the variable floating share, yet, we cannot fully exclude the possibility that there is multicollinearity between the floating share and leverage.

*include the main characteristics Logarithm of Assets and Debt/Assets which serve as proxies for size and leverage, respectively. This specification tests our hypotheses of size and leverage effect on the hedging decision. Model 7 further controls for the market cyclicality in the form of Beta while the Model 8 incorporates short-term assets with the proxy Cash scaled by Assets. Model 9 includes the main company characteristics with both Fair Value risk characteristics together. Models 7 and 8 test the two economic rationales for Fair Value hedging separately, while Model 9 tests both at once. We further report the number of observations in our dataset along with the Akaike information criteria (AIC Score) for each model. *, ** or *** indicates that the estimate is significantly different from zero at the 10%, 5%, or 1% level, respectively.*

Table 5 shows the results of the Probit regression of possible determinants on the Fair Value hedging decision. We observe additional support for Hypothesis 1, given that all models in Table 5 show the expected positive effect of size on the decision to employ fixed-to-floating swaps.

Leverage has no significant effect on the Fair Value hedging decision and may thus be disregarded as a relevant determinant for Fair Value hedging. In Model 7, we control for cyclicality, proxied by the CAPM beta, and see an unexpected negative, however insignificant effect on the hedging decision. Controlling for short-term assets in Model 8 does not significantly affect the hedging decision. Combining Models 7 and 8 in Model 9 yields similar results. The fit does not clearly change amongst Models 6-9, nor do the coefficients of size and leverage distinctly vary.

Examining the combined results of the hedging in general analysis, the Cash Flow hedging analysis and the Fair Value hedging analysis, we can accept Hypothesis 1: *There is a positive correlation between company size and the decision to employ interest rate risk management, which is particularly pronounced for Fair Value hedging activities compared to Cash Flow hedging* and Hypothesis 2: *Leverage has a positive effect on a company's decision to hedge interest rate risk while this effect is stronger for Cash Flow hedging than for Fair Value hedging.*

It is proven to be relevant to not only regard interest rate hedging in general but to refine the two elementary components of Cash Flow and Fair Value hedging, given that the importance of determinants size and leverage changes depending on the underlying risk. Not only do we observe different results when we split the general interest rate risk sample into the two specifications, but also observe differing results when comparing Cash Flow hedging and Fair Value hedging.

5.4 Regression Analysis: Hedging Extent

Heretofore, we considered the external margin of hedging by using the dummy variable *hedging decision* as dependent variable. We continue by extending the analysis and test if the

findings for the external margin also hold for the internal margin of hedging. The internal margin of hedging is proxied by the notional values of floating-to-fixed swaps for Cash Flow hedgers and fixed-to-floating swaps for Fair Value hedgers, divided by total debt. One sample consists of companies that hedge their Cash Flow risk, the other sample consists of firms that hedge Fair Value risk. The respective samples consist only of companies that report notional amounts of derivatives outstanding, which explains the smaller numbers of observations.

We described significant differences in the results of studies that use a dummy hedging variable (e.g. Belghitar et al, 2008) and a continuous hedging variable (e.g. Graham and Rogers, 2002, who use a dummy variable only as a robustness check), as well as in studies that first use a dummy and then a continuous variable (e.g. Carneiro and Sherris, 2008). By looking at a sample of hedgers only, possible differences between the external and internal margin become more apparent compared to taking a sample of all firms, as a firm that hedges to a very small extent would be treated like a non-hedger. Therefore, the following analyses comprise firms that hedge the applicable kind of interest rate risk and disregard non-hedgers.

The dependent variable is continuous in this setting. We therefore apply a multiple linear Ordinary least squares (OLS) regression on the extent analysis but remain mostly consistent to the models used in the Probit regression.

The internal margin analysis covers the results for Cash Flow hedging and Fair Value hedging separately, due to challenges arising with netting the notional amounts of floating-to-fixed swaps and fixed-to-floating swaps (Bretscher et al, 2015; Carneiro and Sherris, 2008).

We use the following linear OLS regression equation for the different models in the hedging extent analysis:

$$y = \beta_0 + \beta_1 Size + \beta_2 Leverage + bZ + \epsilon \quad (4)$$

where:

y = Extent of hedging

$Size$ = Logarithm of assets

$Leverage$ = Total debt over total assets

b = k × 1 Vector for the respective coefficients, where k is the number of independent variables and interaction terms in the particular model

Z = 1 × k Vector for the respective independent variables, where k is the number of independent variables and interaction terms in the particular model

ϵ = Error term

We first apply the regression above on the data set consisting of all companies that classify as Cash Flow Hedgers under our definition. The independent variables in this model are similar to Model 3-5, with the exception of the share of floating-rate debt, which is excluded

as it serves as a basic requirement for the extent of hedging. To illustrate, a company that only has 10% of floating-rate debt will only swap 10% floating-to-fixed debt at maximum. We thus construct only two models, where Model 10 consists of size and leverage and Model 11 includes the interaction terms.

We continue our analysis by using a linear regression on the data set which is comprised of all companies categorized as Fair Value hedgers. For Model 12-15 we follow the same independent variable selection as in Model 6-9, while the extent of hedging for all companies that employ Fair Value hedging serves as the regressor.

5.4.1 Cash Flow Hedging

Table 6:
OLS Regression Extent of Cash Flow hedging

	Model 10		**Model 11**	
	Coeff.	**t-value**	**Coeff.**	**t-value**
Intercept	1.57***	2.83	1.38**	2.13
Log Assets	-0.06***	-2.72	-0.06**	-2.10
D/A	-0.07	-0.89	0.35	1.51
ROA			1.16	1.51
Book-to-market			0.31*	1.69
Volatility of operating income			0.00	-0.33
ROA × D/A			-3.32**	-2.21
Book-to-market × D/A			-1.16**	-2.42
Vol. of op. income × D/A			0.00	0.42
Industry Fixed Effects	Yes		Yes	
Observations	**68**		**68**	
Multiple R^2	**0.35**		**0.43**	
Adjusted R^2	**0.24**		**0.25**	

*This table illustrates the results from linear regression tests for the companies that engage in Cash Flow hedging. We take the extent of Cash Flow hedging measured by the notional amount of floating-to-fixed interest rate swaps divided by total debt for each company that employs Cash Flow hedging and regress it on the respective company characteristics. The main company characteristics included are the Log of Assets (Log Assets) as well as the Debt to Assets (D/A) ratio. Interaction characteristics with leverage consist of Return on Assets, Book- to-market, and the Volatility of Operating Income. The volatility of operating income for each company is a variable equal to the absolute value of the index of dispersion of the firm's operating income from the last 40 quarters. To account for differences between industries we employ a dummy variable for each industry, which is 1 when the company is part of this particular GICS sector and 0 otherwise. Each company is assigned to one GICS sector. In Model 10 we only include the main characteristics Logarithm of Assets and Debt/Assets which serve as proxies for size and leverage, respectively. This specification tests for size and leverage effects on the extent to use floating-to-fixed-rate swaps. Model 11 further controls for possible interaction terms with Debt/Assets and tests whether profitability, growth opportunities and volatility of operating income have any impact on the Cash Flow hedging decision in combination with leverage. *, ** or *** indicates that the estimate is significantly different from zero at the 10%, 5%, or 1% level, respectively.*

Table 6 shows the drivers for the internal margin of Cash Flow hedging. The results differ from the results of the external margin analysis. In Model 10, we observe a negative, significant effect of size on the extent of hedging and no significant effect of leverage. This emphasizes the existence of differences in the determinants for internal and external margins, where we saw no effect of size and a positive effect of leverage (Table 4). We can explain the negative size effect with the existence of substantial fixed costs in hedging. Once small firms overcome the hurdle to implement a risk management program, extensive hedging seems to become more worthwhile than for large firms. The difference in results between the internal and external margins underscores the importance of the fixed cost effect on the hedging decision since the size effect changes from significantly positive to significantly negative once the decision to hedge is made and fixed costs become redundant. Our findings are in line with Graham and Rogers (2002) and Allayanis and Ofek (2001), who first describe the economies of scales effect inherent in hedging.

A negative effect of leverage on the hedging extent could be expected due to the limited flexibility of debt financing, as Appadu (2010) identifies that high leverage firms face higher barriers when accessing capital markets and the possibility to issue fixed-rate debt may initially be restricted or too costly. This may induce the need to create synthetic fixed debt with swaps. Both Model 10 and Model 11 show no significant effect of leverage. Therefore, this theory does not apply to the extent of Cash Flow hedging. While leverage itself has no statistical power, the interaction between profitability and leverage as well as growth opportunities and leverage yield significant results. The negative coefficient for ROA × D/A interaction implies that less profitable companies with higher leverage hedge more than profitable companies with higher leverage. The results above let us conclude that the lower a firm's profitability together with a higher leverage, the more it engages in Cash Flow hedging. The negative coefficient for the explanatory interaction variable book-to-market × D/A further supports the expectation that companies in mature markets together with a higher leverage, feel the need to hedge less than companies with many growth opportunities and higher leverage. The explanatory power of the model slightly improves but the overall effect of the additional variables remains small, analogue to the dummy analysis for Cash Flow hedging.

5.4.2 Fair Value Hedging

Table 7:
OLS Regression Extent of Fair Value hedging

	Model 12		Model 13		Model 14		Model 15	
	Coeff.	**t-value**	**Coeff.**	**t-value**	**Coeff.**	**t-value**	**Coeff.**	**t-value**
Intercept	-0.09	-0.20	-0.08	-0.17	-0.34	-0.76	-0.32	-0.71
Log Assets	0.01	0.54	0.01	0.53	0.02	1.11	0.02	1.08
D/A	-0.36**	-2.50	-0.36**	-2.48	-0.35**	-2.57	-0.36**	-2.57
Beta			-0.01	-0.14			-0.02	-0.31
Cash scaled by assets					0.50***	2.72	0.51***	2.71
Industry Fixed Effects	Yes		Yes		Yes		Yes	
Observations	**79**		**79**		**79**		**79**	
Multiple R^2	**0.20**		**0.20**		**0.28**		**0.28**	
Adjusted R^2	**0.08**		**0.06**		**0.16**		**0.14**	

*This table illustrates the results from linear regression tests for the companies that engage in Fair Value hedging. We take the extent of Fair Value hedging measured by the notional amount of fixed-to-floating interest rate swaps divided by total debt for each company that employs Fair Value hedging and regress it on the respective company characteristics. The main company characteristics included are the Log of Assets (Log Assets) as well as the Debt to Assets (D/A) ratio. The Fair Value interest rate specific company characteristics are Beta which is based on the 5-year monthly beta and Cash scaled by Assets. To account for differences between industries we employ a dummy variable for each industry, which is 1 when the company is part of this particular GICS sector and 0 otherwise. Each company is assigned to one GICS sector. In Model 12 we only include the main characteristics Logarithm of Assets and Debt/Assets which serve as proxies for size and leverage, respectively. This specification tests for size and leverage effects on the extent to use fixed-to-floating rate swaps. Model 13 further controls for the market cyclicality in the form of Beta while Model 14 incorporates short-term assets with the proxy Cash scaled by Assets. Model 15 includes the main company characteristics with both Fair Value risk characteristics together. Model 13 and 14 test the two economic rationales for Fair Value hedging separately, while the last specification tests both at once. *, ** or *** indicates that the estimate is significantly different from zero at the 10%, 5%, or 1% level, respectively.*

Table 7 depicts the results of the regressions with the internal margin of Fair Value hedging as dependent variable. Model 12 shows that highly levered Fair Value hedgers hedge to a significantly smaller extent than Fair Value hedgers with a low leverage. We do not see noteworthy differences when controlling for cyclicality in Model 13. The short-term assets proxy in Model 14 is highly significant and positively affects the hedging extent. This is in line with our expectation that companies with interest-bearing assets utilize fixed-to-floating swaps to a greater extent to match the duration of debt and assets. Including both proxies for cyclicality and short-term assets in Model 15 does not increase the explanatory power R^2 nor changes the significances.

We showed that the determinants of the decision whether to hedge interest rate risk, and the downstream decision what amount of debt to swap, differ significantly for Cash Flow and Fair Value hedging. This confirms our expectation that analyses using a dummy dependent

variable and analyses using a continuous dependent variable must be accounted for separately. The results that the two approaches yield are not directly comparable and an analysis using a continuous variable for the hedging extent cannot confirm or reject the results of a study with a dummy variable for the hedging decision, and vice versa.

5.5 Robustness Tests

5.5.1 Stickiness Analysis

Corporate risk management may change over time and a company could classify as a hedger in one year but may not in the next. A high and steady fluctuation of hedging decisions could weaken our results. We attempt to validate our assumption that corporate interest rate risk management tends to be sticky over time and is not subject to short-term changes in the interest rate or a company's performance. To test our results for robustness, we randomly select 100 companies from our initial sample consisting of the 396 Corporates in the S&P 500. We obtain the annual reports covering the fiscal year 2018 and compare the firms' hedging activities with the activities reported in 2019. Table A.III in the appendix shows the underlying data for the stickiness analysis. We find that 86% of the firms remain in the initially classified group (no interest rate hedging, Cash Flow hedging, Fair Value hedging, both, not disclosed), which supports our results by validating the assumption that the decision to hedge interest rate risk is sticky in the short-term.

In a next step, we test for stickiness in the extent of hedging, comparing the amount of debt swapped in 2019 to the amount of debt swapped in 2018. For this step, we net the extent of Cash Flow and Fair Value hedging by taking the difference, for both years, respectively. The hedging extent was calculated as before by taking the notional value of swaps divided by total debt for each year. From our randomly selected sample only 12% of firms have changed their extent of hedging by more than absolute 10% and only one firm changed their extent by more than 30%.

To summarize, we observe that the hedging decision of firms carries substantial stickiness, at least between the years 2018 and 2019. We thus expect our results to hold over time under the condition that the interest rate environment does not significantly change.

5.5.2 Refinement of Fair Value Exposure

Given that this study is the first in its analysis of Cash Flow and Fair Value hedging, there are no conventions in the definition of Fair Value exposure. To test our results for robustness, we reclassify our definition of Fair Value exposure. We apply a stricter minimum level of 40%

fixed-rate debt as criterion for Fair Value exposure. We choose a level of 40%, as a 40/60 to 60/40 fixed/floating debt ratio is commonly considered a balanced ratio in the screened annual reports, while anything below a fixed-rate debt level of 40% can be considered disproportionate. Hence, a company has Fair Value exposure if it has over 40% fixed-rate borrowings opposed to the initial definition under which a company was exposed to Fair Value risk if it had any fixed-rate debt. The new notion excludes 13 companies. These companies are certainly still exposed to fluctuations in the fair value of their fixed-rate debt. However, their classification as having no Fair Value exposure may be more accurate in the sense that their concern and incentive to employ Fair Value hedging is lower than for companies that carry a large amount of fixed-rate debt. The reclassification only excludes companies that do not utilize fixed-to-floating swaps, and all companies excluded have Cash Flow exposure and thus still classify for interest rate risk exposure in general. Therefore, the samples and results for the hedging in general analyses, as for the hedgers only analysis of Fair Value hedgers, do not change. For the dummy analysis regarding fair value hedging, we find similar results as for the original exposure decisions. No signs of coefficients or significances change. The results are shown in Table A.IV in the appendix.

6 Conclusion

This thesis aimed at investigating the determinants of the interest rate hedging decision and the extent of interest rate hedging as well as examining differences between deviating kinds of interest rate risk. We used a self-constructed data base including all relevant hedging disclosures for corporate companies in the S&P 500 for the fiscal year ending in the twelve months prior to February 29, 2020. We defined criteria for exposure to interest rate risk in general, Cash Flow interest rate risk and Fair Value interest rate risk and classified the companies accordingly. As hypothesized, we proved that size and leverage are significant drivers of the hedging decision, which is in line with the results of Graham and Rogers (2002). Going beyond existing research, the results confirm our hypotheses that the size effect is stronger for Fair Value hedgers than for Cash Flow hedgers, while the leverage effect is stronger for Cash Flow hedgers than for Fair Value hedgers, proving that determinants for Cash Flow and Fair Value hedging differ. We found clear differences between the results with the dummy dependent variable and the results of the hedgers only analysis with the hedging extent as continuous dependent variable. In this analysis, we found negative effects of log assets, return on assets and book-to-market on the extent of Cash Flow hedgers, indicating that small companies, companies with a low leverage and low profitability and companies with a low leverage and high growth opportunities hedge to a larger extent. For Fair Value hedgers, we found a negative effect of leverage on the hedging extent and a positive effect of short-term term assets.

Our findings raise doubt on the practice to disregard Fair Value interest rate hedging when testing for determinants, since this study identifies differing and partly opposing results for Cash Flow hedging and Fair Value hedging. We observed that the size effect also holds for Fair Value hedging and showed that maturity matching of short-term assets and debt drives the Fair Value hedging extent.

With the above results, our study contributes to literature in three ways. First, we confirmed existing results of the early 2000s with our dummy analysis of interest rate hedging in general specifically looking at the fiscal year 2019. We also showed that the hedging decisions were robust over the previous year. Second, we demonstrated that differences between the determinants of the hedging decision and the hedging extent exist. Third, we contribute by showing significant particularities for the Fair Value hedging decision and for

the Fair Value hedging extent. To our knowledge, this is the first study that looked at the determinants of Fair Value hedging separately[9].

This study's explanatory power may be limited by several factors in the analysis of corporate interest rate risk management. A notable result is that we could not confirm all parts of our theoretical framework, since we did not find significant results for the interaction terms of leverage and the proxies for economic rationales for Fair Value hedging in the analyses with the dependent dummy variable. This could also stem from limited data, regarding the sample size or the choice of proxies. Corporate companies do not fully disclose their hedging activities and are only obligated to provide some of this information in their annual reports. The lack of data bases on this matter required us to manually collect and screen annual reports for this analysis, limiting the scope of our data sample and restricting us to focus on one index and one point in time. The focus on one economy or industry limits the understanding of the true effects of hedging (Bartram et al, 2009). Using a large-cap index limited to one country may therefore not be an accurate representation of corporates in general. Further, limited data availability restricts us in our choice of proxies, which is exemplified in our attempt to find an appropriate proxy for refinancing policies. It is moreover difficult to assess the extent of hedging accurately accompanied by a complex combination of various hedging tools. To illustrate, forward starting interest rate locks are not accounted for in our analysis of the extent of hedging but may have an impact on the firm's hedging decision variable. Also, accurately capturing the use of financial risk management at the firm level imposes challenges, as we focus solely on interest rate derivatives use at the firm level. Risk management could however also arise from other factors which are difficult to capture empirically. Thus, it is inherent in all studies that ambiguous results could possibly stem from factors such as earnings smoothing, speculation, or industry competition (Core et al, 2002; Brown, 2001; Tufano, 1996). Further, corporations not only manage interest rate risk with financial derivatives, but also rely on pass-through, operational hedging, and foreign currency debt (Bartram, Brown and Minton, 2009; Guay and Kothari, 2003; Kedia and Mozumdar, 2003).

The rapid growth of the financial derivatives market in the last two decades gives way for further investigation on this topic (Bank for International Settlements, 2020). It would be beneficial to conduct a cross-country study to capture the economic magnitude of transnational factors and allow to compare hedging decisions in different environments. An analysis of the

[9] Chava and Purnanandam (2007) investigate the determinants of the fixed-to-floating debt mix.

cross-effects between interest rate hedging and foreign currency hedging would also present an opportunity to further test the underlying theoretical framework of corporate risk management in the current environment. Increasing transparency and more extensive disclosure requirements, in connection with the option to extract qualitative disclosures in annual reports using artificial intelligence in an automated way, offer unique possibilities for future research to conduct studies with a broader scope of data. This would further help to explain what drives the differences between the determinants of Cash Flow and Fair Value hedging, as well as the differences between the external and internal margin of hedging. Nevertheless, our research already offers insight on the differences in the determinants of Cash Flow and Fair Value hedging, both regarding the hedging decision and the hedging extent. Given that determinants of Fair Value hedging have not been studied in existing literature, we are confident that we revealed the importance to examine both directions of interest rate hedging separately in future research. We consider it worthwhile to explore further variables as determinants of Fair Value hedging and to conduct a cross country study with the aim to find differences in Fair Value hedging for differing debt and derivative markets, accounting requirements and other country characteristics. As long as interest rates continue to fluctuate, managing interest rate risks will remain an important part on the agenda for treasury departments and will continue to be an interesting research topic.

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Appendix

Tables included in the appendix

Table A.I:
Schematic Overview of Models and respective Explanatory Variables

Model	Independent Variables								Sample	Dep. Variable
	Log Assets	D/A	ROA	Book-to-market	Vola. of op. income	Floating share	Beta	Cash		
1	X	X							IR exposure in general	Hedging decision (yes/no)
2	X	X	X	X	X					
3	X	X							CF exposure	
4	X	X				X				
5	X	X	X	X	X	X				
6	X	X							FV exposure	
7	X	X					X			
8	X	X						X		
9	X	X					X	X		
10	X	X							CF hedgers	Hedging extent (%)
11	X	X	X	X	X					
12	X	X							FV hedgers	
13	X	X					X			
14	X	X						X		
15	X	X					X	X		

This table summarizes our model framework. The mark X indicates that an independent variable is included in the respective model. The table further shows information on underlying sample of the model as well as on the dependent variable. Models 1-2 are applied on companies with general interest rate exposure, while Models 3-5 are employed on a data sample with companies exposed to Cash Flow risk. Models 6-9 are applied on companies that carry Fair Value interest rate risk only. Models 10 and 11 are conducted on a sub-sample comprised of companies hedging Cash Flow interest rate risk while Models 12-15 have an underlying sub-sample of companies that hedge Fair Value interest rate risk. All models include industry fixed effects. IR = Interest Rate, CF = Cash Flow, FV = Fair Value.

Table A.II:
Tests for differences in means: Hedging in General incl. Currency & Commodity Price Risk Hedging

	Hedging in general		
	Hedgers	Non-Hedgers	t-stat
Log Assets	23.84	23.22	4.26***
D/A	0.33	0.23	4.29***
ROA (%)	6.76	9.33	-2.81***
Book-to-market	0.39	0.30	2.38**
Volatility of operating income (billion)	2.24	0.74	2.78***
Floating Share	0.15	0.14	0.41
Beta (5y, monthly)	1.06	1.02	0.70
Cash scaled by assets	0.08	0.10	-1.57
Sample Size	320	76	

*This table depicts the tests for differences between hedgers and non-hedgers for all companies in our sample. Hedgers are defined as companies that hold derivatives for non-trading purposes to hedge interest rate risk, foreign currency risk or commodity price risk. Statistical significance is examined with Student's two-sided T-Tests. *, ** or *** indicates that the difference in mean between hedgers and non-hedgers are significantly different from zero at the 10%, 5%, or 1% level, respectively.*

Table A.III:
Results of the stickiness analysis of hedging decision and hedging extent

Ticker	Hedging Decision 2019	Hedging Decision 2018	Sticky	Hedging Extent 2019	Hedging Extent 2018	< 10% Change	< 30% Change
ABMD	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
ADM	CF & FV hedging	CF & FV hedging	✓	-5.6%	-5.9%	✓	✓
ADS	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
ALK	CF hedging	CF hedging	✓	47.8%	18.2%		✓
AMCR	FV hedging	FV hedging	✓	-13.8%	-12.1%	✓	✓
AMD	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
AME	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
AMZN	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
ANET	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
ANSS	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
AOS	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
APD	FV hedging	FV hedging	✓	-6.0%	-15.7%	✓	✓
APH	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
AVGO	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
AZO	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
BKNG	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
BMY	FV hedging	FV hedging	✓	-0.5%	-10.3%	✓	✓
CAG	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
CERN	CF hedging	no IR hedging		57.8%	0.0%		
CF	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
CL	FV hedging	FV hedging	✓	-5.1%	-14.1%	✓	✓
CMI	CF hedging	CF hedging	✓	21.1%	20.2%	✓	✓
COG	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
CPB	CF hedging	CF hedging	✓	0.0%	0.0%	✓	✓
CPRI	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
CPRT	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
CTSH	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
CTVA	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
CVS	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
CVX	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
D	CF & FV hedging	CF & FV hedging	✓	0.0%	0.0%	✓	✓
DAL	FV hedging	FV hedging	✓	-16.8%	-19.4%	✓	✓
DXC	no IR hedging	CF hedging		0.0%	7.9%	✓	✓
EL	CF & FV hedging	FV hedging		-27.8%	-26.8%	✓	✓
EMR	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
EOG	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
ES	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
ETN	CF & FV hedging	CF & FV hedging	✓	-20.7%	-33.9%		✓
FANG	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
FAST	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
FLS	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
FTI	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
GIS	FV hedging	FV hedging	✓	-3.5%	-3.2%	✓	✓
GM	CF & FV hedging	CF & FV hedging	✓	-8.6%	-8.4%	✓	✓
GPS	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
GWW	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
HAS	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
HBI	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓

Ticker	Hedging Decision 2019	Hedging Decision 2018	Sticky	Hedging Extent 2019	Hedging Extent 2018	< 10% Change	< 30% Change
HCA	CF hedging	CF hedging	✓	7.4%	7.6%	✓	✓
HES	FV hedging	FV hedging	✓	-1.4%	-1.5%	✓	✓
HON	FV hedging	FV hedging	✓	-24.7%	-16.0%	✓	✓
HRB	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
HRL	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
IBM	FV hedging	FV hedging	✓	-4.7%	-16.5%		✓
IEX	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
ISRG	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
JCI	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
K	FV hedging	FV hedging	✓	-24.0%	-18.0%	✓	✓
KSS	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
LDOS	CF & FV hedging	CF hedging		35.2%	48.0%		✓
LEG	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
LEN	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
LH	FV hedging	FV hedging	✓	-6.5%	-9.9%	✓	✓
LLY	CF & FV hedging	FV hedging		-8.5%	0.0%	✓	✓
LMT	not disclosed	FV hedging		0.0%	-3.2%	✓	✓
LOW	CF hedging	no IR hedging		4.0%	0.0%	✓	✓
LRCX	CF & FV hedging	FV hedging		-8.8%	-16.0%	✓	✓
MCD	FV hedging	FV hedging	✓	-2.9%	-2.4%	✓	✓
MCHP	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
MMM	FV hedging	FV hedging	✓	-5.4%	-16.4%		✓
MO	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
MPC	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
MSI	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
NBL	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
NEE	CF & FV hedging	CF & FV hedging	✓	20.9%	35.5%		✓
NKE	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
NOW	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
OKE	CF hedging	CF hedging	✓	10.2%	13.8%	✓	✓
OMC	no IR hedging	FV hedging		0.0%	-25.6%		✓
ORLY	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
PG	FV hedging	FV hedging	✓	-25.7%	-14.7%		✓
PKG	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
PRGO	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
PWR	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
PXD	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
ROK	FV hedging	FV hedging	✓	-26.6%	-33.8%	✓	✓
ROL	CF hedging	no IR hedging		27.4%	0.0%		✓
ROST	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
SYK	CF hedging	no IR hedging		0.0%	0.0%	✓	✓
TMO	FV hedging	FV hedging	✓	-5.6%	-17.4%		✓
UAA	no IR hedging	CF hedging		0.0%	16.2%		✓
URI	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
VAR	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
VFC	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
VMC	CF hedging	CF hedging	✓	0.0%	0.0%	✓	✓
WAT	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
WMB	no IR hedging	no IR hedging	✓	0.0%	0.0%	✓	✓
WU	no IR hedging	FV hedging		0.0%	-5.1%	✓	✓
XEL	no IR hedging	CF hedging		0.0%	1.7%	✓	✓

Ticker	Hedging Decision 2019	Hedging Decision 2018	Sticky	Hedging Extent 2019	Hedging Extent 2018	< 10% Change	< 30% Change
XRX	FV hedging	FV hedging	✓	-4.7%	-5.7%	✓	✓
SUM			**86**			**88**	**99**

This table shows the underlying data for the stickiness analysis. The sample consists of 100 randomly selected companies from our initial sample of 396 firms. The first column includes the company ticker. The second and third columns include the hedging decisions for the fiscal years 2019 and 2018, respectively. The fourth column shows if the hedging decision was the same in 2018 and 2019. Columns 5 and 6 show the netted hedging extents for 2019 and 2018, respectively. The netted hedging extent is calculated by dividing the difference between the notional amounts of floating-to-fixed and fixed-to-floating interest swaps the total debt of the respective year. The last two columns show whether the absolute value of the difference between the netting hedging extents of 2019 and 2018 is smaller than 10% and 30%, respectively. The check marks indicate that the respective criterion is fulfilled. IR = interest rate, CF = Cash Flow, FV = Fair Value.

Table A.IV:
Results of Probit Regression using alternative Fair Value Exposure Definition

	Model A.1		**Model A.2**		**Model A.3**		**Model A.4**	
	Coeff.	**z-value**	**Coeff.**	**z-value**	**Coeff.**	**z-value**	**Coeff.**	**z-value**
Intercept	-13.53***	-6.57	-13.42***	-6.52	-13.84***	-6.65	-13.74***	-6.61
Log Assets	0.50***	6.10	0.50***	6.11	0.51***	6.19	0.51***	6.20
D/A	0.46	1.03	0.45	1.00	0.49	1.10	0.48	1.08
Beta			-0.28	-1.16			-0.29	-1.20
Cash scaled by assets					0.86	1.08	0.90	1.13
Industry Fixed Effects	Yes		Yes		Yes		Yes	
Observations	**338**		**338**		**338**		**338**	
AIC Score	**346.42**		**347.1**		**347.26**		**347.84**	

*This table shows the results from a Probit regression model. We regress on the binary variable Fair Value hedging yes/no for each company in our dataset with the alternative definition Fair Value interest rate risk exposure. The main company characteristics included are the Log of Assets (Log Assets) as well as the Debt to Assets (D/A) ratio. The Fair Value interest rate specific company characteristics are Beta which is based on the 5-year monthly beta and Cash scaled by Assets, which consists of cash and short-term assets divided by total assets. To account for differences between industries we employ a dummy variable for each industry, which is 1 when the company is part of this particular GICS sector and 0 otherwise. Each company is assigned to one GICS sector. In Model A.1 we only include the main characteristics Logarithm of Assets and Debt/Assets which serve as proxies for size and leverage, respectively. This specification tests our hypothesis of size and leverage effect on the hedging decision. Model A.2 further controls for the market cyclicality in the form of Beta while Model A.3 incorporates short-term assets with the proxy Cash scaled by Assets. Model A.4 includes the main company characteristics with both Fair Value risk characteristics together. Models A.2 and A.3 test the two economic rationales for Fair Value hedging separately, while Model A.4 tests both at once. We further report the number of observations in our dataset along with the Akaike information criteria (AIC Score) for each model. *, ** or *** indicates that the estimate is significantly different from zero at the 10%, 5%, or 1% level, respectively.*

Table A.V:
Hedging Data Base

Ticker	IR Hedg. in General	CF Hedging	FV Hedging	CF Hedging Extent (%)	FV Hedging Extent (%)	FC Hedging	CP Hedging
A						✓	
AAL							
AAP							
AAPL	✓		✓		28.9%	✓	
ABBV	✓	✓	✓			✓	
ABC							
ABMD							
ABT	✓		✓		16.5%	✓	
ACN						✓	
ADBE	✓	✓	✓			✓	
ADI	✓	✓		18.2%		✓	
ADM	✓	✓	✓		5.6%	✓	✓
ADP							
ADS						✓	
ADSK						✓	
AEE							
AEP	✓	✓	✓				✓
AES	✓	✓		8.9%		✓	✓
AKAM							
ALB						✓	
ALGN						✓	
ALK	✓	✓		47.8%			✓
ALLE	✓	✓		14.0%		✓	
ALXN	✓	✓		67.8%		✓	
AMAT						✓	
AMCR	✓		✓		13.8%	✓	✓
AMD						✓	
AME						✓	✓
AMGN	✓		✓		32.1%	✓	
AMZN							
ANET							
ANSS							
ANTM	✓		✓		6.0%		
AOS						✓	✓
APA						✓	
APD	✓		✓		6.0%	✓	
APH						✓	
APTV						✓	✓
ATO							✓
ATVI						✓	
AVGO							
AVY						✓	
AWK	✓	✓					
AZO							
BA						✓	✓
BAX	✓	✓				✓	
BBY	✓		✓		90.5%	✓	
BDX	✓	✓	✓			✓	

Ticker	IR Hedg. in General	CF Hedging	FV Hedging	CF Hedging Extent (%)	FV Hedging Extent (%)	FC Hedging	CP Hedging
BF/B						✓	✓
BIIB	✓		✓		11.3%	✓	
BKNG						✓	
BKR						✓	✓
BLL	✓	✓		10.6%		✓	✓
BMY	✓		✓		0.5%	✓	
BSX	✓	✓		10.0%		✓	
BWA						✓	✓
CAG						✓	✓
CAH	✓		✓		26.8%	✓	✓
CAT	✓	✓	✓			✓	✓
CCL	✓	✓		2.6%		✓	✓
CDNS						✓	
CDW	✓	✓		43.9%			
CE	✓	✓		10.2%		✓	✓
CERN	✓	✓		57.8%			
CF							✓
CHD	✓		✓		14.5%	✓	✓
CHRW							
CHTR						✓	
CI						✓	
CL	✓		✓		5.1%	✓	
CLX						✓	✓
CMCSA						✓	
CMG							
CMI	✓	✓		21.1%		✓	✓
CMS	✓	✓		0.7%			
CNC	✓		✓		15.3%		
CNP	✓	✓					✓
COG							✓
COO							
COP						✓	✓
COST						✓	✓
COTY	✓	✓		26.1%		✓	
CPB	✓	✓				✓	✓
CPRI						✓	
CPRT							
CRM						✓	
CSCO	✓		✓		18.2%	✓	
CSX							
CTAS	✓	✓		17.5%			
CTSH						✓	
CTVA						✓	✓
CTXS						✓	
CVS							
CVX							✓
CXO							✓
D	✓	✓	✓			✓	✓
DAL	✓		✓		16.8%	✓	✓
DD						✓	✓

Ticker	IR Hedg. in General	CF Hedging	FV Hedging	CF Hedging Extent (%)	FV Hedging Extent (%)	FC Hedging	CP Hedging
DE	✓	✓	✓	6.9%	19.2%	✓	
DG							
DGX	✓	✓	✓	24.7%	5.1%		
DHI	✓	✓		21.4%			
DHR						✓	
DIS	✓		✓		21.1%	✓	
DISCA	✓	✓		25.5%		✓	
DISH							
DLTR							
DOV						✓	
DOW	✓	✓	✓			✓	✓
DRI							✓
DTE						✓	✓
DUK	✓	✓		7.1%			✓
DVA	✓	✓		86.3%			
DVN							✓
DXC						✓	
EA						✓	
EBAY						✓	
ECL						✓	
ED	✓	NA	NA			✓	
EFX							
EIX							✓
EL	✓	✓	✓		27.8%	✓	
EMN	✓		✓		1.3%	✓	✓
EMR						✓	✓
EOG							✓
ES							✓
ETN	✓	✓	✓	6.0%	26.7%	✓	✓
ETR							✓
EVRG	✓	✓					
EW						✓	
EXC	✓	✓	✓	1.5%	3.4%		✓
EXPD							
EXPE						✓	
F	✓		✓		64.3%	✓	✓
FANG					0.0%		✓
FAST							
FB							
FBHS						✓	✓
FCX							✓
FDX							
FE							✓
FFIV							
FIS	✓		✓		2.5%	✓	
FISV						✓	
FLIR	✓	✓		21.2%		✓	
FLS						✓	
FLT	✓	✓		39.7%		✓	
FMC	✓	✓		6.1%		✓	

Ticker	IR Hedg. in General	CF Hedging	FV Hedging	CF Hedging Extent (%)	FV Hedging Extent (%)	FC Hedging	CP Hedging
FOX							
FTI						✓	
FTNT							
FTV							
GD	✓	✓				✓	
GE	✓		✓		29.8%	✓	
GILD						✓	
GIS	✓		✓		3.5%	✓	✓
GLW						✓	
GM	✓	✓	✓	0.6%	9.2%	✓	✓
GOOG						✓	
GPC	✓	✓		23.4%		✓	
GPN	✓	✓		18.8%			
GPS						✓	
GRMN							
GWW							
HAL	✓		✓		1.0%	✓	
HAS						✓	
HBI						✓	
HCA	✓	✓		7.4%			
HD	✓		✓		6.7%		
HES	✓		✓		1.4%	✓	✓
HFC						✓	✓
HII							
HLT	✓	✓		20.0%			
HOG	✓	✓		17.1%		✓	✓
HOLX	✓	✓		32.5%		✓	
HON	✓		✓		24.7%	✓	
HP							
HPE	✓	✓	✓	3.6%	49.6%	✓	
HPQ	✓		✓		14.6%	✓	
HRB							
HRL							✓
HSIC						✓	
HSY	✓		✓		8.2%	✓	✓
HUM							
HWM							
IBM	✓		✓		4.7%	✓	
IDXX						✓	
IEX							
IFF						✓	
ILMN						✓	
INCY							
INTC	✓		✓		49.3%	✓	
INTU							
IP	✓		✓		7.2%	✓	✓
IPG							
IPGP	✓	✓		47.0%			
IQV	✓	✓		10.3%		✓	
ISRG						✓	

Ticker	IR Hedg. in General	CF Hedging	FV Hedging	CF Hedging Extent (%)	FV Hedging Extent (%)	FC Hedging	CP Hedging
IT	✓	✓		64.1%		✓	
ITW							
J							
JBHT	✓		✓		27.0%		
JCI						✓	✓
JKHY							
JNJ						✓	
JNPR	✓		✓		17.8%	✓	
JWN							
K	✓		✓		24.0%	✓	✓
KEYS						✓	
KHC						✓	✓
KLAC						✓	
KMB	✓		✓		3.9%	✓	✓
KMI	✓	✓	✓	0.7%	25.4%	✓	✓
KMX	✓	✓		18.5%			
KO	✓		✓		29.3%	✓	✓
KR	✓	✓		2.3%			
KSS							
KSU	✓	✓		8.5%		✓	
LB						✓	
LDOS	✓	✓	✓	50.2%	15.1%		
LEG						✓	
LEN							
LH	✓		✓		6.5%	✓	
LHX	✓	✓		9.3%		✓	
LIN	✓		✓		12.5%	✓	
LKQ	✓	✓		11.9%		✓	
LLY	✓	✓	✓	6.5%	15.0%	✓	
LMT	✓	NA	NA			✓	
LNT							✓
LOW	✓	✓		4.0%			
LRCX	✓	✓	✓		8.8%	✓	
LUMN	✓	✓		7.2%			
LUV	✓	✓	✓	23.0%	18.8%		✓
LVS	✓	✓		44.0%			
LW							✓
LYB	✓	✓	✓		17.8%	✓	✓
LYV	✓	✓		15.1%		✓	
M							
MAR	✓		✓		10.1%		
MAS							
MCD	✓		✓		2.9%	✓	
MCHP							
MCK						✓	
MDLZ	✓	✓		28.5%		✓	✓
MDT	✓		✓		4.6%	✓	
MGM	✓	✓		16.9%			
MHK							
MKC	✓		✓		8.1%	✓	

Ticker	IR Hedg. in General	CF Hedging	FV Hedging	CF Hedging Extent (%)	FV Hedging Extent (%)	FC Hedging	CP Hedging
MLM							
MMM	✓		✓		5.4%	✓	✓
MNST						✓	
MO						✓	
MOS	✓		✓		12.7%	✓	✓
MPC							✓
MRK	✓		✓		17.6%	✓	
MRO	✓	✓		5.8%			✓
MSFT						✓	
MSI						✓	
MTD	✓	✓		11.6%		✓	
MU						✓	
MXIM						✓	
MYL	✓		✓		5.9%	✓	
NBL							✓
NCLH	✓	✓		25.0%		✓	✓
NEE	✓	✓	✓	22.5%	1.6%	✓	✓
NEM							✓
NFLX							
NI	✓	✓					✓
NKE						✓	
NLOK						✓	
NLSN	✓	✓		24.7%		✓	
NOC						✓	
NOV						✓	
NOW						✓	
NRG							✓
NSC							
NTAP						✓	
NUE							✓
NVDA						✓	
NVR							
NWL	✓		✓		6.6%	✓	✓
NWSA						✓	
ODFL							
OKE	✓	✓		10.2%			✓
OMC						✓	
ORCL	✓		✓		6.2%	✓	
ORLY							
OXY	✓	✓		3.8%			✓
PAYX							
PCAR	✓	✓				✓	
PEG	✓	✓		4.3%			✓
PEP	✓	✓	✓			✓	✓
PFE	✓		✓		12.7%	✓	
PG	✓		✓		25.7%	✓	
PH						✓	
PHM							
PKG							
PKI						✓	

Ticker	IR Hedg. in General	CF Hedging	FV Hedging	CF Hedging Extent (%)	FV Hedging Extent (%)	FC Hedging	CP Hedging
PM	✓	✓				✓	
PNR						✓	
PNW							✓
PPG	✓		✓		10.4%	✓	
PPL	✓	✓		0.6%		✓	
PRGO						✓	
PSX	✓	✓		5.5%			✓
PVH	✓	✓		13.6%		✓	
PWR							
PXD							✓
PYPL						✓	
QCOM	✓		✓		11.3%	✓	
QRVO							
RCL	✓	✓	✓	25.8%	6.7%	✓	✓
REGN							
RHI							
RL	✓		✓		32.5%	✓	
RMD						✓	
ROK	✓		✓		26.6%	✓	
ROL	✓	✓		27.4%		✓	
ROP							
ROST							
RSG	✓	✓	✓	6.6%	3.5%		
RTX						✓	
SBUX	✓	✓		13.4%		✓	✓
SEE						✓	
SHW						✓	
SJM						✓	✓
SLB						✓	
SNA	✓		✓		8.6%	✓	
SNPS						✓	
SO	✓	✓	✓	1.5%	3.8%	✓	✓
SRE	✓	✓		5.6%		✓	✓
STE						✓	✓
STX	✓	✓		11.8%		✓	
STZ	✓	✓		2.8%		✓	✓
SWK	✓	✓		20.4%		✓	
SWKS							
SYK	✓	✓				✓	
SYY	✓		✓		27.6%	✓	✓
T	✓		✓		0.5%	✓	
TAP						✓	✓
TDG	✓	✓		61.5%		✓	
TEL						✓	✓
TFX						✓	
TGT	✓		✓		13.3%		
TIF						✓	✓
TJX						✓	✓
TMO	✓		✓		5.6%	✓	
TMUS							

Ticker	IR Hedg. in General	CF Hedging	FV Hedging	CF Hedging Extent (%)	FV Hedging Extent (%)	FC Hedging	CP Hedging
TPR							
TSCO	✓	✓		33.7%			
TSN	✓	✓		4.1%		✓	✓
TT						✓	
TTWO						✓	
TWTR						✓	
TXN						✓	
TXT						✓	
UAA						✓	
UAL							
UHS						✓	
ULTA							
UNH							
UNP							
UPS	✓	✓	✓	3.1%	14.6%	✓	
URI							
VAR						✓	
VFC						✓	
VIAC						✓	
VLO						✓	✓
VMC	✓	✓					
VRSK							
VRSN						✓	
VRTX						✓	
VZ	✓	✓	✓		15.2%	✓	
WAB						✓	
WAT						✓	
WBA						✓	
WDC	✓	✓		19.0%		✓	
WEC	✓	✓		2.0%			✓
WHR	✓	✓		6.0%		✓	✓
WM							
WMB							✓
WMT	✓		✓		7.3%	✓	
WRK	✓	NA	NA			✓	✓
WU						✓	
WYNN	✓	✓		5.9%			
XEC							✓
XEL							✓
XLNX	✓		✓		60.7%	✓	
XOM							✓
XRAY	✓	✓		9.1%		✓	
XRX	✓		✓		4.7%	✓	
XYL						✓	
YUM	✓	✓		14.7%		✓	
ZBH						✓	
ZBRA	✓	✓		62.6%		✓	
ZTS	✓	✓	✓		2.3%	✓	
SUM	**172**	**108**	**90**			**249**	**111**

This table shows the self-constructed hedging data base of the 396 corporates in our sample. The first column includes the company ticker, the second column shows if the company hedges interest rate risk in general. Columns 3 and 4 show if the company hedges Cash Flow interest rate risk and Fair Value interest rate risk. Column 5 includes the hedging extents for Cash Flow hedging and Fair Value hedging, respectively. The hedging extent is calculated by dividing the notional amounts of the floating-to-fixed swaps (CF hedging) or fixed-to-floating swaps (FV hedging) by total debt. Forward starting swaps are not counted towards the hedging extent. Blank cells indicate that a company either does not engage in Cash Flow / Fair Value hedging or does not disclose information regarding notional amounts. The last two columns show whether the company engages in Foreign Currency hedging and Commodity Price risk hedging, respectively. IR = Interest rate, CF = Cash Flow, FV = Fair Value, FC = Foreign Currency, CP = Commodity Price.