

Three Essays in the Corporate Use of Financial Derivatives

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Abstract

This thesis discusses three topics concerned with the corporate use of financial derivatives. The first paper studies the effects of interest rate swaps on firms' default risk. The second paper examines the relationship between creditor rights and airlines' hedging behaviour. The final paper investigates how managerial holdings of inside debt (pension benefits and deferred compensation) can impact the decision to hedge via the use of interest rate swaps.

The first paper attempts to examine the question of whether the use of interest rate swaps by corporates and the direction of interest rate swaps increase or decrease firms' probability of default. Our sample consists of United Kingdom (UK) listed non-financial firms for the period between 2001 and 2015. Using a pooled Ordinary Least Squares (OLS) model, we document that the use of interest rate swaps reduces the probability of default for both firms swapping into fixed and those swapping into floating. This result is robust when we use a range of econometric methods, including a fixed effects model, a propensity score matching technique, an instrumental variables approach, and a System Generalised Method of Moments model. Additionally, we find that a failure to account for differences between small and large firms can lead to incomplete or misleading inferences of the impact of interest rate swap usage on firms' default risk. Our results show that whereas the use of interest rate swaps by small firms, irrespective of the direction of the swap, leads to a reduction in their default risk, large firms that swap into floating-rate debt are associated with an increase in their probability of default. Additionally, we show that the negative impact of swapping into fixed rate debt on firms' default risk remains the same during the period of heightened economic policy uncertainty, whereas the effectiveness of swapping into floating rate debt in decreasing firms' probability of default is weakened during this period. Moreover, this paper demonstrates that the recent period of zero lower bound interest rates affects the efficacy of swapping into fixed rate debt versus swapping into floating rate debt. Our results indicate that while swapping into fixed rate debt leads to a reduction in the probability of default during the zero lower bound period, the risk-mitigating effects of swapping into floating rate debt are significantly dampened during this period.

In the second paper, we use a sample consisting of airlines from 36 countries over the period from 2002 to 2016 to investigate the impact of creditor rights on corporate hedging behaviour, measured by the extent of jet fuel hedging. Using a pooled Ordinary Least Squares model, we find that airlines undertake more jet fuel hedging in stronger creditor rights countries. These results are robust when we employ other econometric methods, such as a Tobit model, a Heckman model, or an instrumental variable technique. Moreover, we identify six creditor rights reforms during our sample period and employ a model that is akin to a difference-in-difference model. The results show that the change that increases the creditor rights index can lead to an increase in airlines' jet fuel hedging. In addition, we find that the positive impact of creditor rights on the extent of jet fuel hedging is weakened during the financial crisis but strengthened during periods of high jet fuel prices. This study also sheds new light on the role of hedging in ameliorating the adverse effects of strong creditor rights. We show that jet fuel hedging can boost an airline's leverage. Furthermore, hedging allows an airline to engage in high-risk but potentially value-enhancing investment activities, therefore alleviating the underinvestment problem observed in strong creditor rights countries.

The third paper looks at how managerial compensation incentives, measured using data on the chief executive officer (CEO) pension benefits and deferred compensation (commonly referred to as inside debt), affect the decision to hedge via the use of interest rate swaps. Our sample consists of 912 listed United States (US) firms during the periods from 2006 to 2014. Using a probit model, we show that firms with more CEO inside debt are less likely to use interest rate swaps. Moreover, using a pooled OLS model, we find a negative relationship between CEO inside debt holdings and the extent to which a firm hedges using interest rate swaps. In this paper, we attempt to distinguish between protected and non-protected CEO inside debt. Whereas protected CEO inside debt is funded and secured, the non-protected one is not. Our result suggests that the negative association between CEO inside debt and hedging by interest rate swaps only exists if the CEO inside debt is non-protected. These results are robust when we employ a range of different econometric methods, including a Tobit regression model and an instrumental variables technique. Furthermore, we show that the negative impact of non-protected CEO inside debt is weakened when firms are financially constrained or during periods of heightened interest rate uncertainty. Finally, we document that non-protected CEO

inside debt can have negative effects on firms' default risk. However, our further analysis indicates that the negative effects of non-protected CEO inside debt on firms' default risk are dampened when firms hedge using interest rate swaps, which can explain why firms with large CEO inside debt holdings hedge less with interest rate swaps.

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Abbreviation

BIS	Bank for International Settlements
CAPIQ	Capital IQ
CEO	Chief Executive Officier
CRSP	Centre for Research in Security Prices
EDF	Expected default frequency
EFL	Ethnolinguistic fractionalisation
EIA	Energy Information Administration
EPU	Economic policy uncertainty
ERISA	Employee Retirement Income Security Act
FRS	Financial Reporting Standard
FTT	Financial transactions tax
GAAP	Generally Accepted Accounting Principles
GDP	Gross Domestic Product
IFRS	International Financial Reporting Standards
IRU	Interest rate uncertainty
IV	Instrumental variables
M&A	Merger and acquisition
OLS	Ordinary Least Squares
PDI	Power distance index
R&D	Research and development
S&P	Standard & Poor's
SEC	Security and Exchange Commission
SERP	supplemental executive retirement plan
SGMM	System Generalised Method of Moments
UK	United Kingdom
US	United States

Chapter 1: Introduction

Over the last three decades, there is a considerable line of literature on the practice of risk management by using financial derivatives. For example, hedging theories suggest that firms use financial derivatives to decrease the costs of financial distress (Smith and Stulz, 1985; and Froot et al., 1993), to alleviate credit rationing (Froot et al., 1993), to reduce expected taxes (Smith and Stulz, 1985), and to mitigate the agency costs of debt (Mayers and Smith, 1987; and Bessembinder, 1991). Based on these theories, many empirical studies have attempted to investigate the determinants of hedging and provided mixed evidence related to these theories (e.g., Nance et al., 1993; Geczy et al., 1997; Haushalter, 2000; Graham and Rogers, 2002; Carter et al., 2006; Bartram et al., 2009; Lel, 2012; Lievenbruck and Schmid, 2014; and Bartram, 2019).

This thesis includes three empirical essays that are related to the corporate use of financial derivatives. The first essay studies whether the use of an interest rate swap, which is a type of financial derivatives, is associated with a reduction in firms' default risk. If yes, the natural extension of this thesis is to find out what factors affect the corporate use of financial derivatives. The second essay will focus on a country-level factor, namely creditor rights, and the third essay will focus on a firm-level factor, namely CEO inside debt.

The remainder of this chapter is organised as follows. Section 1.1 presents the motivation for this thesis. Section 1.2 discusses the objectives of this thesis. The research questions of each empirical essay in this thesis are mentioned in Section 1.3. Section 1.4 summarises the findings and contributions of these essays. Finally, Section 1.5 provides the structure of this thesis.

1.1. Motivation for the thesis

The main motivation for this thesis comes from the mixed evidence of whether interest rate swaps that swap into floating rate debt decrease or increase firm risk (essay 1) and the limited corporate hedging studies that are related to creditor rights (essay 2) and CEO inside debt (essay 3). The following part will discuss this in detail.

1.1.1. The first essay

The first essay of this thesis is entitled "Does the direction of interest rate swaps matter?" This essay investigates the effect of interest rate swaps on the default probability of firms. Hedging theory suggests that one of the key motivations for firms to use financial derivatives is to reduce their likelihood of bankruptcy, which in turn decreases the expected costs of bankruptcy (Smith and Stulz, 1985; Froot et al., 1993; and Purnanandam, 2008). By using financial derivatives for hedging purposes, firms can enjoy a reduction in their cash flow volatility and so decrease their risk. A small but growing number of empirical studies have examined the relationship between the corporate use of financial derivatives and firms' risk and found evidence supporting the hedging theory (e.g., Guay, 1999b; Hentschel and Kothari, 2001; Nguyen and Faff, 2010; Bartram et al., 2011; and Bartram, 2019). The common point of these studies is that all of them use a proxy constructed from an asset pricing framework to measure firms' risk. However, this proxy may not necessarily account for firms' default risk.

One of the first studies proposing a model that helps to compute a firm's probability of default is Merton (1974). In this model, the equity value of a firm is equal to the value of a call option with the value of the firm being the underlying value and the face value of the firm's debt being the strike price. In essence, Merton (1974) points out that an increase in the asset volatility of a firm is positively associated with an increase in the bonds' risk premium, which is mentioned as a measure of the probability of default in Black and Scholes (1973). The basic concept of computing firms' probability of default in Merton (1974) has been widely applied in both academic study and practice. For example, there are some empirical studies using Merton (1974)'s model to measure firms' probability of default in their samples, such as Campbell et al. (2008), Magee (2013), Schultz et al. (2017), and Gregory (2020). Among these studies, Magee (2013) has examined the relationship between the corporate use of foreign exchange derivatives and firms' default risk. This study finds that the corporate use of foreign exchange derivatives can help firms reduce their default risk.

With regard to the corporate use of interest rate swaps, hedging theory suggests that whether swapping into fixed or floating rate debt can decrease risk depends on the correlation between a firm's operating cash flows and interest rates, referred to as the cash flow interest rate beta (e.g., Chernenko and Faulkender, 2011; and Oberoi,

2018). Conditional on the sign of the cash flow interest rate beta, a firm can choose the floating or fixed sides of an interest rate swap contract to reduce the cash flow volatility. For example, a firm with a negative or zero cash flow interest rate beta should use a swapping into fixed rate debt strategy to reduce the variability of its cash flow. In contrast, a firm with a positive cash flow interest rate beta should employ a swapping into floating rate debt strategy to decrease its cash flow volatility. This suggests that both swapping into fixed rate debt and swapping into floating rate debt can reduce the fluctuation of firms' cash flow, which can lead to a decrease in the fluctuation of the firms' asset value because the asset value can be computed as the sum of the present value of the cash flow generated from this asset. Merton (1974) proves that a reduction in the volatility of asset value leads to a decrease in bonds' risk premium, which is mentioned as a measure of default risk in Black and Scholes (1973). This suggests that the corporate use of interest rate swaps, irrespective of the direction, can reduce the companies' probability of default if the companies use interest rate swaps for hedging purposes.

However, there are tensions in the empirical literature as to whether swapping into floating decreases risk. Whereas some studies suggest that the use of a swapping into floating rate debt strategy is associated with an increase in firm risk (e.g., Faulkender, 2005; Chava and Purnanadam, 2007; Disatnik et al., 2014; and Ippolito et al., 2018), other studies suggest otherwise (e.g., Chernenko and Faulkender, 2011; and Oberio 2018). As a result, it is of vital importance to examine whether interest rate swap direction matters using a novel dataset in a completely new setting and more importantly during a period when interest rates were at the zero lower bound.

In this essay, we select a setting including UK listed non-financial companies. The protection of creditor rights in the UK market is stronger than that in the US market (e.g., La Porta et al., 1998; and Djankov et al., 2007), which makes the probability of UK firms falling into administration and ultimately liquidation, all else being equal, much larger than that faced by US firms. This might suggest that UK firms have higher risk avoidance incentives than US counterparts, which can make the results in this essay different from the related literature on US firms. Specifically, we predict that we will find strong evidence supporting that both swapping into fixed rate debt and swapping into floating rate debt can reduce firms' default risk.

Moreover, the sample period of this essay contains a period when interest rates were very close to zero, the so-called zero lower bound period. This enables us to distinguish the differences in the impacts of swapping into fixed rate debt and swapping into floating rate debt on the firms' default risk. During the zero lower bound period, there is no room for the interest rate to reduce. As a result, swapping into floating rate debt may not be an effective instrument for reducing firms' risk because this type of swap bets on the decrease of the interest rate. By contrast, swapping into fixed rate debt still can reduce firms' risk during this period since when the interest rate increases, it helps firms to fix the payment of interest expenses at the low level of the interest rate. Overall, this essay is motivated by the mixed evidence of whether interest rate swaps that swap into floating rate debt decrease or increase firm risk, the dearth of corporate derivative studies in the UK, and the special sample period including several years when the interest rates were very close to zero.

1.1.2. The second essay

This essay presents the second empirical study "Creditor rights and corporate hedging: Evidence from the airline industry." This essay examines the effect of creditor rights on corporate hedging behaviour, measured by the extent of jet fuel hedging. A large part of the previous empirical literature has studied the determinants of hedging behaviour in a single country setting, such as for US firms (e.g., Nance et al., 1993; Geczy et al., 1997; Haushalter, 2000; Graham and Rogers, 2002; and Carter et al., 2006). Recently, several cross-country studies have attempted to integrate hedging theory with legal frameworks to explain the roles of legal frameworks in influencing the corporate use of financial derivatives (e.g., Bartram et al., 2009; Lel, 2012; Lievenbruck and Schmid, 2014; and Bartram, 2019). However, it seems that the literature on the determinants of corporate hedging has overlooked the potential impact of creditor rights.

Creditor rights refer to the rights accorded to creditors against defaulting debtors in different legal institutions. Firms in strong creditor rights countries tend to avoid risk-taking activities because these firms face a higher likelihood of liquidation if they fail to meet the terms and conditions of its debt contract than those in weak creditor rights countries. For instance, firms in strong creditor rights countries tend to use less leverage (Rajan and Zingales, 1995; Acharya et al., 2011; and Cho et al.,

2014) or engage less in R&D activities (Seifert and Gonenc, 2012), which can adversely affect firm value. For example, a reduction in the leverage may suggest that firms face a shortage of funds for investing in new profitable investments. Or a decrease in firms' R&D expenditure is harmful to the development of the firms since successful R&D investment enables firms to develop better products at a lower cost, which can lead to an increase in the firms' cash flow.

Hedging theory suggests that firms can reduce their risk by using financial derivatives (e.g., Smith and Stulz, 1985; and Froot et al., 1993). As a result, it is arguable that firms are more likely to engage in hedging via financial derivatives in stronger creditor rights countries. Several studies have attempted to examine the impact of creditor rights on corporate hedging (e.g, Lel, 2012; and Lievenbruck and Schmid, 2014). However, none of them finds evidence of any relationship between creditor rights and corporate hedging. This may be because the design and data employed by these studies may not have been ideal to detect the impact of creditor rights on corporate hedging. For instance, the heterogeneity in different industries may make it difficult to find out a meaningful hedging–creditor rights relationship (e.g., Lel, 2012). Or the measure of hedging may be too simple to explore this relationship (e.g., Lievenbruck and Schmid, 2014).

Furthermore, an area that has received limited attention is the role of corporate hedging in an international context. The role of corporate hedging is documented in many studies. For example, hedging can help firms increase their leverage (e.g., Stulz, 1996; Ross, 1997; Leland, 1998; and Graham and Rogers, 2002), decrease their financial distress (e.g., Smith and Stulz, 1985; and Froot et al., 1993), and mitigate the underinvestment problem (e.g., Bessembinder, 1991; and Froot et al., 1993). To the best of my knowledge, there are no studies distinguishing between the roles of corporate hedging in strong creditor rights countries and those in weak creditor rights countries. In sum, the motivation for this essay stems from the limited corporate hedging studies that examine the impact of creditor rights on corporate hedging behaviour and compare the role of hedging in strong and weak creditor rights countries.

1.1.3. The third essay

The third essay is titled "CEO inside debt and corporate hedging decisions: Evidence from the use of interest rate swaps." This essay studies the impact of CEO

inside debt on corporate hedging via the use of interest rate swaps. The term "inside debt" was first used by Jensen and Meckling (1976). They define inside debt as the debt held by managers and suggest that inside debt can mitigate the conflict between companies' managers and their debt holders. Basically, CEO inside debt includes CEO pension benefits and deferred compensation plans that represent a company's fixed obligations to make future payments at or after a manager's retirement so long as the company is solvent. It should be noted that a large part of pension benefits and deferred compensation are typically unfunded and unsecured. This characteristic makes them resemble unsecured debt financing.

Jensen and Meckling (1976) suggest that CEO inside debt can mitigate the conflict between companies and their debt holders, or the agency cost of debt. Many empirical studies find evidence supporting this argument. Specifically, most of these studies show that inside debt induces managers to follow conservative financing and investment policies. For instance, Cassell et al. (2012) and Phan (2014) report that a high level of CEO inside debt is negatively related to risky corporate decisions. Liu et al. (2014) indicate that CEOs holding more inside debt tend to hold more cash, which implies risk-averse behaviour. Other studies show that CEO inside debt is negatively associated with firm risk, measured by default risk, stock price volatility, credit default swap spreads, or cost of debt (e.g., Sundaram and Yermack, 2007; Wei and Yermack, 2011; Anantharaman et al., 2014; Dang and Phan, 2016; and Freund et al., 2018).

Several studies have attempted to examine the debt-like compensation function of the components of CEO inside debt. CEO pension benefits usually consist of tax-qualified plans and supplemental executive retirement plans (SERPs). Whereas the former component needs to be funded and secured under the Employee Retirement Income Security Act (ERISA) of 1974, the latter component does not need to be funded and secured. As a result, if firms are liquidated, only tax-qualified plans are protected from the firms' liquidation to some extent. Different from pension benefits, the whole amount of deferred compensation is not funded or secured. These imply that only the payoff of SERPs and deferred compensation resembles that of unsecured debt and therefore can mitigate the conflict between companies and their debtholders.

To the best of our knowledge, there are only two studies investigating the "unsecured" characteristics of CEO inside debt (Anantharaman et al., 2014; and

Colonnello et al., 2017). Anantharaman et al. (2014) examine the impact of inside debt and its components on the design of a debt contract. They find that only SERPs can reduce both the costs of debt and the number of restrictive covenants. Colonnello et al. (2017) study the effects of inside debt on the cost of debt and the risk of firm assets. In this study, non-protected (unsecured) CEO inside debt is defined as the sum of SERPs and deferred compensation plans. Colonnello et al. (2017) show that only the non-protected part of CEO inside debt is negatively related to credit default swap spreads, assets volatility, and yield spreads. These studies suggest that only non-protected part of CEO inside debt has payoffs that are similar to those of outside unsecured debtholders and therefore can mitigate the conflict between companies and their debtholders.

Inside debt is a part of managers' wealth portfolio that also includes equity-based components. Whereas there are several studies investigating the effect of CEO equity-based incentives on the corporate hedging decision (e.g., Knopf et al., 2002; Borokhovich et al., 2004; and Bakke et al., 2016), to the best of my knowledge, there have been no studies that investigate how CEO inside debt holdings interact with non-financial companies' hedging behaviour. It is arguable that CEO inside debt holdings can impact corporate hedging in two opposite ways.

On one hand, CEO inside debt holdings can exert a positive impact on corporate hedging via the use of interest rate swaps. Many studies show that the use of financial derivatives such as interest rate swaps can decrease firms' risk (e.g., Smith and Stulz, 1985; Froot et al., 1993; Guay, 1999b; Hentschel and Kothari, 2001; Purnanandam, 2008; Nguyen and Faff, 2010; Bartram et al., 2011; and Bartram, 2019). Because CEOs with high inside debt holdings tend to follow risk-reducing corporate policies (e.g., Jensen and Meckling, 1976; Edmans and Liu, 2011; and Wei and Yermack, 2011), they are more likely to hedge by using interest rate swaps.

On the other hand, CEO inside debt holdings can be negatively associated with corporate hedging. This is due to CEOs with large inside debt holdings have lower incentives to hedge. Hedging theory suggests that firms use financial derivatives to decrease their financial distress (Smith and Stulz, 1985; and Froot et al., 1993). Previous studies find that firms possessing a higher level of CEO inside debt hold more cash (Liu et al., 2014) and have lower default risk (Sundaram and Yermack, 2007). This suggests that these firms have lower financial distress. Consequently, the CEOs of these firms may have lower motivation for hedging by financial derivatives.

Additionally, hedging theory also suggests that firms use financial derivatives to reduce asymmetric information between shareholders and potential bondholders (Mayers and Smith, 1987; and Bessembinder, 1991). Previous studies suggest that CEO inside debt can also mitigate the conflict between shareholders and bondholders (e.g., Jensen and Meckling, 1976; Edmans and Liu, 2011; and Wei and Yermack, 2011). As a result, CEO inside debt may discourage firms' incentives to hedge by financial derivatives.

As discussed above, inside debt can be classified into protected and non-protected parts and only non-protected part can reduce the agency costs of debt. As a result, this essay will extend the analysis by investigating the effects of protected and non-protected inside debt on corporate hedging.

Edmans and Liu (2011) build a theoretical model predicting that the impacts of CEO inside debt on alleviating the conflict between companies and their debtholders are weakened when the default risk of these companies is low. Nevertheless, no study finds empirical evidence supporting this prediction so far. Hedging theory suggests that companies can use financial derivatives, such as interest rate swaps, to reduce their default risk (Smith and Stulz, 1985; Froot et al., 1993; and Purnanandam, 2008). Some empirical studies find evidence supporting the hedging theory (Guay, 1999b; Hentschel and Kothari, 2001; Bartram et al., 2011; and Bartram, 2019). Therefore, the setting of this essay, which incorporates the corporate use of interest rate swaps with CEO inside debt, is special because it helps to test empirically the prediction of Edmans and Liu's (2011) model. Overall, the third essay is motivated by the absent studies investigating the impacts of CEO inside debt and its components on corporate hedging and the lack of empirical evidence supporting the prediction of Edman and Liu's (2011) model.

1.2. Objectives of the studies and research questions

The overall objective of this thesis is to provide a better understanding of the corporate use of financial derivatives. The specific objectives of each empirical essay and its research questions are discussed as follows.

1.2.1. The first essay

This essay aims to investigate how the corporate use of interest rate swaps interacts with the firms' default risk. The main research question of this essay is

"When firms choose to swap into fixed or floating of interest rate, how does this decision affect their default probability?"

The five following sub-questions will help to answer the main question:

(i) Can swapping into fixed and swapping into floating rate debt reduce firms' default risk?

(ii) Does the impact of the use of interest rate swaps on firms' probability of default vary with respect to firm size?

(iii) How does uncertainty about interest rate affect the relationship between the use of interest rate swaps and firms' default risk?

(iv) How does economic policy uncertainty affect the relationship between the use of interest rate swaps and firms' default risk?

(v) How does the zero lower bound period impact the relationship between the use of interest rate swaps and firms' probability of default?

1.2.2. The second essay

The second essay attempts to examine the effects of creditor rights on international airlines' hedging behaviour, measured by the extent of jet fuel hedging. The main research questions of this essay are "How do creditor rights affect the extent of jet fuel hedging?" and "Why do airlines have such behaviour?"

The six following sub-questions will help to answer the two main questions:

(i) How do strong creditor rights impact the extent of jet fuel hedging?

(ii) How does the relationship between creditor rights and the extent of jet fuel hedging change during the crisis period?

(iii) How does the relationship between creditor rights and the extent of jet fuel hedging change during the period of high jet fuel prices?

(iv) How does a jet fuel hedging policy impact the relationship between creditor rights and airlines' leverage?

(v) How does a jet fuel hedging policy impact the relationship between creditor rights and airlines' default risk?

(vi) How does a jet fuel hedging policy impact the relationship between creditor rights and airlines' investment?

1.2.3. The third essay

The purpose of this essay is to study how managerial compensation incentives, measured using data on the CEO pension benefits and deferred compensation (commonly referred to as inside debt), affect the decision to hedge via the use of interest rate swaps. The main research question of this essay is "How does CEO inside debt impact the corporate decision to hedge via the use of interest rate swaps?"

The three following sub-questions will help to answer the main question:

(i) How does CEO inside debt affect the decision to use interest rate swaps?

(ii) How does protected and non-protected CEO inside debt affect the decision to use interest rate swaps?

(iii) Why do firms have such behaviour?

1.3. Data sources and methodologies

This thesis employs many sources to collect the necessary data and applies a range of econometric methodologies to achieve the aforementioned objectives. The detail of the data sources and methodology is presented as follows.

1.3.1. The first essay

The sample of this essay consists of UK listed non-financial companies during the period from 2001 to 2015. We focus on non-financial companies as financial companies such as banks or other financial institutions may have different underlying motives for using interest rate swaps compared to non-financial companies. We collect expected default frequency, which is a measure for firms' probability of default, from Moody's Analytics. Additionally, we source the information about interest rate swap usage from UK annual reports and S&P Capital IQ. Financial data is also gathered from S&P Capital IQ. Stock excess returns are obtained from Datastream. Interest rate uncertainty and economic policy uncertainty indexes are collected from Istrefi and Mouabbi (2018) and Baker et al. (2016), respectively. Finally, we source UK annual percentage growth rate of Gross Domestic Product (GDP) from the World Bank.

We select a UK setting because of the following reasons. First, the number of studies investigating the corporate use of interest rate swaps outside the US is scarce. The creditor rights in the UK are stronger than that in the US (La Porta et

al., 1998; and Djankov et al., 2007), which makes UK firms more easily fall into administration and ultimately liquidation, all else being equal, than US firms. This would suggest that the former have a greater incentive to avoid default compared to the latter. Second, in the data analysis, we indicate that the use of interest rate swaps by UK firms is more widespread and extensive than that of US firms.

Our sample starts in 2001 because Financial Reporting Standard (FRS) 13 has required UK firms to disclose narrative and numerical information explaining the role that financial instruments, such as interest rate swaps, played in creating or changing the risks that a firm faced in its activities from March 1999. We do not include the year of 1999 and 2000 because the number of observations in these two years is little. And our sample ends in 2015 in order to avoid the impact of the withdrawal of the UK from the European Union (Brexit) in 2016, which can make our estimation biased.

We also select the period 2001 to 2015 because macroeconomic uncertainty and corporate financial distress in the UK during this period were relatively substantial. For instance, the European Commission (2015) documents that corporate bankruptcy increased by 22% in 2009 for Western Europe, which made it the worst year in the UK since 1993. Additionally, it should be noted that our sample period includes several years when interest rates were very close to zero, the so-called zero lower bound period. It follows that our sample period provides a great opportunity to examine the relationship between the use of interest rate swaps and firms' default risk as it includes times when one might expect such activity to be most beneficial and for the direction of interest rate swaps to matter.

In this essay, we follow previous studies that examine firms' default risk and use a pooled Ordinary Least Squares as the baseline regression (e.g., Brogaard et al., 2017). To deal with endogeneity problems, we employ a battery of econometric methods in robustness checks, such as a fixed effects model, a propensity score matching technique, an instrumental variables approach, and a System Generalised Method of Moments model.

1.3.2. The second essay

In this essay, we use a sample consisting of airlines from 36 countries over the period from 2002 to 2016. We select an international setting because the variations in creditor rights of different countries help us to examine the relationship between

creditor rights and airlines' jet fuel hedging. We focus on airlines' jet fuel hedging practices due to the following reasons. Firstly, our data indicate that expenditure on jet fuel by airlines is a significant component of their operating costs, which implies that the exposure of jet fuel price volatility faced by airlines is high. Secondly, we hold constant other characteristics of the business environment that might vary across industries by concentrating on the airline industry. As the airline industry is largely homogeneous and competitive we can avoid the complication of heterogeneity in a cross-industry sample. Thirdly, many airlines disclose their jet fuel hedging plans in a detailed manner in their annual reports, which can help us to have a very precise measure of hedging.

We use S&P Capital IQ to gather a list of annual reports going back in time as far as we can for all of the public airlines listed on this database. It is of vital importance that the countries in which the airlines are based must be covered in Djankov et al. (2007) so that we have the information about the creditor rights. We start our sample from 2002 because we can gather only a few annual reports before this year.

After having the list of airlines, we manually collect information about the airlines' jet fuel hedging from their annual reports. The financial data for these airlines is sourced from S&P Capital IQ. In this essay, we also gather some country-level variables from previous studies (Djankov et al., 2008; La Porta et al., 1998; Djankov, Hart, McLiesh, and Shleifer, 2008; La Porta et al, 1999; and Alesina et al., 2003). The strength of legal rights index is obtained from the World Bank Doing Business database. We source countries' GDP per capita and the annual growth rate of the GDP implicit deflator from the World Bank database. Finally, the data to calculate countries' derivative market rank is obtained from the Bank for International Settlements (BIS).

This essay follows the previous studies that investigate the determinants of hedging to employ a pooled OLS model as the baseline regression (e.g., Rampini et al., 2014). In addition, this essay uses a Tobit model to deal with the natural characteristic of our jet fuel hedging measure, which is that this measure is censored at 0 and 1. To address endogeneity problems, this essay applies a range of econometric methods such as a Heckman regression model or an instrumental variables technique. This essay also identifies some creditor rights reform in the sample to employ a model that is akin to a difference-in-difference model.

1.3.3. The third essay

The sample of this essay consists of all companies in Bretscher et al.'s (2018) sample for the period from 2006 to 2014. Bretscher et al. (2018) gather information on the use of interest rate swaps by the largest 1,600 US firms in Standard & Poor's Compustat (Compustat). The sample period starts from 2006 since the 2006 Security and Exchange Commission (SEC) reform required all US listed companies to disclose and describe the pension benefits and deferred compensation of their top executives. And the sample period ends in the year 2014 because this is the final year in Bretscher et al.'s (2018) data.

This essay gathers CEO compensation data from Standard & Poor's Executive Compensation (ExecuComp) database. In addition, the financial data and stock return data are obtained from Compustat and the Centre for Research in Security Prices (CRSP), respectively. As in Anantharaman et al. (2014) and Bretscher et al. (2018), we exclude financial firms from our sample.

This essay follows Bretscher et al. (2018) that examine the determinants of corporate hedging by interest rate swaps to use a pooled OLS model as the baseline regression. Because our hedging variable is censored at 0, we also employ a Tobit model in this essay. To reduce the bias caused by endogeneity problems, this essay applies an instrumental variables model.

1.4. Findings and contributions

The findings of this thesis contribute to the common literature on the corporate use of financial derivatives. In addition to the contribution to this literature, each empirical essay contributes to some other specific lines of literature. This section will provide the findings and contributions of each empirical essay in this thesis.

1.4.1. The first essay

The first essay finds that a higher level of interest rate swap usage, irrespective of swap direction, can lead to a larger reduction in the probability of default. In economic terms, a one standard deviation increase in the level of interest rate swap usage on average decreases a firm's probability of default by around 12 percent. Although swapping into either fixed or floating rate debt generates a statistically significant reduction in the probability of default, given the same level of swap usage, the results show that swapping into fixed rate debt generates an

economically greater decrease in firm default risk than swapping into floating rate debt.

This essay also finds that the use of interest rate swaps by small- and medium-sized firms reduces their default risk whether they are swapping into fixed or floating rate debt. However, the default risk of very large firms does not change when these firms swap into fixed rate debt and their default risk increases when they swap into floating rate debt. These results imply that although swap direction does not matter for small- and medium-sized firms, it does matter for large firms. These findings are in line with the notion that larger firms have lower risk avoidance incentives because they in general have lower default risk (Brogaard et al., 2017).

Moreover, the results of this essay show that the negative effect of swapping into fixed rate debt on firms' default risk remains the same during the period of elevated economic policy uncertainty. By contrast, the effectiveness of swapping into floating rate debt in decreasing firms' probability of default is weakened during this period. This suggests that swap direction seems to matter in periods of high economic policy uncertainty. Finally, this essay finds that in periods when the base rate is high, the corporate use of interest rate swaps is associated with a reduction in a firm's likelihood of default whether the firms are swapping into fixed or floating rate debt. However, during the zero lower bound period, we find that swapping into floating rate debt does not decrease a firm's default risk, whereas swapping into fixed rate debt does.

This essay contributes to the literature in many aspects. First, by showing that swapping into floating rate debt can reduce firms' default risk for the majority of firms in our sample, this essay contradicts most of the existing results in the corporate hedging and debt structure literature (e.g., Faulkender, 2005; Chava and Purnanandam, 2007; Disatnik et al., 2014; and Ippolito et al. 2018). This implies that the effect of swapping into floating rate debt on firm risk is not homogeneous across the UK and US. This may be because firms operating in the UK, where creditor rights are much stronger compared to the US, may have a greater risk of bankruptcy and therefore they do not use interest rate swaps for speculative motives.

Second, this essay contributes to a small but growing strand of literature on the relationship between various manifestations of economic uncertainty and firm investment and financing decisions (e.g., Kang et al., 2014; and Bretscher et al.,

2018). We show that the negative effect of swapping into fixed rate debt on the probability of default is not affected by the uncertainty surrounding economic policy whereas the negative impact of swapping into floating is weakened during a period of high economic policy uncertainty. Finally, this essay contributes to the literature on the relationship between the monetary policy and the corporate use of interest rate swaps (e.g., Ippolito et al., 2018). We believe we are the first to report evidence indicating that swapping into fixed rate debt can lead to a reduction in the firms' default risk during the zero lower bound period, whereas swapping into floating rate debt cannot.

1.4.2. The second essay

The result of this essay shows that airlines undertake more jet fuel hedging in stronger creditor rights countries. In economic terms, the result shows that a unit increase in the creditor rights index leads to an increase in airlines' jet fuel hedging ratio by around 7.5%, which accounts for approximately a third of the mean proportion of jet fuel hedging in the sample. Additionally, the results show that airlines undertake more jet fuel hedging in settings where it is relatively easy during reorganisation for creditors to seize control of assets and/or remove senior executives from their posts. In a robustness test, we are able to identify six creditor rights reforms during our sample period and use a model that is akin to a difference-in-difference model. The results of this analysis indicate that airlines hedge more of their exposure to the fluctuation of jet fuel prices after the reforms that enhance creditor rights protection.

In this essay, we also investigate the effect of creditor rights on airlines' jet fuel hedging during the period of the financial crisis and during episodes of high jet fuel prices. The results report that the positive relationship between creditor rights and the extent of jet fuel hedging is weakened during the financial crisis. This may be because of a drop in the willingness of banks to act as counterparties to derivative transactions during this period. By contrast, the positive effect of creditor rights on the extent of jet fuel hedging is strengthened during the period of high jet fuel prices. However, this effect disappears during the financial crisis.

Finally, this essay finds that hedging can mitigate the adverse effects of strong creditor rights on airlines' leverage and investment. Hedging may enable airlines to take part in value-enhancing risk-taking activities that similar firms without hedging

cannot implement in strong creditor rights countries. The results indicate that jet fuel hedging can allow airlines to increase their leverage and investment in aircraft by around 17.9% and 55.3% in strong creditor rights countries, respectively.

This essay contributes to several lines of the literature. First, we indicate, for the first time, that the protection of creditor rights is one of the most important determinants of corporate hedging. Additionally, the effects of creditor rights on corporate hedging are weakened during periods of economy-wide financial distress. These findings are new to the established literature on the determinants of hedging (e.g., Nance et al., 1993; Geczy et al., 1997; Haushalter, 2000; Judge, 2006; Lel, 2012; and Lievenbruck and Schmid, 2014). Second, to the best of our knowledge, we believe we are the first to provide evidence suggesting that hedging can ameliorate the adverse side effects of strong creditor rights. This is important to the long line of literature on the real effects of hedging (e.g. Graham and Rogers, 2002; Campello et al., 2011; Magee, 2013; Disatnik et al., 2014; and Chen and King, 2014).

1.4.3. The third essay

This essay indicates that CEOs with a high level of inside debt tend to use less interest rate swaps. Additionally, the results show a negative relationship between CEO inside debt holdings and the extent to which a firm hedges using interest rate swaps. This essay also attempts to distinguish between protected and non-protected CEO inside debt. Whereas protected CEO inside debt is funded and secured, the non-protected one is not. This essay finds that the negative relationship between CEO inside debt and hedging by interest rate swaps only exists if the CEO inside debt is non-protected.

Moreover, this essay indicates that there are circumstances where the negative impact of non-protected CEO inside debt on hedging by interest rate swaps is dampened. Specifically, this essay finds that the negative impact of non-protected CEO inside debt is weakened when firms are financially constrained or during the periods of heightened interest rate uncertainty. This may be because firms find that hedging is more necessary when they are financially constrained (Froot et al., 1993; and Kuersten and Linde, 2011) or during the period of elevated interest rate uncertainty (Bretscher et al., 2018).

Next, the result of this essay confirms the previous finding of a negative relationship between CEO inside debt and firms' default risk. Furthermore, this

essay shows that only non-protected CEO inside debt reduces firms' default risk, which supports the argument that only non-protected CEO inside debt can align the benefits of managers and debt holders (Anantharaman et al., 2014; and Colonnello et al., 2017).

The final results of this essay find that the negative impact of non-protected CEO inside debt on companies' default risk is weakened when the companies increase hedging by interest rate swaps. In economic terms, a one percentage point increase in the extent of interest rate swap usage can lead to a reduction in the negative effect of non-protected CEO inside debt on firms' default risk by around 18.52%. This finding is consistent with the prediction of Edmans and Liu's (2011) model, which suggests that the effect of inside debt is dampened when companies are in a state of low default risk. This finding also helps to explain why firms with high CEO inside debt holdings use fewer interest rate swaps.

This essay contributes to the literature in several ways. First, this essay shows that CEO inside debt is negatively related to corporate hedging via the use of interest rate swaps. Furthermore, the results show that only non-protected CEO inside debt exerts a negative impact on corporate hedging. As a result, these findings add to an established body of literature documenting various determinants of the corporate hedging by financial derivatives (e.g., Nance et al., 1993; Geczy et al., 1997; Judge, 2006; and Bartram et al., 2009), a growing line of literature on the relationship between managerial compensation and the corporate hedging decisions (e.g., Knopf et al., 2002; Borokhovich et al., 2004; and Bakke et al., 2016), as well as an ever-emerging strand of literature on the role of inside debt in adjusting firms' investment and financial policies (e.g., Phan, 2014; Liu et al., 2014; and Dang and Phan, 2016).

Second, by showing that only non-protected CEO inside debt reduces firms' default risk, this essay complements and extends the study of Subdaram and Yermack (2007). This finding is also consistent with the evidence that a high amount of total CEO inside debt in general and of non-protected CEO inside debt in particular can lead to a reduction in credit default swap spreads, costs of debt, and assets volatility (Wei and Yermack, 2011; Cassell et al., 2012; Anantharaman et al., 2014; Dang and Phan, 2016; Colonnello et al., 2017; and Freund et al., 2018).

Finally, this essay shows that the negative effects of CEO inside debt on companies' default risk are weakened when the companies hedge using interest rate swaps. Given that hedging by interest rate swaps can reduce firms' probability of

default, this empirical evidence supports the prediction of Edmans and Liu's (2011) model stating that inside debt is less valuable when the companies have a lower likelihood of default.

1.5. Structure of the thesis

The structure of this thesis is as follows. Chapter 2 provides the first empirical essay investigating whether the use of interest rate swaps by corporates and the direction of interest rate swaps will increase or decrease firms' probability of default. Chapter 3 presents the second empirical essay examining the impact of creditor rights on corporate hedging behaviour, measured by the extent of jet fuel hedging. Chapter 4 discusses the third empirical essay studying how CEO inside debt affects the decision to hedge via the use of interest rate swaps. Finally, Chapter 5 concludes this thesis by summarising the main findings of the three essays, suggesting some research implications for policymakers, drawing limitations, and offering avenues for future research.

Chapter 2: Does the Direction of Interest Rate Swaps Matter?

2.1. Introduction

The question of whether firms are using interest rate swaps to increase or decrease risk is important in light of attempts by regulators to curb the use of over-the-counter derivatives as a response to the 2008 financial crisis, concerns about systemic risk in the financial sector and more recently the prospect of the introduction of the financial transactions tax (FTT). In the Bank of England's October 2009 Systemic Risk Survey, market participants ranked household and corporate default second in a list of the five risks they believed would have the greatest impact on the UK financial system if they were to materialise. Furthermore, the proportion of respondents citing household and corporate default as a key risk to the UK financial system increased to 49 percent, from 45 percent in May 2009.[1] Additionally, the FTT has generated widespread concern amongst financial institutions and the corporate sector. The derivatives markets are predicted to bear a high burden of the FTT. Wyman et al. (2012) report that the increase in direct costs on derivative transactions as a result of the FTT could be in the region of 18 times the bid/offer spread in normal market conditions. It follows that in attempting to discourage socially undesirable transactions such as excessive risk taking, the FTT may adversely affect socially and economically desirable activities such as hedging. We believe that the FTT in relation to corporate derivative transactions will be necessary only if it can be shown that a large swathe of corporates use derivative instruments to increase risk, which could then result in large-scale defaults and ultimately systemic risk, as reported by the Bank of England survey alluded to above.

With this in mind, the aim of this paper is to shed light on whether the use of interest rate swaps by corporates and the direction of interest rate swaps increase or decrease firms' probability of default. Specifically, we examine the impact of the use of interest rate swaps by UK listed non-financial companies on their likelihood of default, which is measured using default probabilities obtained from Moody's Analytics for the period from 2001 to 2015.

[1] Financial Stability Report, Bank of England, December 2010.

In this chapter, we examine whether the use of interest rate swaps or whether it is the direction of an interest rate swap that matters, that is, are floating-to-fixed or fixed-to-floating rate swaps important in driving the relationship between interest rate swaps use and firm default risk?[2] Whether swapping into fixed or floating rate debt is risk reducing depends on the correlation between a firm's operating cash flows and interest rates, referred to as the cash flow interest rate beta. When a firm with a negative or zero cash flow interest rate beta uses an interest rate swap that swaps from floating to fixed rate debt, its cash flow volatility will fall. Similarly, when a firm with a positive cash flow interest rate beta uses an interest rate swap that swaps from fixed to floating rate debt, its cash flow volatility will reduce. Therefore, the direction of interest rate swaps will not be important if firms are using interest rate swaps for risk reduction (hedging). The value of an asset can be calculated based on the discounted value of the cash flow generated from this asset. As a result, the reduction in cash flow volatility can cause a decrease in asset volatility. Merton (1974) shows that a decrease in the asset volatility leads to a decrease in bonds' risk premium, which is mentioned as a measure of default risk in Black and Scholes (1973). This suggests that the corporate use of interest rate swaps, irrespective of the direction, can reduce the companies' probability of default if the companies use interest rate swaps for hedging purposes. However, there are tensions in the empirical literature as to whether swapping into floating decreases risk. For example, Faulkender (2005), Chava and Purnanadam (2007), Disatnik et al. (2014), and Ippolito et al. (2018) suggest that swapping into floating rate debt increases risk, whereas Chernenko and Faulkender (2011) and Oberoi (2018) suggest otherwise. This chapter tests whether interest rate swap direction matters using a novel dataset in a completely new setting and more importantly during a period when interest rates were at the zero lower bound.

We believe that this question is important in a UK setting for several reasons compared to a US setting where all interest rate swap studies have been undertaken. Firstly, the bankruptcy code in the UK is creditor friendly, which makes the likelihood of a UK firm falling into administration and ultimately liquidation, all else being equal, much greater than that faced by US firms that operate under a shareholder-friendly system of bankruptcy. This would imply that

[2] Floating-to-fixed interest rate swaps are sometimes referred to as a cash flow hedge and likewise fixed-to-floating interest rate swaps are referred to as a fair value hedge (e.g, Disatik et al., 2014).

UK firms have a greater incentive to avoid default compared to US firms. Consistent with this, Acharya et al. (2011) find that the probability of diversifying mergers is significantly higher in the UK. Secondly, we show through our careful data collection that the use of interest rate swaps is more widespread and extensive amongst UK corporates than in the US corporate sector. Thirdly, the period 2001 to 2015 examined in this study experienced heightened levels of both macroeconomic uncertainty and corporate financial distress in the UK. For example, the European Commission (2015) reports that corporate insolvencies grew 22% in 2009 to 185,111 for Western Europe, which made it the worst year in the UK since 1993. Furthermore, our sample period includes several years when interest rates were very close to zero, the so-called zero lower bound period. It follows that our sample period provides a great opportunity to examine the relationship between the use of interest rate swaps and firms' default risk as it includes times when one might expect such activity to be most beneficial and for the direction of interest rate swaps to matter. The aforementioned set of regulatory, macroeconomic and monetary policy circumstances coupled with the absence of studies that investigate the effects of the use of interest rate swaps on the probability of default and the dearth of corporate derivative studies in the UK makes an analysis of UK firms a very interesting and important case study.

In this chapter, we collect a rich new hand-collected dataset covering a period of 15 years on firms' interest rate structure of debt after the effects of interest rate swaps. We also gather data from S&P Capital IQ (CAPIQ) on the percentage of floating rate debt, which is provided before the effect of interest rate swaps. We take the difference between the after and before percentage of floating rate debt to determine the extent of interest rate swap usage, with positive (negative) values indicating firms have a net swapping to floating (fixed) position. We are one of only three studies to utilise a measure of swap usage in empirical work, the first outside of the US and the first study to measure interest rate swap usage in the way we have described.[3] This measure is better than the measures of interest rate swaps in other empirical studies. For example, when examining the impact of the use of interest rate swaps on liquidity choices, Disatnik et al. (2014) do not consider the

[3] Chernenko and Faulkender (2011) and Bretscher et al. (2018) use disclosures in financial statements on the interest rate structure of debt before the effect of interest rate swaps and the types and amounts of interest rate swap used to construct their measure of interest rate swap usage.

combined or net effects of both swapping into fixed and swapping into floating rate debt. Our measure of the use of interest rate swaps is better than their study because we can distinguish between the effect of swapping into fixed rate debt and the effect of swapping into floating rate debt in net terms. We use the absolute value of our measure to examine the relationship between the extent of interest rate swap usage and the probability of default. Our findings show that a higher level of interest rate swap usage, irrespective of swap direction, generates a larger reduction in the probability of default. In economic terms, a one standard deviation increase in the level of interest rate swap usage on average decreases a firm's probability of default by around 12 percent. From our interest rate swap usage data, we are also able to determine whether in net terms a firm has swapped into fixed or floating rate debt. We find that swapping into either fixed or floating rate debt generates a statistically significant reduction in the probability of default, suggesting that swap direction or how a firm arrives at its final interest rate structure of debt does not matter when firms are reducing interest rate risk. However, given the same level of swap usage, swapping into fixed rate debt leads to an economically greater decrease in firm default risk than swapping into floating rate debt. Since we find that swapping into either fixed or floating rate debt generates a fall in default risk, these findings seem to contradict those of Disatnik et al. (2014) as they argue that fair value hedging (swapping to floating rate debt) should not reduce the volatility of cash flows. Overall, our analysis and these results are new to the literature.

The majority of previous studies find that larger firms are more likely to use derivatives than smaller ones (e.g., Adam, 2002). However, although large firms are more likely to use interest rate swaps, it is not necessarily the case that they use them more extensively or use them to lower financial risks, as suggested by Bartram et al. (2011). We, therefore, extend our swap direction and swap usage analysis by conducting a series of disaggregated tests based on firm size quartiles. We find that the use of interest rate swaps by small- and medium-sized firms reduces their probability of default whether they are swapping into fixed or floating rate debt. However, we find very large firms that swap into floating rate debt increase their default risk, and when these firms swap into fixed rate debt the impact on the probability of default is insignificant. This suggests that although swap direction does not matter for small- and medium-sized firms, it does matter

for large firms. It follows then that our findings for the majority of firms in our sample are contrary to those of previous studies (e.g., Faulkender, 2005; Chava and Purnanandam, 2007; Disatnik et al., 2014; and Ippolito et al. 2018) and only partially consistent with these studies for very large firms. Our results are in line with the notion that larger firms have lower risk avoidance incentives because they in general have lower default risk (Brogaard et al., 2017) and therefore face lower financial distress costs (Warner, 1977). Froot et al. (1993) suggest that if external funds are more costly than internal funds then hedging could be value-enhancing, especially for financially constrained firms. If smaller firms are more financially constrained then they might conduct more hedging in order to avoid having to acquire costly external financing. Stulz (1996) points out that small firms possess more variable cash flows, less access to external capital and therefore stronger reasons to hedge to avoid financial distress. Our findings are consistent with the arguments of Froot et al. (1993) and Stulz (1996). In view of this, it could be argued that larger firms have not only a lower incentive to hedge but also an inclination to hedge less. Consistent with this we find that quartile sorts of swap usage based on firm size show that larger firms use interest rate swaps less intensely than small firms.

Recently a small but growing body of literature empirically examines the relationship between various manifestations of economic uncertainty and firm investment and financing decisions (for example, Kang et al., 2014; Bretscher et al., 2018). When a firm operates in a period of high economic policy uncertainty, its future projected cash flows may fall due to a decrease in investment (Kang et al., 2014). Furthermore, a change in government spending can also affect firms' cash flows.[4] Moreover, it can be difficult to predict the direction of any future change in the interest rate during a period of heightened economic policy uncertainty. Baker et al. (2016) show that economic policy uncertainty may lead to greater stock price volatility, which in turn may lead to greater default risk. We, therefore, investigate whether economic policy uncertainty affects the link between interest rate swap usage and firm default risk. Our results show that economic policy uncertainty does

[4] Ann Pettifor writing for The Guardian in March 2018 says, "There is growing consensus among economists that Osborne's post-crisis austerity programme deepened and lengthened Britain's post-crisis recession, causing public and private investment to fall further and real wages to decline. Making large reductions to government spending is itself a major reason why the economy has been so slow in recovering." https://www.theguardian.com/commentisfree/2018/mar/04/george-osborne-eliminating-current-deficit-austerity-terrible-cost-hubris.

not affect the negative impact of swapping into fixed rate debt on firms' default risk whereas it does dampen the effectiveness of swapping into floating rate debt in decreasing firms' probability of default. Therefore, swap direction seems to matter in periods of high economic policy uncertainty. To the best of our knowledge, this paper is the first to show this.

Finally, our paper is the first to show that there are monetary policy circumstances where the direction of interest rate swap usage does matter. We find that there is a noticeable change in how firms make use of interest rate swaps during the zero lower bound period compared to the rest of the sample period. Our data shows that there is a significant reduction in the level of swapping into floating rate debt and a large increase in the level of swapping into fixed rate debt by firms around the start of the zero lower bound period, with the difference in the levels of swapping into fixed and floating rate debt being maintained for the duration of this period. Moreover, we find that in periods when the base rate is high, using interest rate swaps can decrease a firm's likelihood of default whether firms are swapping into fixed or floating rate debt. However, during the zero lower bound period, we find, consistent with our a priori expectations, that swapping into floating rate debt does not decrease a firm's default risk, whereas swapping into fixed rate debt does. These findings are new and provide a significant contribution to the interest rate swaps and more generally the corporate hedging literature.

Overall, our findings contradict most of the existing results in the literature and suggest that the impact of swapping into floating on firm risk is not homogeneous across the UK and US. Given that our firms operate in the UK, where creditor rights are much stronger compared to the US, implying a greater risk of bankruptcy, it is reassuring for UK firms' stakeholders that we find for the overwhelming majority of firms that their credit risk decreases irrespective of the direction of an interest rate swap. Therefore, our results provide strong and robust support for an alternative narrative on the relationship between swapping into floating rate debt and firm risk. Furthermore, our finding suggests that a rethink on the efficacy of fair value hedging as purported by Disatnik et al. (2014) is warranted. It follows that our paper makes important contributions to the corporate hedging and debt structure literature.

The rest of this chapter is organised as follows. Section 2.2 reviews the related empirical literature. Section 2.3 describes our sample and methodology. Section 2.4

presents our empirical results of the impact of interest rate swaps direction on a firm's default risk. Finally, section 2.5 draws some conclusions.

2.2. Literature review

2.2.1. Overview of the corporate use of interest rate swaps

The literature on the corporate use of interest rate swaps is relatively scarce, which is surprising given that interest rate swaps are among the most heavily traded derivatives by volume.[5] A lot of this literature is subsumed in studies that investigate whether it is hedging (risk-reducing) or speculative (risk-increasing) motives that determine the interest rate structure of debt after the effect of interest rate swaps, that is the fixed-floating rate debt mix (e.g., Bodnar et al., 1998; Faulkender, 2005; Chava and Purnanandam, 2007; Chernenko and Faulkender, 2011; and Oberoi, 2018). For example, Bodnar et al. (1998) report that over half of firms responding to their survey on derivatives usage admitted to allowing their view of future interest rates to affect their interest rate derivative position in terms of direction, size or timing. Faulkender (2005) finds evidence suggesting that US firms in the chemical sector are timing the market with respect to the use of interest rate swaps and their final interest rate mix of debt. His results show that firms swapping into floating rate debt are doing so in response to movements in the yield spread, which is consistent with risk-increasing rather than hedging motives.

Chava and Purnanandam (2007) point out that floating rate debt can have a volatility-decreasing effect if a firm's before-interest operating cash flow is positively correlated with interest rates. Otherwise higher floating rate debt can increase the volatility of cash flow. They find that over 90% of sample firms with floating rate debt do not have a natural hedge with respect to the fluctuations in interest rates. Thus, for the majority of firms in their sample, floating rate debt leads to an increase in firm risk.[6] Chernenko and Faulkender (2011) find evidence suggesting that firms are using interest rate swaps to both reduce risk and increase risk. Ippolito et al. (2018) also present evidence that swapping into floating rate debt increases risk. Overall, there is overwhelming empirical support for the notion that

[5] BIS reports that the global notional amounts outstanding of interest rate swaps is equal to approximately 59 percent of the global notional amounts outstanding of all derivative contracts in the first half of 2018. Available at: https://stats.bis.org/statx/srs/table/d5.1

[6] Chava and Purnanandam (2007) do find that hedging considerations play a role in the debt structure choice for small financially distressed firms.

swap direction matters in the aforementioned studies with swapping into floating rate debt being a risk-increasing interest rate swap strategy for US non-financial firms.

Recent studies draw the distinction between fair value and cash flow hedging and their implication for cash flow volatility. For example, Disatnik et al. (2014) argue that cash flow hedging, which includes firms swapping from floating rate to fixed rate debt, can reduce the variability of a firm's cash flow, whereas fair value hedging, which is mostly composed of firms swapping from fixed rate to floating rate debt, cannot. Consistent with this idea, they find that because cash flow hedging reduces the likelihood of violating an existing cash-flow-based financial covenant, it reduces a firm's precautionary demand for cash, which therefore allows it to rely relatively more on bank lines of credit rather than cash holdings for its liquidity provision. According to Disatnik et al. (2014), this is value enhancing because it reduces the liquidity premium that the use of cash holdings entails. However, their argument that fair value hedging (or swapping to floating rate debt) increases the volatility of the firm's cash flow stream needs to be treated with some caution as it could be argued that this type of hedging can also hedge the firm's cash flows.

According to hedging theories (Smith and Stulz, 1985; and Froot et al., 1993), firms having the operating cash flows before interest expenses that are positively correlated with interest rates should possess higher (or swap to) floating rate debt to avoid the costs associated with low cash flow states. For this type of firm, when the interest rate goes up, the firm pays more in interest expenses but the firm also has more cash flow to pay the higher interest expenses.[7] Chernenko and Faulkender (2011) find evidence in support of this as they show that high-investment firms whose operational cash flows rise (fall) when interest rates increase (decrease) use more floating rate debt than high-investment firms whose cash flows have the reverse sensitivity to interest rates. In these circumstances swapping into floating rate debt (or fair value hedging) makes it more likely that internally generated cash flows will cover both the firm's interest expenses and its investment needs. This result is in line with the model of Froot et al. (1993), who demonstrate that firms may benefit from hedging if they face costly external financing and have valuable

[7] In the Appendix, we provide several examples of interest rate risk management disclosures in UK annual reports where swapping into floating rate debt or fair value hedging provides a cash flow hedging solution. In all cases, these firms are attempting to match the interest rate profile of their debt with their assets.

investment opportunities. Oberoi (2018) also recognises that a firm's value may be related to variations in the market rate of interest and acknowledges that the presence of debt can modify this exposure. So swapping into floating rate debt reduces cash flow variability for firms whose cash flows are positively correlated with interest rates.

Although Disatnik et al. (2014) do distinguish between fair value and cash flow hedging, they use the gross notional value of swap usage rather than the net value of swap usage for each type of hedging, such that values for both appear in the model specification. We would argue that when a firm uses both cash flow and fair value hedging, the impact of these hedging activities on a final outcome, such as its value or default risk, should be the result of the combined or net effects of both types of hedging. Therefore, we would argue that the most appropriate metric in this context is one that distinguishes between fair value and cash flow hedging in net terms. The above discussion pours some doubt over Disatnik et al.'s (2014) assertion that fair value hedging does not reduce the volatility of the firm's cash flow stream.

2.2.2. The corporate use of interest rates swaps and firms' probability of default

One of the key rationales for corporate hedging is the desire to reduce the likelihood of bankruptcy, which in turn decreases the expected costs of bankruptcy (Smith and Stulz, 1985; Froot et al., 1993; and Purnanandam, 2008). If financial derivatives are used for hedging they can lower the variability of a firm's cash flows and so reduce a firm's risk. A small but growing number of empirical studies have investigated the impact of the corporate use of derivatives on firms' risk (e.g., Guay, 1999b; Hentschel and Kothari, 2001; Nguyen and Faff, 2010; Bartram et al., 2011; and Bartram, 2019). All of these studies measure firm risk employing an asset pricing framework, which does not necessarily account for a firm's probability of default.

Merton (1974) is one of the first studies constructing a model that helps to calculate a firm's probability of default. In this model, the equity value of a firm is the value of a call option with the value of the firm being the underlying value and the face value of the firm's debt being the strike price. Merton (1974) proves that an increase in the asset volatility of a firm can increase the bonds' risk premium, which is mentioned as a measure of the probability of default in Black and Scholes (1973). Merton's (1974) model has been widely applied in both academic study and practice. For example, some empirical studies have computed their proxy for firms' probability of default

based on this model such as Campbell et al. (2008), Magee (2013), Schultz et al. (2017), and Gregory (2020). Among these studies, Magee (2013) has looked into the impact of derivatives on default risk. This study shows that firms using foreign currency derivatives more extensively possess lower default risk. However, it is not clear why Magee (2013) focuses only on foreign currency derivatives and does not include interest rate derivatives such as interest rate swaps since the latter would be expected to have a stronger impact on the firms' default risk.

In practice, Moody's Analytics (formerly Moody's KMV) has developed Merton's (1974) model to estimate the default probability of a firm. Moody's Analytics names its proxy of the default probability "Expected Default Frequency" (EDF). The EDF measures the likelihood that a company will fail to pay the interest and principal payments within a given period. Crouhy et al. (2000) suggest that EDFs have been shown to be useful indicators of default. They note that when the financial situation of a firm starts to deteriorate, EDFs tend to increase quickly until the default occurs. According to Crouhy et al. (2000), KMV has analysed more than 2,000 US firms that have defaulted or entered into bankruptcy. In all instances, KMV has shown a sharp increase in the slope of the EDF between 1 and 2 years prior to default. It is also noted by Crouhy et al. (2000) that changes in EDFs tend to anticipate by at least 1 year prior to a credit rating downgrade. Additionally, they point out that EDFs are not biased by periods of high or low defaults. Furthermore, Bharath and Shumway (2008) demonstrate that EDF performs well at forecasting corporate bankruptcies out of sample.

As discussed in Section 2.2.1, some empirical studies suggest that only swapping into fixed rate debt can reduce the firms' risk whereas swapping into floating rate debt cannot or even increase firms' risk (e.g., Faulkender, 2005; Disatnik et al., 2014; and Ippolito et al., 2018). Other empirical studies imply both swapping to fixed and swapping to floating rate debt can reduce firms' risk (e.g., Chernenko and Faulkender, 2011; and Oberoi, 2018). However, based on hedging theories, the use of interest rate swaps can reduce the volatility of the firm cash flow irrespective of the direction of the swaps if the firms use interest rate swaps for hedging purposes (e.g, Smith and Stulz, 1985). In essence, firms with negative (positive) cash flow interest rate beta should use swapping to fixed (floating) rate debt to reduce their cash flow risk. Given that the value of an asset can be calculated based on the discounted value of the cash flow generated from this asset, the fall in the volatility

of the firm cash flow can cause a decrease in the asset volatility. Merton (1974) and Black and Scholes (1973) mention that this decrease will reduce the bonds' risk premium and firms' probability of default. Consequently, we predict that both swapping into fixed and floating rate debt can reduce the firms' probability of default.

Firm size is seen as an important driver of the use of derivatives in general and interest rate swaps in particular, with most empirical studies reporting that large firms are more likely to use derivatives (e.g., Adam 2002), which is consistent with the economies of scale argument of derivative use. The extant literature on the use of financial derivatives focuses on whether large firms are more likely to hedge with derivatives. For example, using a relatively small survey sample, Geczy et al. (2007) find that frequent speculators are significantly larger than firms that sometimes speculate, but not significantly larger than firms that never speculate. In a multivariate setting, they report that frequent speculators and the firms that never speculate are significantly larger than the firms that sometimes take a view. What we do know from the extant survey evidence is that some large firms do use derivatives in ways that could be considered to be speculation. For example, in a survey of large global multinationals, Servaes et al. (2009) find that 48% of respondents actively take positions in currency markets based on a market view of exchange rates, and 52% of respondents actively take positions in interest rate markets based on a market view of interest rates. This line of literature suggests that large firms usually use financial derivatives to speculate the market. To the best of our knowledge, there is no evidence as to whether the impact of derivative use on firm risk varies with respect to firm size.

Recent papers have examined the real effects of economic policy uncertainty on firm investment and financing decisions (e.g., Kang et al., 2014; Bretscher et al., 2018). Economic policy uncertainty refers to uncertainty about "who will make economic policy decisions, what economic policy actions will be undertaken and when, and the economic effects of policy actions (or inaction) - including uncertainties related to the economic ramifications of "noneconomic" policy matters, for example, military actions" (Baker et al., 2016, page 1598). The model of Bernanke (1983) implies that the increase in long-term uncertainty can delay a firm's irreversible investment and therefore affecting its future projected cash flows. Kang et al (2014) also mention that economic policy uncertainty affects firms' cash flow.

Specifically, a firm operating in a period of heightened economic policy uncertainty can experience a decrease in its investment, which can lead to a fall in its future cash flow. Furthermore, it is arguable that predicting the direction of any future change in the interest rate is more difficult during periods of high economic policy uncertainty than during periods of low economic policy uncertainty. This line of arguments implies that economic policy uncertainty can affect the volatility of firms' cash flow and therefore can affect the firms' default risk (Merton, 1974). Baker et al. (2016) find that an increase in economic policy uncertainty is associated with an increase in the volatility of stock price, which can increase the variation of the stock return. This in turn can lead to a greater probability of default (Bharath and Shumway, 2008).

We predict that the effect of interest rate swap direction on firm default risk is affected by economic policy uncertainty. During a period of heightened economic policy uncertainty, a swapping into fixed rate debt strategy is potentially more valuable in terms of reducing default risk because it negates the additional cash flow risk. On the other hand, implementing a swapping into floating rate debt strategy when there is more economic policy uncertainty has the potential to be less effective in mitigating default risk because it increases cash flow risk for firms whose cash flows are not positively correlated with interest rates.

The literature on the use of financial derivatives in general and of interest rate swaps in particular has implied an assumption that the impact of these financial derivatives does not change over time (e.g., Guay, 1999b; Hentschel and Kothari, 2001; Nguyen and Faff, 2010; Disatnik et al., 2014; Bartram, 2019; and Anbil et al., 2019). We argue that this is not the case for the use of swapping into floating rate debt. This is because unlike other types of financial derivatives, swapping into floating rate debt is a useful tool to reduce the firms' risk only when the interest rate is not around 0 percent. When the interest rate is around 0 percent, there is no room for it to reduce, and therefore swapping into floating rate debt, which bets on the decrease of the interest rate, cannot be effective. As a result, we predict that the impact of swapping into fixed and floating rate debt on a firm's default risk is different over time, depending on the level of the prevailing interest rate.

2.3. Data, methodology, and variable construction

2.3.1. Data

This chapter examines the impact of the use of interest rate swaps on the default probability for a sample of UK listed non-financial companies between 2001 and 2015. Our sample starts in 2001 because FRS 13 has required UK firms to disclose narrative and numerical information explaining the role that financial instruments, such as interest rate swaps, played in creating or changing the risks that a firm faced in its activities from March 1999. We do not include the year of 1999 and 2000 because the number of observations in these two years is little. And our sample ends in 2015 in order to avoid the impact of the withdrawal of the UK from the European Union (Brexit) in 2016, which can make our estimation biased.

We focus on non-financial companies as financial companies such as banks or other financial institutions may have different underlying motives for using interest rate swaps compared to non-financial companies. For example, it is not unusual for financial companies to take speculative positions in derivatives, particularly in their proprietary trading. It follows then that the inclusion of financial firms in the sample could potentially bias our results. Following Chernenko and Faulkender (2011) we exclude from our sample observations that do not have any debt. In addition, we require that firms in our sample have available financial information from Capital IQ and stock prices from Datastream. Our final sample consists of 395 firms and 2,331 firm-year observations.

2.3.2. Methodology

We employ regression analysis to investigate the impacts of the use of interest rate swaps on the probability of default. We follow the extant literature on default risk (e.g., Shumway, 2001; Chava and Jarrow, 2004; and Campbell et al., 2008) to construct a model that includes some potential drivers of the probability of default to which we add our interest rate swaps use variables. Specifically, we run the following regression model to examine the impact of the corporate use of interest rate swaps on the firms' probability of default:

$$EDF_{i,t} = \beta_0 + \beta_1 SWAP_PROXY_{i,t} + \gamma CONTROL_{i,t} + \varepsilon_{i,t} \quad (2.1)$$

where i and t denote company i and time t, respectively. The dependent variable in our model is the expected default frequency (EDF) measured at the calendar year

end. SWAP_PROXY is a set of continuous variables for interest rate swap usage. Specifically, SWAP_PROXY in Equation 2.1 can be |SWAP_USAGE|, |SWAP_TO_FIXED|, or |SWAP_TO_FLOATING|. CONTROL is a set of control variables for Equation 2.1. Specifically, we control for firm size (FIRM_SIZE), leverage (LEVERAGE), profitability (PROFITABILITY), liquidity (LIQUIDITY), equity volatility (EQUITY_VOLATILITY), excess return (EXCESS_RETURN), and credit ratings (RATED). The definition of these variables will be presented in Section 2.3.3.

In this chapter, we also investigate the impact of interest rate uncertainty on the relationship between the firms' use of interest rate swaps and the probability of default. To do this, we need a proxy for interest rate uncertainty. The recent study of Istrefi and Mouabbi (2018) measures long-term interest rate uncertainty based on professional forecasts of long-term interest rates that account for both disagreement among forecasters and the perceived volatility of future aggregate shocks. A higher value for this measure is associated with a higher level of interest rate uncertainty. Our proxy for interest rate uncertainty is sourced from Istrefi and Mouabbi (2018). To examine whether the interest rate uncertainty affects the impact of interest rate swap direction on firm default risk, we interact our swap usage variables with our proxy for interest rate uncertainty (IRU). Specifically, we run the following regressions:

$$EDF_{i,t} = \beta_0 + \beta_1 SWAP_PROXY_{i,t} + \beta_2 SWAP_PROXY_{i,t} * (IRU_t - \overline{IRU}) + \gamma CONTROL_{i,t} + \varepsilon_{i,t} \quad (2.2)$$

where i and t denote company i and time t, respectively. EDF is expected default frequency. SWAP_PROXY in Equation 2.2 can be either |SWAP_TO_FIXED| or |SWAP_TO_FLOATING|. IRU is the proxy for interest rate uncertainty. We do not include IRU in our specification because it will be dropped when we have year dummy fixed effects. $\overline{IRU}$ is the sample mean of IRU. We interact the swap usage variables with (IRU - $\overline{IRU}$) in Equation 2.2. CONTROL is a set of control variables that is similar to Equation 2.1. In this equation, β_1 measures the relationship between the firm's swap usage and the probability of default at the sample mean of IRU, and β_2 assesses the impact of the firm's swap usage at different levels of IRU.

To examine the impact of economic policy uncertainty on the relationship between the firms' use of interest rate swaps and the probability of default, we estimate the following regression:

$$EDF_{i,t} = \beta_0 + \beta_1 SWAP_PROXY_{i,t} + \beta_2 SWAP_PROXY_{i,t} * (EPU_t - \overline{EPU}) + \gamma CONTROL_{i,t} + \varepsilon_{i,t} \quad (2.3)$$

where i and t denote company i and time t. EDF is expected default frequency. SWAP_PROXY in Equation 2.3 can be either |SWAP_TO_FIXED| or |SWAP_TO_FLOATING|. EPU is the proxy for economic policy uncertainty. It is constructed based on the method of Baker et al. (2016).[8] A high level of this proxy is associated with a high level of economic policy uncertainty. We do not include this variable in our specification because it will be dropped when we have year dummy fixed effects. $\overline{EPU}$ is the sample mean of EPU. We interact the swap usage variables with (EPU - $\overline{EPU}$) in Equation 2.3. CONTROL is a set of control variables that is similar to Equation 2.1. In this equation, β_1 measures the relationship between the firm's swap usage and the probability of default at the sample mean of EPU and β_2 assesses the impact of the firm's swap usage at different levels of EPU.

The final test of this chapter is to study the impact of interest rate swaps during the zero lower bound period. The Bank of England base rate decreased substantially from 5.25% in February 2008 to 0.5% in March 2009 and then remaining at this level for the rest of the period in our sample. We create a dummy variable POST that equals 1 for the period from 2009 to 2015 and zero otherwise, and run the following regression to investigate the effects of interest rate swaps on firms' default risk during the zero lower bound period:

$$EDF_{i,t} = \beta_0 + \beta_1 SWAP_PROXY_{i,t} + \beta_2 SWAP_PROXY_{i,t} * POST_t + \gamma CONTROL_{i,t} + \varepsilon_{i,t} \quad (2.4)$$

where i indexes firm i and t indexes time t, respectively. EDF is expected default frequency. SWAP_PROXY in Equation 2.4 can be either |SWAP_TO_FIXED| or |SWAP_TO_FLOATING|. CONTROL is a set of control variables that is similar to Equation 1. In Equation 2.4, β_1 measures the relationship between the firm's swap usage and the probability of default for the period that is prior to the zero lower bound period and β_2 assesses the impact of the firm's swap usage for the zero lower bound period.

[8] The variable EPU is sourced from the following website: http://www.policyuncertainty.com/index.html. This website provides monthly EPU data for the UK. We take the average of the monthly data over a year to arrive at a yearly figure for EPU.

2.3.3. Variable construction

2.3.3.1. Probability of default

In this chapter, we use a firm's expected default frequency to proxy for the probability of default. We source this data from Moody's Analytics (formerly Moody's KMV).[9] A higher value of this proxy suggests a greater probability that a company will fail to pay the interest and principal payments within a given period. Employing EDFs has advantages in predicting the probability of default. Crossen et al. (2011) mention that the predicting power of EDFs is not affected significantly by different credit cycles. This helps to enhance the validity of our results because our data covers a rather long period from 2001 to 2015, which includes the global financial crisis of 2007 to 2008. Korablev and Dwyer (2007) show that the predicting power of EDFs is much better than rating-based default prediction over the period from 2001 to 2006. Finally, Berndt et al. (2018) point out that another advantage of EDFs is that they are readily available for a large number of public firms, including UK listed companies, and they are robust to model misspecification.

2.3.3.2. Interest rate swap variables

We use data hand-collected from annual reports and data sourced from the S&P Capital IQ database to measure the extent of interest rate swap usage.[10] As mentioned in Section 2.3.1, FRS 13, which entered into force in March 1999, required firms to disclose narrative and numerical information explaining the role that financial instruments, such as interest rate swaps, played in creating or changing the risks that a firm faced in its activities. As a result of this standard, UK firms have disclosed in their annual reports the interest rate structure of debt after the effect of interest rate derivatives. This enables us to calculate the percentage of fixed or floating rate debt after the effects of firms' derivatives activities such as interest rate and cross-currency swaps. In the vast majority of cases, the derivative in question is the interest rate swap. We also source data on the percentage of fixed and floating rate debt from the CAPIQ database. The CAPIQ database reports a firm's interest rate structure of debt before the effects of interest rate swaps.[11] We can use the

[9] Details on how a firm's expected default frequency is calculated can be obtained from Bohn and Crosbie (2003).

[10] Based on the annual reports, we are also able to identify whether firms use interest rate swaps or not.

[11] Data analysts at CAPIQ have confirmed this.

CAPIQ and annual report data to calculate for each firm the proportion of debt that is swapped to a floating rate by taking the difference between the final floating rate debt percentage (after the effects of interest rate swaps) and the initial floating rate debt percentage (before the effects of interest rate swaps). We call this variable swap usage.[12] A firm's swap usage value will be positive if it swaps more of its debt into floating than fixed rate (net swap to floating), will be negative if it swaps more into fixed than floating rate (net swap to fixed) and will be zero if the firm does not use interest rate swaps.

Based on the actual values of the swap usage variable we go on to construct three continuous variables, which measure the extent of interest rate swap usage. The first variable is the absolute value of swap usage, which measures the extent of interest rate swap usage irrespective of swap direction (|SWAP_USAGE|). The second (third) variable is equal to the absolute value of swap usage but only for those firms that are in net terms swapping to floating (fixed) rate debt and non-swap users. We call this variable |SWAP_TO_FLOATING| (|SWAP_TO_FIXED|). For example, if a company has the final and initial floating rate debt of 60% and 40%, respectively, it follows that in this case the proportion of debt that is swapped into floating rate is 20% (final floating 60% - initial floating 40%). Thus, its |SWAP_USAGE| will be 20% and |SWAP_TO_FLOATING| will also be 20%. In contrast, if a company has final and initial floating rate debt of 40% and 60%, respectively, its proportion of debt that is swapped into floating rate is -20% (final floating 40% – initial floating 60%). In this case, its |SWAP_USAGE| will be 20% and |SWAP_TO_FIXED| will also be 20%.[13] Our measures of interest rate swap usage allow us to examine the link between the extent of interest rate swaps use and the likelihood of default and also permits the use of alternative econometric modelling techniques.

[12] Swap Usage = Final Floating % - Initial Floating %

[13] In effect, our measure of the extent of interest rate swap usage is no different from those employed in Chernenko and Faulkender (2011) and Bretscher et al. (2018). In these studies, the authors calculate interest rate swap usage directly, by dividing the net floating swap notional amount by the total debt outstanding at the end of the fiscal year. Interest rate swap usage takes values between -1 or -100% (all debt swapped to fixed) and +1 or +100% (all debt swapped to floating). If the swap usage percentage is added to the initial floating rate debt percentage one can arrive at the proportion of the firm's debt that is floating after accounting for interest rate swaps (i.e. initial floating% + swap usage% = final floating%). In this chapter, we calculate interest rate swap usage indirectly by taking the difference between final floating% and initial floating%.

2.3.3.3. Control variables

We follow Shumway (2001), Chava and Jarrow (2004) and Campbell et al. (2008) to use a set of control variables in our regression model, including firm size, leverage, profitability, liquidity, equity volatility, excess return, and credit rating. Firm size is the natural logarithm of the market value of total assets (in $million). Leverage is calculated as the total debt divided to the market value of total assets. Profitability is computed by dividing the earnings before interest and taxes (EBIT) by the book value of total assets. Liquidity is the ratio of cash and cash equivalent over total assets. Excess return is measured as the difference between the stock's annual return and the value weighted FTSE all shares index annual return. Finally, credit rating is a dummy variable that equals 1 if the firm has a long-term credit rating and 0 otherwise.

Except for the extent of interest rate swap usage variables, we winsorise all continuous variables at the 1st and 99th percentiles to remove the impact of outliers.[14] In addition, we include year dummies to control for common shocks overtime to the probability of default for all firms and industry dummies to control for industry effects in the model. Standard errors are corrected for heteroskedasticity and are clustered at the firm level. The definitions of all variables used in our study are provided in Table 2.1.

[14] Based on the construction of our extent of interest rate swap usage variables, they are bounded between 0% and 100%. As a result, it is unnecessary to winsorise these variables. However, our results do not change if we winsorise these variables at the 1st and 99th percentiles.

Table 2.1: Variable definition

This table provides the definition of the variables used in this study.

Variable	Definition	Data sources
EDF	Expected default frequency	Moody's Analytics
|SWAP_USAGE|	Calculated as the absolute value of the difference between the final floating rate debt percentage and the initial floating rate debt percentage.	Annual report and CAPIQ
|SWAP_TO_FLOATING|	Calculated as the absolute value of the swap usage variable but only for those firms that are in net terms swapping to floating and non-swap users.	Annual report and CAPIQ
|SWAP_TO_FIXED|	Calculated as the absolute value of the swap usage variable but only for those firms that are in net terms swapping to fixed and non-swap users.	Annual report and CAPIQ
FIRM_SIZE	Natural logarithm of market value of assets (in million $).	CAPIQ
LEVERAGE	Calculated as the ratio of total debt to market value of assets.	CAPIQ
PROFITABILITY	Calculated as the ratio of EBIT over total assets.	CAPIQ
LIQUIDITY	Calculated as the ratio of cash and cash equivalent over total assets.	CAPIQ
EQUITY_VOLATILITY	The annualised standard deviation of monthly stock returns over the prior twelve months.	CAPIQ
EXCESS_RETURN	Calculated as the difference between the stock's annual return and the value weighted FTSE all shares index annual return over the same period.	Datastream

RATED	Dummy variable that is equal 1 if the firm has long-term credit rating.	CAPIQ
IRU	Interest rate uncertainty.	Istrefi and Mouabbi (2018)
EPU	Economic policy uncertainty.	Baker et al. (2016)
GDP_GROWTH	Annual percentage growth rate of Gross Domestic Product in UK	World Bank

2.4. Empirical results

2.4.1. Summary statistics of interest rate swap usage

In panel A of Table 2.2, we present summary statistics of the data on the percentage of initial and final floating rated debt for the sample consisting of all companies that we have information of the floating rate debt from either CAPIQ database or the annual reports.

Table 2.2: Floating rate debt and interest rate swap usage by UK firms

This table provides summary statistics for floating-rate debt and interest rate swap usage by UK listed non-financial firms between 2001 and 2015. Panel A reports summary statistics of the data on the percentage of initial and final floating-rate debt for the sample consisting of all companies that we have information of the floating rate debt from either CAPIQ database or the annual reports. Initial floating-rate debt and final floating-rate debt are the percentages of outstanding debt that is floating before and after accounting for the effect of interest rate swaps, respectively. The former is sourced from the CAPIQ database and the latter is hand-collected from annual reports. Panel B reports summary statistics of the data on the percentage of initial and final floating rate debt for the sample including companies that we have information of the floating rate debt from both CAPIQ database and the annual reports. Swap usage is calculated by deducting final floating-rate debt from initial floating-rate debt. Panel C reports summary statistics for those firms that use interest rate swaps at least once during our sample period. Swap users are firms that report to use interest rate swaps at least once during the sample period. Panel D reports the mean of swap usage and its absolute value according to firm size. In each year, we assign our sample of interest rate swap users to firm size quartiles using the market value of assets as our measure of firm size. By construction, the variable "Q1" comprises the smallest 25 percent of firms that use interest rate swaps and the variable "Q4" comprises the largest 25 percent of firms that indicate they use interest rate swaps.

Variable	N	Mean	Median	Std. Dev.	Min	Max
Panel A: Full sample						
Initial floating-rate debt (%)	1,944	57.66	70.33	41.53	0.00	100.0
Final floating-rate debt (%)	2,121	58.64	59.00	37.68	0.00	100.0
Panel B: Matched sample						
Initial floating-rate debt (%)	1,819	58.33	72.08	41.17	0.00	100.0
Final floating-rate debt (%)	1,819	57.44	57.00	37.48	0.00	100.0
Swap usage (%)	1,819	-0.89	0.000	40.54	-100.0	100.0
|Swap usage| (%)	1,819	25.58	9.13	31.47	0.00	100.0
Panel C: Swap users						
Initial floating-rate debt (%)	1,678	56.43	63.40	40.94	0.00	100.0
Final floating-rate debt (%)	1,678	56.10	54.17	36.77	0.00	100.0
Swap usage (%)	1,678	-0.33	>0.00	41.51	-100.0	100.0
|Swap usage| (%)	1,678	26.96	12.26	31.56	0.00	100.0

Panel D: Quartile sorts of swap usage based on firm size		
	Swap usage (%mean)	|Swap usage| (%mean)
Q1	-14.17	33.07
Q2	-4.95	31.65
Q3	7.60	31.27
Q4	20.88	26.55
Q1 - Q4	-35.06***	6.52**

From the CAPIQ database, we are able to source the percentage of initial floating rate debt for 1,944 firm-year observations and find that the mean percentage of

initial floating rate debt over our sample period is 57.66 percent. From annual reports, we have 2,121 firm-year observations for which we are able to calculate the percentage of final floating rate debt. For this sample, the mean is slightly higher at 58.64 percent. A more meaningful comparison would be for those firms for which we have both the CAPIQ and annual report floating rate debt data. In panel B, we report summary statistics of the data on the percentage of initial and final floating rate debt for the sample including companies that we have information of the floating rate debt from both CAPIQ database and the annual reports. Panel B shows that we have this data for 1,819 firm-year observations with a mean (median) level of initial floating rate debt of 58.33 percent (72.08 percent) and a mean (median) level of final floating rate debt of 57.44 percent (57.00 percent). Chava and Purnanandam (2007) report similar percentages of 58 percent for initial floating rate debt and 57 percent for final floating rate debt for their sample of US firms for the fiscal year 1996/1997. Chernenko and Faulkender (2011) for US firms over the period 1993 to 2003 report much lower figures of 41.6 percent for initial floating rate debt and 38.3 percent for final floating rate debt.

For each firm we take the difference between the final floating rate debt and initial floating rate debt to determine the percentage of debt that is swapped to floating. For our sample, the average proportion of debt that is swapped into floating rate is -0.89 percent, which suggests that firms in our sample are on average swapping into fixed rate debt. The corresponding figure in Chernenko and Faulkender's (2011) sample is -3.4 percent, indicating that their firms are also on average swapping into fixed. Chava and Purnanandam (2007) report a figure of -1 percent for their sample. If we ignore the direction of the swap and focus on the absolute amount swapped, we find that for our sample the average proportion of debt that is swapped is 25.58 percent.

In panel C, we present summary statistics for those firms that use interest rate swaps at least once during our sample period. Panel C shows that the average of the absolute amount swapped is 26.96 percent of a firm's debt.[15] This level of swap usage is around 4 times larger than the corresponding figure of 6.9 percent reported by Bretscher et al. (2018) for their sample and over 2 times bigger than the 12.3

[15] This is higher than the corresponding number in Panel B because we have fewer firm-year observations of interest rate swap non-users in Panel C.

percent in Chernenko and Faulkender's (2011) sample.[16] Firms in our sample are on average swapping 0.33 percent of their debt into fixed. US firms also have on average a preference for swapping into fixed as shown by Chernenko and Faulkender (2011) and Bretscher et al. (2018) who report figures of 6.1 percent and 1.7 percent, respectively. The standard deviation of swap usage in our sample is 31 percent compared to 21 percent in Chernenko and Faulkender (2011) and only 16 percent in Bretscher et al. (2018). This suggests that there is much more variation across firms and over time in the direction and amount of swap usage amongst UK firms than the US counterparts.

If we ignore the Chava and Purnanandam (2007) data, as it is only sourced from one year, another point of significant difference is that UK firms possess substantially larger levels of floating rate debt whether it is measured by initial or final floating-rate debt. For example, in our sample, on average the final floating-rate debt is 56.1 percent, compared to 35.8 percent for US firms in the Bretscher et al. (2018) sample and 36.8 percent in the Chernenko and Faulkender (2011) sample. Ippolito et al. (2018) employ a sample of US firms from 2003 to 2008 and find that the initial floating-rate debt represents on average 38.3 percent of total debt, which they suggest is a large amount of floating rate debt. The corresponding figure in our sample is much larger at 56.43 percent.[17]

In Panel D, we sort the percent amount swapped into floating into size quartiles. Specifically, in each year we assign our sample of interest rate swap users to firm size quartiles using the market value of assets as our measure of firm size. By construction, the variable "Q1" comprises the smallest 25 percent of firms that use interest rate swaps and the variable "Q4" comprises the largest 25 percent of firms that indicate they use interest rate swaps. Our results show that small firms tend to be fixed rate payers and swap on average 14.17 percent of their debt into fixed rate. This figure is more than the 8.1 percent reported by Bretscher et al. (2018) for their

[16] If we restrict our sample to firm years in which an interest rate swap is used, the average swap is equivalent to 31.5 percent of a firm's debt, which is still larger than the corresponding average swap size of 25.7 percent in Chernenko and Faulkender (2011).

[17] The reason we find high percentages of floating rate debt for UK firms is because on average bank debt financing is the dominant source of debt capital used by UK firms and this type of debt tends to be tied to floating rate indices. Like Chernenko and Faulkender (2011) and Bretscher et al. (2018), we study relatively large firms (compared to the size distribution of listed firms in the UK) and so this feature of our data is not driven by the size of the sample firms. For our sample, CAPIQ data shows that bank debt as a fraction of total debt is on average 64 percent whereas bond debt makes up on average only 24 percent of balance sheet debt. Corresponding figures for large US firms will very likely be the other way round.

smallest firms. However, large firms in our sample tend to be floating rate payers who swap on average 20.88 percent of their debt into floating rate. This difference between small and large firms is statistically significant. Large firms in the Bretscher et al. (2018) sample also tend to be floating-rate payers, however, they swap on average only 2.7 percent of their initial exposure.[18] Panel D also shows that the absolute amount of swapping by small firms is significantly higher than large firms, and similarly Bretscher et al. (2018) also report that smaller firms have greater swap usage. Bretscher et al. (2018) suggest that this shows that small firms hedge more in absolute terms. In summary, compared to data for the US, the proportion of firms using interest rate swaps is higher in the UK, firms in the UK have substantially higher levels of both initial and final floating rate debt, the magnitude of interest rate of swap usage is higher in the UK, and there is far more variation in the impact of swap usage on firms' interest rate structure of debt. This makes the UK an extremely interesting setting for examining the impact of interest rate swap use on the probability of default.

2.4.2. Descriptive Statistics

Table 2.3 provides descriptive statistics for all variables employed in our analysis. The average default probability (EDF) is 1.512 percent and the median value is 0.646 percent. The corresponding values for Brogaard et al.'s (2017) sample of US firms are 6.19 percent and 0 percent. However, their EDF data is highly skewed with a maximum value of 100 percent. Comparing medians, firms in the UK seem to possess higher default probabilities, notwithstanding the fact that there are likely to be subtle differences between the structural models used to calculate the EDFs.[19] Table 2.3 also shows that the average of the absolute value of the extent of interest rate swap usage for firms in our sample is 14.90 percent.[20]

[18] These features of the data across the size distribution for our sample and that of Bretscher et al. (2018) are not unexpected since large firms tend to finance mostly fixed rate and swap into floating rate whereas small firms in the main do the opposite.

[19] A comparison is potentially meaningful because our sample period falls within the Brogaard et al. (2017) period and both sample periods include the financial crisis years from 2007 to 2009.

[20] The mean value of swap usage reported in Table 2.3 is lower than that reported in Table 2.2 because the sample in Table 2.3 includes more non-uses of interest rate swaps, who by definition have a swap usage equal to zero.

Table 2.3: Summary statistics

This table shows the summary statistics for the variables used in the regression analysis. The sample consists of UK listed non-financial companies between 2001 and 2015. EDF is the expected default frequency. |SWAP_USAGE| is calculated as the absolute value of the difference between the final floating rate debt percentage and the initial floating rate debt percentage. |SWAP_TO_FLOATING| is calculated as the absolute value of the swap usage variable but only for those firms that are in net terms swapping to floating and non-swap users. |SWAP_TO_FIXED| is calculated as the absolute value of the swap usage variable but only for those firms that are in net terms swapping to fixed and non-swap users. FIRM_SIZE is the natural logarithm of the market value of assets (in million $). LEVERAGE is calculated as the ratio of total debt to the market value of assets. PROFITABILITY is calculated as the ratio of EBIT over total assets. LIQUIDITY is calculated as the ratio of cash and cash equivalent over total assets. EQUITY_VOLATILITY is the annualised standard deviation of monthly stock returns over the prior twelve months. EXCESS_RETURN is calculated as the difference between the stock's annual return and the value weighted FTSE all shares index annual return over the same period. RATED is a dummy variable that is equal to 1 if the firm has long-term credit rating. The continuous variable, except the absolute value of swap variables, are winsorised at the 1st and 99th percentile.

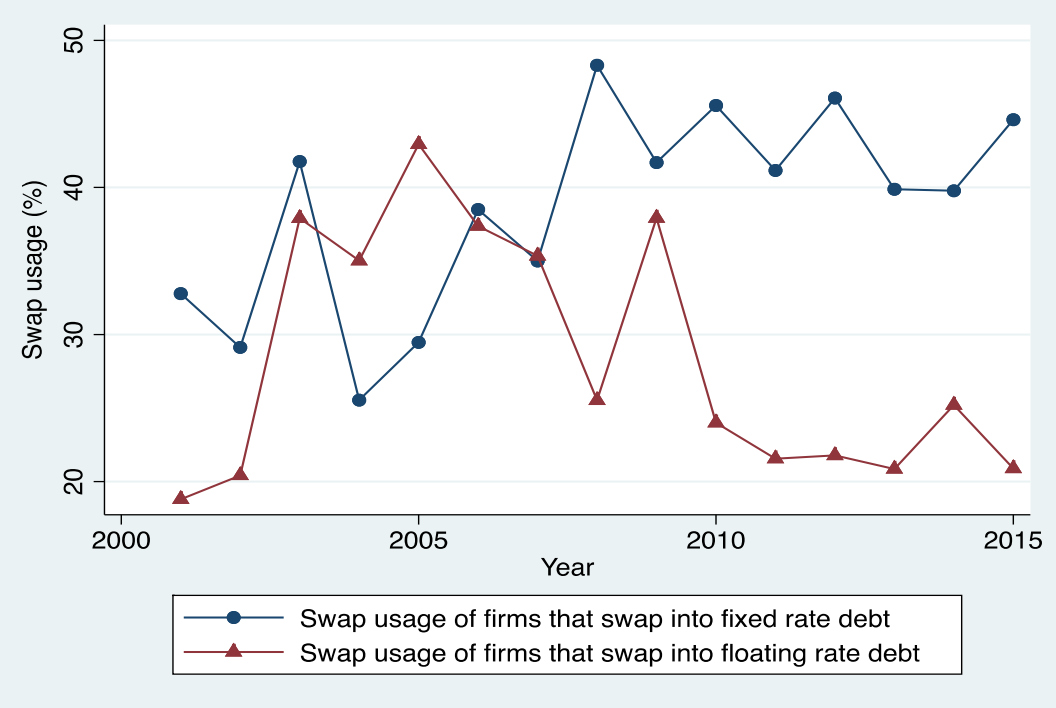
Variable	Obs	Mean	Median	Std. Dev.	Min	Max
EDF (%)	2,331	1.512	0.646	2.308	0.070	14.417
|SWAP_USAGE| (%)	2,331	14.901	0.000	26.357	0.000	100.000
|SWAP_TO_FLOATING| (%)	1,881	9.114	0.000	21.589	0.000	100.000
|SWAP_TO_FIXED| (%)	1,725	10.198	0.000	22.720	0.000	100.000
FIRM_SIZE	2,331	6.631	6.516	1.631	3.022	11.492
LEVERAGE	2,331	0.226	0.190	0.190	0.0003	0.882
PROFITABILITY	2,331	0.081	0.082	0.086	-0.341	0.307
LIQUIDITY	2,331	0.093	0.065	0.091	0.001	0.489
EQUITY_VOLATILITY (%)	2,331	37.130	30.691	21.496	13.356	152.266
EXCESS_RETURN (%)	2,331	7.242	3.320	42.797	-81.620	181.000
RATED	2,331	0.187	0.000	0.387	0.000	1.000

Table 2.3 shows that the mean value for firm leverage is 22.6 percent, which is slightly lower than the corresponding value of 25.5 percent reported by Bartram et al. (2011) for their sample of firms. The minimum and maximum values for our sample firms' profitability are -34.1 percent and 30.7 percent, suggesting the existence of both loss-making and very profitable firms in our sample. On average firms in our sample have higher returns than the FTSE all shares market during the sample period. The average value of liquidity for our sample is 0.093 with a median value of 0.065.

In Figure 2.1, we plot the time series profile of our extent of swap usage variables for firms that are swapping into fixed rate debt and those that are swapping into floating rate debt.[21]

Figure 2.1: Swap usage of interest rate swap users

This figure plots the swap usage of firms that swap into fixed rate debt and firm that swap into floating rate debt in our sample. Data are yearly and cover the period from 2001 to 2015.



From 2001 through to 2007, we do not observe any clear trend in the extent and direction in which firms are swapping. During this period, we observe some years where there is more swapping into fixed rate debt and in other years it is the opposite. A pattern seems to emerge from 2008 with the extent to which firms were

[21] Firms that do not use interest rate swaps and hence whose extent of swap usage is zero percent are excluded from this analysis.

swapping into fixed rate debt going up to nearly 50% from 35% and simultaneously the extent to which firms were swapping into floating rate debt dropping from 35% to 26%. In 2009, we see a convergence in the extent and direction firms are swapping with the average level of swapping to fixed rate debt dropping to 42% and the corresponding average for firms swapping to floating rate debt rising to 38%. The rise in the level of swapping into floating rate debt during this year partly reflects the surge in bond market issuance by UK firms in the early part of 2009, with many large firms issuing fixed rate bonds and subsequently swapping into floating interest rate at this time. After 2009, we observe a sharp decline in the extent to which firms are swapping into floating rate debt with the average dropping to 24% in 2010 and settling a little below this level for the remaining years of our sample period. For firms swapping into fixed rate debt, we see that the average swap usage picks up a little in 2010 to 46% and then averages around 42% through to 2015.

Although we measure swap usage in relative terms and Bretscher et al. (2018) measure in absolute terms, there does seem to be some similarity in the movements of our swap usage series for UK firms and for US firms.[22] For example, in our series swapping into floating rate debt (fair value swaps) is on a general upward trend from 2001 to 2005. The corresponding data for Bretscher et al. (2018) is also on an upward trajectory during this period, peaking a year earlier in 2004. Swapping into fixed rate debt hits a low point in 2004 and peaks in 2008 as does the corresponding series in Bretscher et al. (2018). Around the same time, swapping into floating rate debt charts a downward trajectory in both our series and that of Bretscher et al.'s (2018). Swapping into floating rate debt rebounds in 2009 whereas swapping into fixed rate debt falls in both the UK and US. After 2009, the similarity between our swap usage series and that of Bretscher et al. (2018) ends. In the US, from 2010, absolute levels of swapping into fixed and floating rate debt are on a downward trend and tend to track each other with swapping into floating rate debt falling slightly faster than swapping into fixed rate debt. In our series for the UK, we observe close to a 40% drop in the level of swapping into floating rate debt in 2010 and then staying at this level for the rest of the period. Levels of swapping into fixed rate debt are quite stable during this period, averaging around 43% of total debt. In

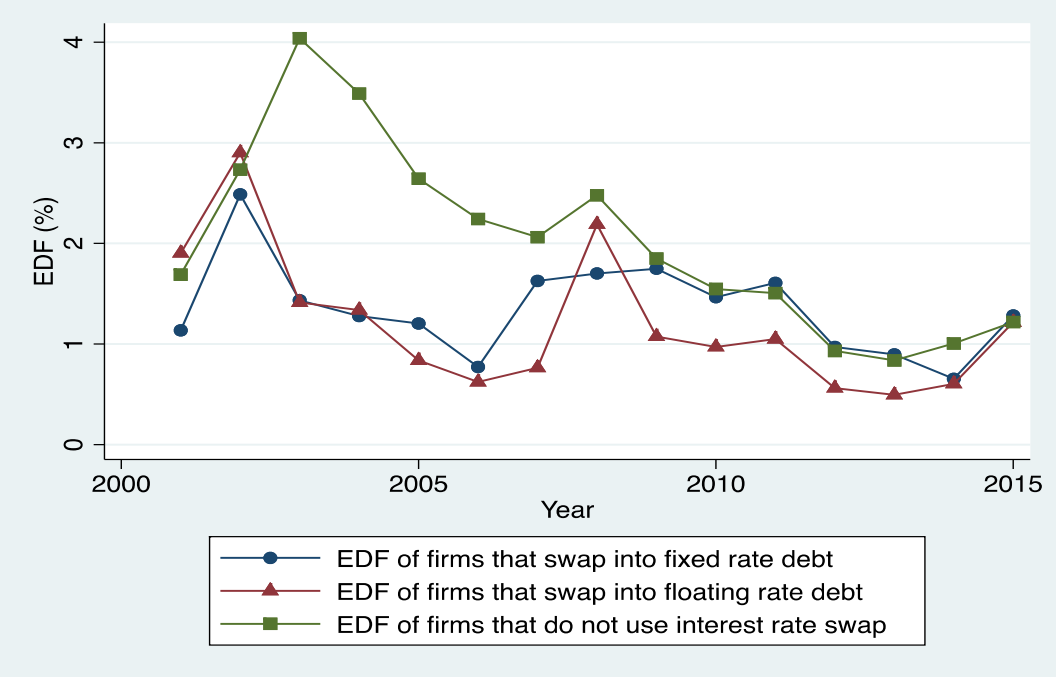
[22] See Figure 3 page 3030 in Bretscher et al. (2018).

conclusion, there is a clear divergence in the direction firms are swapping in the UK compared to the US during the latter half of our sample period.

Figure 2.2 plots the average EDFs of users and non-users of interest rate swaps. For users of interest rate swaps, we distinguish between firms swapping into fixed rate debt and those swapping into floating rate debt and present separate EDF time series profiles for each type of interest rate swap user.

Figure 2.2: Expected default frequency of firms

This figure plots the expected default frequencies of firms that swap into fixed rate debt, of firms that swap into floating rate debt, and of firms that do not use interest rate swap in our sample. Data are yearly and cover the period from 2001 to 2015.



In 11 out of 15 years, firms swapping into fixed rate debt have higher EDFs than firms swapping into floating rate debt. However, in unreported analysis the differences over time are statistically significant in only 3 out of 15 years, suggesting that there is very little difference in the credit risk between these swap users at a univariate level. In 9 years, non-users of interest rate swaps have higher EDFs than users, providing some support for the notion that firms are using interest rate swaps, regardless of direction, for risk reduction.[23] Interestingly, the time series variation in EDFs is greatest for non-users of interest rate swaps, followed by firms that swap into floating, with firms swapping into fixed exhibiting the lowest degree of variation in EDFs over time. In 2008, we observe a sharp increase in the EDFs of

[23] It should be noted that we have not controlled for other factors that might impact EDFs.

firms swapping into floating rate debt and non-users but hardly any change in the EDFs of firms swapping into fixed rate debt.

2.4.3. Multivariate results

Table 2.4 reports the regression results of Equation 2.1. In column 1, we use the absolute amount of the extent of interest rate swap usage, which includes both firms swapping into fixed and floating rate debt. This variable measures the magnitude of interest rate swap usage. The coefficient on the interest rate swap usage variable is negative and significant at the one percent level, suggesting that a higher level of swap usage, irrespective of swap direction, generates a larger reduction in the probability of default. In economic terms, a one standard deviation increase in the absolute amount of the extent of interest rate swap usage on average reduces firms' probability of default by approximately 12 percent.[24] Since there are default cycles within industries, we include variables that are generated by the interaction of industry and year dummy variables to control for industry-year fixed effects. The results are reported in column 2 and are similar to those in column 1.

[24] 12% = 26.357*0.006/1.367*100%, where 26.357 is one standard deviation of |SWAP_USAGE|, 0.006 is the absolute value of the coefficient on |SWAP_USAGE| in column 1 of Table 2.4, and 1.367 is the mean of EDF in our sample.

Table 2.4: The impact of interest rate swap usage on firms' probability of default

This table presents the results of the impact of interest rate swaps, which are proxied by the extent of using interest rate swap usage, on the probability of default. The sample consists of UK listed non-financial companies between 2001 and 2015. The dependent variable is EDF, which is the expected default frequency. |SWAP_USAGE| is calculated as the absolute value of the difference between the final floating rate debt percentage and the initial floating rate debt percentage. |SWAP_TO_FLOATING| is calculated as the absolute value of the swap usage variable but only for those firms that are in net terms swapping to floating and non-swap users. |SWAP_TO_FIXED| is calculated as the absolute value of the swap usage variable but only for those firms that are in net terms swapping to fixed and non-swap users. FIRM_SIZE is the natural logarithm of the market value of assets (in million $). LEVERAGE is calculated as the ratio of total debt to the market value of assets. PROFITABILITY is calculated as the ratio of EBIT over total assets. LIQUIDITY is calculated as the ratio of cash and cash equivalent over total assets. EQUITY_VOLATILITY is the annualised standard deviation of monthly stock returns over the prior twelve months. EXCESS_RETURN is calculated as the difference between the stock's annual return and the value weighted FTSE all shares index annual return over the same period. RATED is a dummy variable that is equal to 1 if the firm has long-term credit rating. The standard errors, reported in parentheses, are adjusted for heteroskedasticity and clustering at the firm level. ***, **, * denote significance at the 1%, 5%, or 10% levels, respectively. The regressions include industry and year dummy variables in columns 1, 3, and 5 and include the interactions of industry and year dummy variables in columns 2, 4, and 6, respectively.

	Dependent variable: EDF					
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
|SWAP_USAGE|	-0.006***	-0.005***				
	(0.002)	(0.001)				
|SWAP_TO_FLOATING|			-0.005***	-0.005**		
			(0.002)	(0.002)		
|SWAP_TO_FIXED|					-0.008***	-0.007***
					(0.002)	(0.002)
FIRM_SIZE	-0.456***	-0.459***	-0.470***	-0.468***	-0.524***	-0.526***
	(0.054)	(0.057)	(0.061)	(0.064)	(0.067)	(0.071)
LEVERAGE	3.353***	3.201***	3.796***	3.625***	3.607***	3.479***
	(0.442)	(0.447)	(0.526)	(0.533)	(0.515)	(0.517)
PROFITABILITY	-2.898***	-2.764***	-3.090***	-2.980***	-3.106***	-3.086***
	(0.805)	(0.865)	(0.843)	(0.920)	(0.957)	(1.021)
LIQUIDITY	1.052*	0.794	0.975	0.739	0.791	0.500
	(0.598)	(0.601)	(0.644)	(0.653)	(0.667)	(0.679)

EQUITY_VOLATILITY	0.041***	0.040***	0.037***	0.036***	0.040***	0.039***
	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)	(0.005)
EXCESS_RETURN	-0.006***	-0.006***	-0.006***	-0.006***	-0.006***	-0.006***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
RATED	0.413**	0.445**	0.407**	0.439**	0.094	0.085
	(0.185)	(0.178)	(0.204)	(0.195)	(0.229)	(0.228)
Constant	4.658**	7.207***	4.756**	7.412***	10.404***	1.635***
	(2.346)	(0.689)	(2.349)	(0.780)	(0.572)	(0.390)
Observations	2,331	2,331	1,881	1,881	1,725	1,725
Industry FE	YES		YES		YES	
Year FE	YES		YES		YES	
Industry x Year FE		YES		YES		YES
R-squared	0.649	0.672	0.656	0.678	0.671	0.690

We are also interested in the impact of the direction of swap usage on default risk. In this analysis, for brevity, we define firms swapping net into fixed rate and net into floating rate debt as firms swapping into fixed and firms swapping into floating, respectively. In columns 3 and 4, we drop firms that swap into fixed and therefore are left with values of interest rate swap usage for firms that swap into floating and non-users of interest rate swaps. In columns 5 and 6, we drop firms that swap into floating and therefore are left with values of swap usage for firms that swap into fixed and again non-users of interest rate swaps. In columns 3 and 5, we include the industry and year dummy variables separately. In columns 4 and 6, we include the interaction on industry and year dummy variables. Our results show that both swapping into floating and swapping into fixed generates a significant reduction in the probability of default. Although the difference between the coefficients on |SWAP_TO_FLOATING| and |SWAP_TO_FIXED| is statistically insignificant, in economic terms the difference is substantial. In unreported analysis, we find that a one standard deviation increase in |SWAP_TO_FIXED| can lead to a decrease in EDF that is 1.5 times higher than the corresponding figure for |SWAP_TO_FLOATING|. Overall, our empirical results indicate that the use of interest rate swaps regardless of direction has a negative impact on the firm's probability of default. In unreported analysis, we find that our results in Table 2.4 do not change when we cluster the standard errors at the firm and year level.

As we find evidence that both swapping into fixed and swapping into floating decrease firms' default risk, our results contradict those of Chava and Purnanadan (2007) who find that floating rate debt structures increase risk for their sample of US firms. Our findings are also not consistent with Disatnik et al. (2014) who argue that while cash flow hedging, such as swapping into fixed rate debt, reduces the variability of a firm's future cash flow stream, fair value hedging, such as swapping into floating rate debt, exposes the firm to cash flow risk because future interest payments are uncertain. In their study, they find that only cash flow hedging, which includes swapping into fixed rate debt, decreases a firm's precautionary demand for cash. Furthermore, our findings imply that Ippolito et al.'s (2018) assumption that only firms swapping into fixed interest rates are hedging may not be valid. Our results are inconsistent with these studies due to different samples. Given that the creditor rights in the UK are much stronger than in the US, UK firms face a greater risk of bankruptcy than US firms. As a result, the overwhelming majority of UK

firms use interest rate swaps to reduce default risk irrespective of the direction of the interest rate swaps.

2.4.4. Robustness checks

In this section, we conduct a series of robustness checks by employing a variety of econometric methods to deal with endogeneity-related issues associated with our extent of interest rate swap usage variables. The results are presented in Table 2.5. In Panel A, we employ the absolute value of the extent of interest rate swap usage |SWAP_USAGE|. In column 1, we estimate a firm fixed-effects model to control for the time-invariant unobservable characteristics that are correlated with the independent variable. In column 2, we use a one-year lag of right-hand side variables to reduce concerns related to reverse causality. In column 3, we use a propensity score matching technique to match firms based on their propensity to use interest rate swaps for hedging. Specifically, we attempt to match with no replacement one interest rate swap user with one interest rate swap non-user based on firm size, leverage, profitability, liquidity, equity volatility, excess return, and whether a firm has a credit rating.[25] The new subsample will include the matched firms. We then use a pooled OLS regression to estimate Equation 2.1. The significant negative coefficients on |SWAP_USAGE| in columns 1 to 3 are consistent with our previous findings.

[25] We also include industry dummy variables and year dummy variables in the logistic regression that identify the matched firms.

Table 2.5: Controlling for endogeneity - Continuous variable

This table presents the results of the impact of interest rate swaps, which are proxied by the extent of using interest rate swap usage, on the probability of default, using a range of different techniques to deal with endogeneity problems. The sample consists of UK listed non-financial companies between 2001 and 2015. PANEL A, PANEL B, and PANEL C present the regression results when the variables of interest are |SWAP_USAGE|, |SWAP_TO_FLOATING|, and |SWAP_TO_FIXED|, respectively. EDF is the expected default frequency. |SWAP_USAGE| is calculated as the absolute value of the difference between the final floating rate debt percentage and the initial floating rate debt percentage. |SWAP_TO_FLOATING| is calculated as the absolute value of the swap usage variable but only for those firms that are in net terms swapping to floating and non-swap users. |SWAP_TO_FIXED| is calculated as the absolute value of the swap usage variable but only for those firms that are in net terms swapping to fixed and non-swap users. In column 1, we use a firm fixed effects model to estimate Equation 2.1. In column 2, we run regression of Equation 2.1 with one-year lagged of all right-hand side variables. In column 3, we employ a propensity score matching technique to match interest rate swap users with interest rate swap non-user and then estimate Equation 2.1. In column 4, we employ an instrumental variables technique to regress Equation 2.1. The instruments for |SWAP_USAGE| are the percentage of firms having a positive value for |SWAP_USAGE| in the same industry each year and the average of the absolute value of the extent of interest rate swap usage of US firms in the same industry each year. The instruments for |SWAP_TO_FLOATING| are the percentage of firms having a positive value for |SWAP_TO_FLOATING| in the same industry each year and the average of the absolute value of the extent of the positive values of interest rate swap usage of US firms in the same industry each year. The instruments for |SWAP_TO_FIXED| are the percentage of firms having a positive value for |SWAP_TO_FIXED| in the same industry each year and the average of the absolute value of the extent of the negative values of interest rate swap usage of US firms in the same industry each year. In column 5, we use a System General Method of Moment (S-GMM) model. The dependent variable is the probability of default (EDF). The standard errors, reported in parentheses, are adjusted for heteroskedasticity and clustering at the firm level. ***, **, * denote significance at the 1%, 5%, or 10% levels, respectively.

PANEL A: |SWAP_USAGE|					
	Dependent variable: EDF				
	FE	LAG	PSM	IV	SGMM
VARIABLES	(1)	(2)	(3)	(4)	(5)
L.EDF					0.625***
					(0.057)
|SWAP_USAGE|	-0.005***	-0.006***	-0.006***	-0.028**	-0.007**
	(0.002)	(0.002)	(0.002)	(0.013)	(0.003)
		(Control variables included)			
Observations	2,331	1,986	1,945	2,331	2,086
Industry FE	NO	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Kleibergen-Paap rk LM statistic (p-value)				0.000	
Cragg-Donald Wald F statistic				18.490	
Hansen test of over-identification (p-value)				0.221	0.243
AR(1) test (p-value)					0.004
AR(2) test (p-value)					0.838
R-squared	0.505	0.513	0.673	0.563	0.807

Table 5 (continued): Control for endogeneity - Continuous variable

PANEL B: |SWAP_TO_FLOATING|					
	Dependent variable: EDF				
	FE	LAG	PSM	IV	SGMM
VARIABLES	(1)	(2)	(3)	(4)	(5)
L.EDF					0.602***
					(0.063)
|SWAP_TO_FLOATING|	-0.003	-0.006***	-0.006**	-0.032**	-0.006*
	(0.002)	(0.002)	(0.002)	(0.015)	(0.003)
		(Control variables included)			
Observations	1,881	1,589	1,643	1,881	1,678
Industry FE	NO	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Kleibergen-Paap rk LM statistic (p-value)				0.000	
Cragg-Donald Wald F statistic				15.487	
Hansen test of over-identification (p-value)				0.980	0.543
AR(1) test (p-value)					0.007
AR(2) test (p-value)					0.570
R-squared	0.501	0.540	0.675	0.576	0.814
PANEL C: |SWAP_TO_FIXED|					
	Dependent variable: EDF				
	FE	LAG	PSM	IV	SGMM
VARIABLES	(1)	(2)	(3)	(4)	(5)
L.EDF					0.629***
					(0.060)
|SWAP_TO_FIXED|	-0.006**	-0.008***	-0.007***	-0.025*	-0.007*
	(0.002)	(0.002)	(0.002)	(0.013)	(0.004)
		(Control variables included)			
Observations	1,725	1,437	1,564	1,725	1,532
Industry FE	NO	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Kleibergen-Paap rk LM statistic (p-value)				0.002	
Cragg-Donald Wald F statistic				15.904	
Hansen test of over-identification (p-value)				0.361	0.878
AR(1) test (p-value)					0.005
AR(2) test (p-value)					0.418
R-squared	0.510	0.540	0.683	0.622	0.834

In addition, we employ an instrumental variables (IV) technique and a system generalised method of moment (SGMM) model to estimate our specification. In column 4, we report the results from a two-stage least squares regression model. We use two instruments in the IV technique. The first instrument is the percentage of firms having a positive value for the extent of interest rate swap usage in the same industry each year. The second instrument is the average of the absolute value of the

extent of interest rate swap usage of US firms in the same industry each year. We collect the data for the second instrument from Brestcher et al. (2018).[26] It can be argued that these two instruments do not affect the UK firms' default risk directly. In the first stage, we regress the absolute value of the extent of interest rate swap usage on the instruments and other control variables in the regression. Then in the second stage, we regress the expected default frequency on the predicted value of the extent of interest rate swap usage in the first stage and other control variables. The post-estimation tests confirm the validity of our instrumental variables. The Kleibergen-Paap rk LM statistic is significant, suggesting that our instruments are relevant to the endogenous variable. In addition, the Cragg-Donald Wald F statistic is higher than 10, implying that our instruments are not weak. Moreover, the p-value of Hansen test of over-identification is higher than 0.100, which suggests that our instruments are uncorrelated with the error term. The results from the instrumental variable technique show that the estimated coefficient on |SWAP_USAGE| is still significantly negative at the five percent level.

In column 5, we employ an SGMM model to investigate the impact of interest rate swap usage on the firms' default risk.[27] We add the one-year lag value of EDF to the right-hand side of our specification to control for the dynamic effects of the model. The advantage of this model is that we do not need to find any new instruments for endogenous variables. The model uses the lags of the endogenous variable as the instruments for the endogenous variable and the contemporary exogenous variable as the instruments for the exogenous variables. In our model, we assume that the interest rate swap variable and all financial variables are endogenous. The SGMM model has two post-estimation tests. The first post-estimation test is for the autocorrelation of the lag two of the endogenous variables. If there is an autocorrelation of the second lags of the endogenous variables, the lag of endogenous variables may not be appropriate instruments for the contemporary value. The second post-estimation test is the Hansen test of over-identification restrictions. The null hypothesis of this test is that the instruments are valid instruments. Therefore, we expect not to reject the null hypothesis of the Hansen test. To reduce the redundancy of many instruments for endogenous variables, we

[26] The sample period in Brestcher et al. (2018) is from 1994 to 2014. We assume that the behaviour of US firms using interest rate swap in 2015 is similar to one in 2014.

[27] For a detailed understanding of the SGMM model, see Arellano and Bover (1995) and Blundell and Bond (1998).

use the three-year lag of endogenous variables as the instruments. This move is also to help the model to satisfy all the post-estimation tests mentioned above. The results estimated from the SGMM model confirm our previous finding as they show that the coefficient on the absolute value of the extent of interest rate swap usage is negative and significant at the five percent level. Furthermore, the lag value of EDF is significantly positive at the one percent level, suggesting that the previous year's default risk can exert a positive impact on the current year's default risk.

We follow the approach above to deal with the endogeneity issues associated with our other extent of interest rate swap usage variables that focus on the direction of the interest rate swap, these being |SWAP_TO_FLOATING| and |SWAP_TO_FIXED|. We present our results in Panels B and C of Table 2.5. In Panel B, except for the firm fixed effects results in column 1, the results using a lag model, a propensity score matching technique, an instrumental technique, and an SGMM model show that the coefficient estimated on |SWAP_TO_FLOATING| is negative and significant.[28] The structure of Panel C is similar to Panels A and B. The results in Panel C indicate that our findings relating to |SWAP_TO_FIXED| are robust to endogeneity concerns.

2.4.5. Firm size and the impact of interest rate swaps on the probability of default

Firm size is seen as an important driver of the use of derivatives with most empirical studies reporting that large firms are more likely to use derivatives, which is consistent with the economies of scale argument of derivative use. However, although Bartram et al. (2011) suggest that large firms are more likely to use interest rate swaps, we would argue it is not necessarily the case that they use them more extensively or use them to lower financial risks. To the best of our knowledge, there is no evidence as to whether the impact of derivative use on firm risk varies with respect to firm size. It follows that an interesting question in the context of this study is whether the negative impact of using interest rate swaps on firm default risk as observed above is larger or smaller for large firms or might it even possibly work in the opposite direction in that it could be indicative of risk-increasing behaviour. In this section, we investigate this by conducting an examination of the effects of firm size on the relation between interest rate swap use and the probability of default. We

[28] In column 1 of Panel B, the p-value of |SWAP_TO_FLOATING| is 0.132.

sort the percent amount swapping to floating rate debt into size quartiles in the same manner we sort in Panel D of Table 2.2. The variable "Q1" ("Q4") includes the smallest (largest) 25 percent of firms that use interest rate swaps.

Table 2.6 reports the results of the impact of interest rate swap usage on firms' probability of default according to firm size. To deal with endogeneity concerns relating to the extent of interest rate swap usage, we employ an instrumental variables method similar to the analysis in Section 2.4.4. [29] We interact the predicted value of our extent of interest rate swap usage variable with the firm size quartile dummy variable such that we get a unique swap usage coefficient for each size quartile. In column 1 of Table 2.6, we include the predicted value of the absolute value of swap usage for all swap users in the specification and also include non-users of swaps (zero swap-usage). We find that the extent of interest rate swap usage across the first three size quartiles decreases default risk. However, the results in column 1 show that swap usage by the largest firms in our sample leads to an increase in default risk. An interesting question is whether there is any particular type of interest rate swap usage that is driving this result. Could it be firms swapping into fixed or firms swapping into floating that is behind our finding?

[29] Our results do not change when we use a pooled OLS regression in this analysis.

Table 2.6: Firm size and the impact of interest rate swap usage on firms' probability of default

The table presents the results of the effects of interest rate swap usage on the default probability according to firm size quartile, using an instrumental variables technique. The sample consists of UK listed non-financial companies between 2001 and 2015. The dependent variable is EDF, which is the expected default frequency. |SWAP_USAGE| is calculated as the absolute value of the difference between the final floating rate debt percentage and the initial floating rate debt percentage. |SWAP_TO_FLOATING| is calculated as the absolute value of the swap usage variable but only for those firms that are in net terms swapping to floating and non-swap users. |SWAP_TO_FIXED| is calculated as the absolute value of the swap usage variable but only for those firms that are in net terms swapping to fixed and non-swap users. |SWAP_USAGE|Q1, |SWAP_USAGE|Q2, |SWAP_USAGE|Q3, and |SWAP_USAGE|Q4 are the predicted values of |SWAP_USAGE| from the first stage of the instrumental variable technique for the companies belonging to firm size quartiles Q1, Q2, Q3, and Q4, where Q1 includes the companies belong to the smallest 25 percent of firms that use interest rate swaps, Q2 includes the companies belonging to the next smallest 25 percent of firms that use interest rate swaps, Q3 includes the companies belonging to the next smallest 25 percent of firms that use interest rate swaps, and Q4 includes the companies belonging to the largest 25 percent of firms that use interest rate swaps, respectively. |SWAP_TO_FIXED|Q1, |SWAP_TO_FIXED|Q2, |SWAP_TO_FIXED|Q3, and |SWAP_TO_FIXED|Q4 are the predicted value of |SWAP_TO_FIXED| from the first stage regression for the companies belonging to firm size quartiles Q1, Q2, Q3, and Q4, respectively. |SWAP_TO_FLOATING|Q1, |SWAP_TO_FLOATING|Q2, |SWAP_TO_FLOATING|Q3, and |SWAP_TO_FLOATING|Q4 are the predicted value of |SWAP_TO_FLOATING| from the first stage regression for the companies belonging to firm size quartiles Q1, Q2, Q3, and Q4, respectively. The standard errors, reported in parentheses, are adjusted for heteroskedasticity and clustering at the firm level. ***, **, * denote significance at the 1%, 5%, or 10% levels, respectively. The regressions include industry and year dummies.

	Dependent variable: EDF		
VARIABLES	(1)	(2)	(3)
|SWAP_USAGE| Q1	-0.032***		
	(0.010)		
|SWAP_USAGE| Q2	-0.036***		
	(0.007)		
|SWAP_USAGE| Q3	-0.023***		
	(0.008)		
|SWAP_USAGE| Q4	0.022**		
	(0.010)		
|SWAP_TO_FIXED| Q1		-0.040***	
		(0.012)	
|SWAP_TO_FIXED| Q2		-0.040***	
		(0.010)	
|SWAP_TO_FIXED| Q3		-0.031**	
		(0.012)	
|SWAP_TO_FIXED| Q4		0.012	
		(0.016)	
|SWAP_TO_FLOATING| Q1			-0.048**
			(0.020)
|SWAP_TO_FLOATING| Q2			-0.054***
			(0.013)
|SWAP_TO_FLOATING| Q3			-0.031***
			(0.011)
|SWAP_TO_FLOATING| Q4			0.026**
			(0.012)
	(control variable included)		
Observations	2,331	1,725	1,881
Industry FE	YES	YES	YES
Year FE	YES	YES	YES
Kleibergen-Paap rk LM statistic (p-value)	0.000	0.002	0.000
Cragg-Donald Wald F statistic	18.490	15.904	15.487
Hansen test of over-identification (p-value)	0.221	0.361	0.980
R-squared	0.663	0.677	0.672

In column 2, we include in the specification only the predicted value of the absolute value of the extent of interest rate swap usage for firms swapping into fixed as well as non-users of interest rate swaps. Our results show that across all four firm size categories (Q1 to Q4) we find no circumstances where swapping into fixed increases default risk. In fact we find that swapping into fixed rate debt by firms in size quartiles 1, 2, and 3 leads to a statistically significant reduction in default risk. However, the large (Q4) firms that swap into fixed neither decrease nor increase credit risk. This latter finding suggests that swapping into fixed is not driving the large firm (Q4) result in column 1. In column 3, we include in the specification only the predicted value of the absolute value of the extent of interest rate swap usage for firms swapping into floating and as before non-users of swaps. The results show that swapping into floating rate debt by quartile 1, 2, and 3 firms generates a significant reduction in default risk. In contrast, for quartile 4 firms we observe a statistically significant increase in default risk. The results in columns 2 and 3 clearly show that firms swapping into floating are driving the large firms' (Q4) swap usage results in column 1. This finding is consistent with Chava and Purnanandam (2007) who also find that having more floating rate debt is a risk-increasing debt structure strategy. Furthermore, Ippolito et al. (2018) also see swapping into floating rate debt as a speculative activity. However, more importantly our analysis shows that swapping into floating is not risk increasing for all firms as suggested by Chava and Purnanandam (2007) and Ippolito et al. (2018), but only for very large firms.

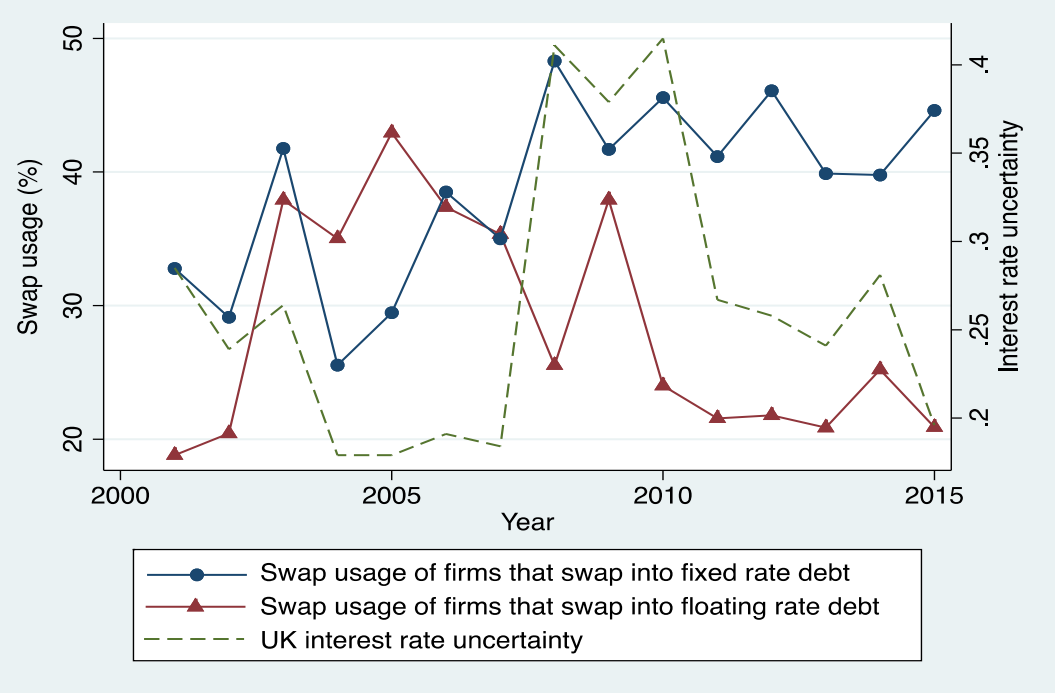
2.4.6. The interaction effects of interest rate uncertainty and interest rate swap usage on firm default probabilities

As interest rate swaps can hedge against the consequences of interest rate uncertainty, a natural extension of the previous analysis would be to examine whether the effect of interest rate swap direction on firm default risk is affected by uncertainty about monetary policy and the future path of interest rates. As mentioned in Section 2.3.3, Istrefi and Mouabbi (2018) measure long-term interest rate uncertainty based on professional forecasts of long-term interest rates that account for both disagreement among forecasters and the perceived volatility of future aggregate shocks. A higher value for this measure suggests a higher level of interest rate uncertainty. During our sample period (2001-2015), the level of interest rate

uncertainty, as measured by Istrefi and Mouabbi (2018), exhibited large variation as shown in Figure 2.3.

Figure 2.3: Interest rate uncertainty and interest rate swap usage

This figure plots the interest rate swap uncertainty index, which is sourced from Istrefi and Mouabbi (2018), and swap usage of firms that swap into fixed rate debt and firms that swap into floating rate debt in our sample. Data are yearly and cover the period from 2001 to 2015.



Additionally, Figure 2.3 shows that the extent to which firms in our sample on average were swapping into fixed or floating rate debt also varied significantly during this period. It is arguable that the effects of interest rate uncertainty on the relationship between interest rate swap usage and the firms' default risk might be dependent on the direction of the swap. Increased interest rate uncertainty could invariably lead to increased cash flow uncertainty of a firm. As a result, during the period of high interest rate uncertainty, a firm that does not possess a positive cash flow interest rate beta may not enjoy a reduction in its default risk when it uses a swapping into floating rate debt strategy. However, during this period, a firm that uses a swapping into fixed rated debt strategy can always reduce its cash flow volatility and therefore decreasing its default risk whether it has positive or negative cash flow interest rate beta.

We report the results for this analysis in Table 2.7. We employ an instrumental variables technique that is similar in manner to that used in the previous section to

deal with endogeneity concerns related to the swap usage variables.[30] The results in columns 1 and 2 show that the coefficients estimated on the interaction term between the swap variables and interest rate uncertainty are insignificant, whether the swap variables are |SWAP_TO_FIXED| or |SWAP_TO_FLOATING|. Our finding suggests that interest rate uncertainty did not exert any significant impact on the negative relationship between interest rate swap usage and a firm's default risk during our sample period. In effect, the EDFs of our two groups of interest rate swap users were not differentially affected in response to interest rate uncertainty. This result implies that both swap direction strategies are default risk reducing.

[30] Our results do not change when we use a pooled OLS regression in this analysis.

Table 2.7: The impact of interest rate uncertainty

The table presents the results of the effects of interest rate swap direction on the default probability in the context of UK interest rate uncertainty, using an instrumental variables technique. The sample consists of UK listed non-financial companies between 2001 and 2015. The dependent variable is EDF, which is the expected default frequency. IRU is the proxy for interest rate uncertainty. |SWAP_TO_FIXED| is calculated as the absolute value of the swap usage variable but only for those firms that are in net terms swapping to fixed and non-swap users. The instruments for |SWAP_TO_FIXED| are the percentage of firms having a positive value for |SWAP_TO_FIXED| in the same industry each year and the average of the absolute value of the extent of the negative values of interest rate swap usage of US firms in the same industry each year. |SWAP_TO_FLOATING| is calculated as the absolute value of the swap usage variable but only for those firms that are in net terms swapping to floating and non-swap users. The instruments for |SWAP_TO_FLOATING| are the percentage of firms having a positive value for |SWAP_TO_FLOATING| in the same industry each year and the average of the absolute value of the extent of the positive values of interest rate swap usage of US firms in the same industry each year. In the regression, we use the predicted value of |SWAP_TO_FIXED| and |SWAP_TO_FLOATING| from the first-stage regression in columns 1 and 2, respectively. FIRM_SIZE is the natural logarithm of the market value of assets (in million $). LEVERAGE is calculated as the ratio of total debt to the market value of assets. PROFITABILITY is calculated as the ratio of EBIT over total assets. LIQUIDITY is calculated as the ratio of cash and cash equivalent over total assets. EQUITY_VOLATILITY is the annualised standard deviation of monthly stock returns over the prior twelve months. EXCESS_RETURN is calculated as the difference between the stock's annual return and the value weighted FTSE all shares index annual return over the same period. RATED is a dummy variable that is equal to 1 if the firm has long-term credit rating. The standard errors, reported in parentheses, are adjusted for heteroskedasticity and clustering at the firm level. ***, **, * denote significance at the 1%, 5%, or 10% levels, respectively. The regressions include year and industry dummies.

	Dependent variable: EDF	
VARIABLES	(1)	(2)
|SWAP_TO_FIXED|	-0.025**	
	(0.011)	
|SWAP_TO_FLOATING|		-0.032**
		(0.014)
|SWAP_TO_FIXED| * (IRU - $\overline{IRU}$)	-0.029	
	(0.079)	
|SWAP_TO_FLOATING| * (IRU - $\overline{IRU}$)		0.033
		(0.055)
FIRM_SIZE	-0.527***	-0.382***
	(0.069)	(0.078)
LEVERAGE	4.024***	4.031***
	(0.576)	(0.554)
PROFITABILITY	-3.076***	-3.475***
	(0.965)	(0.865)
LIQUIDITY	0.339	0.874
	(0.767)	(0.647)
EQUITY_VOLATILITY	0.037***	0.036***
	(0.005)	(0.004)
EXCESS_RETURN	-0.006***	-0.006***
	(0.001)	(0.001)
RATED	-0.088	0.513**
	(0.249)	(0.198)
Constant	10.352***	4.730*
	(0.556)	(2.426)
Observations	1,725	1,881
Industry FE	YES	YES
Year FE	YES	YES
Kleibergen-Paap rk LM statistic (p-value)	0.002	0.000
Cragg-Donald Wald F statistic	15.904	15.487
Hansen test of over-identification (p-value)	0.361	0.980
R-squared	0.667	0.655

2.4.7. The interaction effects of economic policy uncertainty and interest rate swap usage on firm default probabilities

In previous sections, we have shown that for all but the largest firms, the use of interest rate swaps, irrespective of the direction, leads to a reduction in the probability of default. Additionally, we have found that interest rate uncertainty does not impact the negative relationship between the use of interest rate swap and a firm' probability of default. In this section, we investigate whether the relationship between interest rate swap usage and default risk holds during periods of heightened economic policy uncertainty. Baker et al. (2016) show that economic policy uncertainty may lead to greater stock price volatility, which can increase firm default risk. When a firm operates in a period of high economic policy uncertainty, its cash flows may fall relative to a period of low economic policy uncertainty due to factors such as lower spending by households and a decrease in investment by firms (Kang et al., 2014). In addition, a sudden change in tax or government spending, or government regulation can affect a firm's cash flow.

Similar to the effects of interest rate uncertainty, the effects of economic policy uncertainty on the relationship between interest rate swap usage and firms' default risk might be dependent on the direction of the swap. We report the results from this analysis in Table 2.8. We use an instrumental variables technique that is similar in manner to that used in the previous section to deal with endogeneity concerns related to the swap usage variables.[31] In column 1, the interaction term between |SWAP_TO_FIXED| and (EPU - $\overline{\text{EPU}}$) is statistically insignificant. In columns 2, the interaction term between |SWAP_TO_FLOATING| and (EPU - $\overline{\text{EPU}}$) is positive and significant at the 10 percent level. These results suggest that the negative impact of swapping into fixed on the probability of default is not affected by the uncertainty surrounding economic policy whereas the negative impact of swapping into floating is weakened during a period of high economic policy uncertainty. A possible explanation for our results showing the insignificant impact of IRU but significant impact of EPU on the effects of swapping into floating might be that EPU measure can capture a higher level of cash flow volatility than IRU measure. The former is able to capture not only the uncertainty in interest rate but also other uncertainty that affects a firm's cash flow.

[31] Our results do not change when we use a pooled OLS regression in this analysis.

Table 2.8: The impact of economic policy uncertainty

The table presents the results of the effects of economic policy uncertainty on the relationship between interest rate swap usage and default risk, using instrumental variables technique. The sample consists of UK listed non-financial companies between 2001 and 2015. The dependent variable is EDF, which is the expected default frequency. EPU is the proxy for economic policy uncertainty. |SWAP_TO_FIXED| is calculated as the absolute value of the swap usage variable but only for those firms that are in net terms swapping to fixed and non-swap users. The instruments for |SWAP_TO_FIXED| are the percentage of firms having a positive value for |SWAP_TO_FIXED| in the same industry each year and the average of the absolute value of the extent of the negative values of interest rate swap usage of US firms in the same industry each year. |SWAP_TO_FLOATING| is calculated as the absolute value of the swap usage variable but only for those firms that are in net terms swapping to floating and non-swap users. The instruments for |SWAP_TO_FLOATING| are the percentage of firms having a positive value for |SWAP_TO_FLOATING| in the same industry each year and the average of the absolute value of the extent of the positive values of interest rate swap usage of US firms in the same industry each year. In the regression, we use the predicted value of |SWAP_TO_FIXED| and |SWAP_TO_FLOATING| from the first-stage regression in columns 1 and 2, respectively. FIRM_SIZE is the natural logarithm of the market value of assets (in million $). LEVERAGE is calculated as the ratio of total debt to the market value of assets. PROFITABILITY is calculated as the ratio of EBIT over total assets. LIQUIDITY is calculated as the ratio of cash and cash equivalent over total assets. EQUITY_VOLATILITY is the annualised standard deviation of monthly stock returns over the prior twelve months. EXCESS_RETURN is calculated as the difference between the stock's annual return and the value weighted FTSE all shares index annual return over the same period. RATED is a dummy variable that is equal to 1 if the firm has long-term credit rating. The standard errors, reported in parentheses, are adjusted for heteroskedasticity and clustering at the firm level. ***, **, * denote significance at the 1%, 5%, or 10% levels, respectively. The regressions include industry and year dummies.

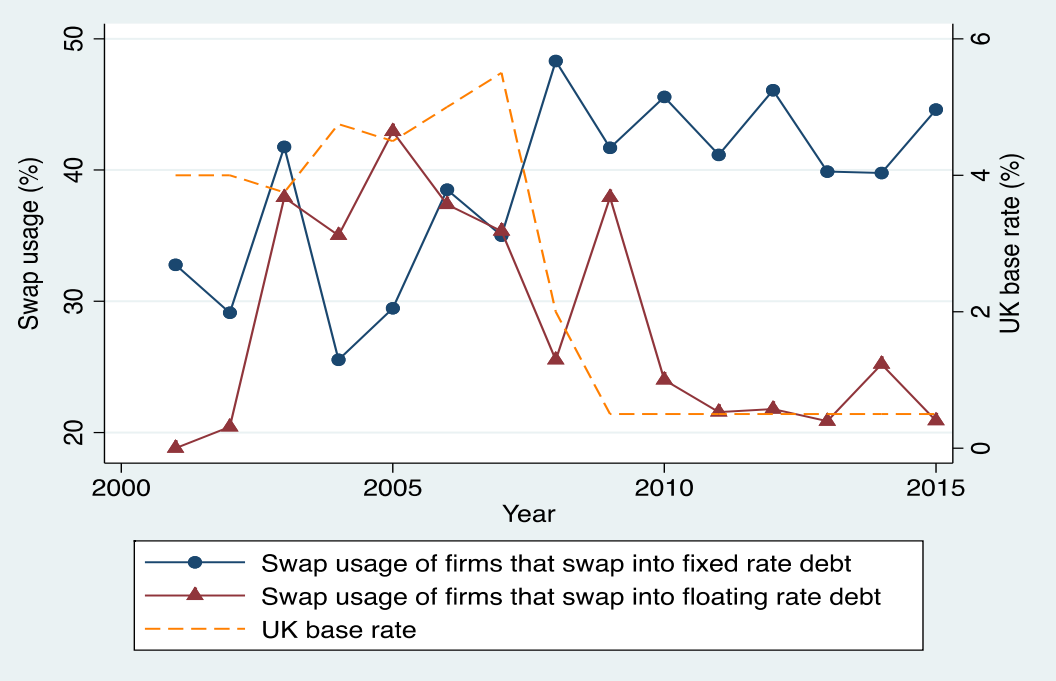
	Dependent variable: EDF	
VARIABLES	(1)	(2)
|SWAP_TO_FIXED|	-0.0252**	
	(0.0112)	
|SWAP_TO_FIXED| * (EPU - $\overline{EPU}$)	-0.0000	
	(0.0002)	
|SWAP_TO_FLOATING|		-0.0284**
		(0.0139)
|SWAP_TO_FLOATING| * (EPU - $\overline{EPU}$)		0.0003*
		(0.0001)
FIRM_SIZE	-0.5271***	-0.3936***
	(0.0688)	(0.0787)
LEVERAGE	4.0215***	3.9931***
	(0.5714)	(0.5511)
PRORITABILITY	-3.0750***	-3.4485***
	(0.9635)	(0.8657)
LIQUIDITY	0.3305	0.8568
	(0.7604)	(0.6453)
EQUITY_VOLATILITY	0.0367***	0.0359***
	(0.0046)	(0.0044)
EXCESS_RETURN	-0.0056***	-0.0057***
	(0.0012)	(0.0011)
Constant	-0.0890	0.4976**
	(0.2478)	(0.1955)
Observations	1,725	1,881
Industry FE	YES	YES
Year FE	YES	YES
Kleibergen-Paap rk LM statistic (p-value)	0.002	0.000
Cragg-Donald Wald F statistic	15.904	15.487
Hansen test of over-identification (p-value)	0.361	0.980
R-squared	0.623	0.576

2.4.8. Impact of interest rate swaps during the zero lower bound period

Figure 2.4 shows that during our sample period there was a substantial fall in the Bank of England base rate during the years leading up to 2010, with base rates falling from 5.25% in February 2008 to 0.5% in March 2009 and then remaining at this level for the rest of the period. As a result, our sample period is a special case because, for all intents and purposes, it includes seven years where the UK base rate was effectively at its zero lower bound. This drop in the base rate is exogenous, and it could cause an exogenous variation in the level of swap usage. For example, Figure 2.4 shows that on average the proportion of debt that was swapped into floating rate debt decreased significantly after 2009. Furthermore, the extent to which firms swapped into fixed rate debt during this period was on average higher than before this period.

Figure 2.4: The level of interest rate and interest rate swap usage

This figure plots the level of UK base rate, which is sourced from Bank of England, and swap usage of firms that swap into fixed rate debt and firms that swap into floating rate debt in our sample. Data are yearly and cover the period from 2001 to 2015.



At the zero lower bound, firms with positive cash flow interest rate betas can reduce risk by swapping into floating. This makes their future cash flows more certain. However, at the zero lower bound, interest rates can either be maintained at zero or go up, and therefore if these firms swap into fixed their future cash flows will either be non-changing if interest rates remain unchanged or increase in the event

that interest rates go up. The latter happens because cash flows from the firm's operations rise (because they have a positive cash flow interest rate beta), but debt service payments remain unchanged (because they have swapped to fixed), resulting in an overall increase in cash flows. In this extreme interest rate environment, it makes economic sense for firms with positive cash flow interest rate betas to swap into fixed. Firms with negative cash flow betas can only reduce risk by swapping into fixed. These firms should be swapping into fixed regardless of the level of interest rates. It follows that, for all firms, swapping into fixed in the zero lower bound interest rate environment would be expected to reduce default risk and more so than swapping into floating.[32] We, therefore, predict that since the base rate was approximately 0 percent after 2008, the use of interest rate swaps that swap into floating rate debt during the zero lower bound period (2009-2015) will be less effective in reducing default risk. The effect of the use of interest rate swaps that swap into fixed rate debt will be independent of the change in the base rate for firms with negative cash flow interest rate betas but will be influenced by the change in the base rate for firms with positive cash flow interest rate betas.

The results estimated from Equation 2.4 are reported in Table 2.9. We employ an instrumental variables technique that is similar in manner to that used in the previous section to deal with endogeneity concerns related to the swap usage variables.[33] In column 1, the coefficient estimated on |SWAP_TO_FIXED| is negative and significant at the 5 percent level, while the coefficient on its interaction term with POST is insignificant. This suggests that the negative impact of swapping into fixed on default risk persists before and after the start of the zero lower bound period. In contrast, in column 2, the coefficients estimated on |SWAP_TO_FLOATING| and on its interaction term are significantly negative and positive, respectively, suggesting that the negative impact of swapping into floating disappears during the zero lower bound period. Overall, we find evidence showing that a swapping into fixed rate debt strategy can reduce the firms' default risk during the zero lower bound period, whereas a swapping into floating rate debt strategy cannot. These results are new for the hedging and interest rate swaps literature.

[32] Firms with a negative cash flow interest rate beta will obviously increase their default risk if they swap into floating rate debt.

[33] Our results do not change when we use a pooled OLS regression in this analysis.

Table 2.9: The impact of zero lower bound

The table presents the results of the impact of zero lower bound on the relationship between interest rate swap usage and the default probability, using an instrumental variables technique. The sample consists of UK listed non-financial companies between 2001 and 2015. The dependent variable is EDF, which is the expected default frequency. |SWAP_TO_FIXED| is calculated as the absolute value of the swap usage variable but only for those firms that are in net terms swapping to fixed and non-swap users. The instruments for |SWAP_TO_FIXED| are the percentage of firms having a positive value for |SWAP_TO_FIXED| in the same industry each year and the average of the absolute value of the extent of the negative values of interest rate swap usage of US firms in the same industry each year. |SWAP_TO_FLOATING| is calculated as the absolute value of the swap usage variable but only for those firms that are in net terms swapping to floating and non-swap users. The instruments for |SWAP_TO_FLOATING| are the percentage of firms having a positive value for |SWAP_TO_FLOATING| in the same industry each year and the average of the absolute value of the extent of the positive values of interest rate swap usage of US firms in the same industry each year. In the regression, we use the predicted value of |SWAP_TO_FIXED| and |SWAP_TO_FLOATING| from the first-stage regression in columns 1 and 2, respectively. POST is a dummy variable, taking the value of one for the period from 2009 to 2015, and zero otherwise. FIRM_SIZE is the natural logarithm of the market value of assets (in million $). LEVERAGE is calculated as the ratio of total debt to the market value of assets. PROFITABILITY is calculated as the ratio of EBIT over total assets. LIQUIDITY is calculated as the ratio of cash and cash equivalent over total assets. EQUITY_VOLATILITY is the annualised standard deviation of monthly stock returns over the prior twelve months. EXCESS_RETURN is calculated as the difference between the stock's annual return and the value weighted FTSE all shares index annual return over the same period. RATED is a dummy variable that is equal to 1 if the firm has long-term credit rating. The standard errors, reported in parentheses, are adjusted for heteroskedasticity and clustering at the firm level. ***, **, * denote significance at the 1%, 5%, or 10% levels, respectively. The regressions include year and industry dummies.

	Dependent variable: EDF	
VARIABLES	(1)	(2)
|SWAP_TO_FIXED|	-0.025**	
	(0.012)	
|SWAP_TO_FIXED| * POST	-0.001	
	(0.015)	
|SWAP_TO_FLOATING|		-0.040***
		(0.015)
|SWAP_TO_FLOATING| * POST		0.040***
		(0.012)
FIRM_SIZE	-0.527***	-0.426***
	(0.069)	(0.081)
LEVERAGE	4.021***	3.940***
	(0.566)	(0.545)
PROFITABILITY	-3.075***	-3.240***
	(0.955)	(0.864)
LIQUIDITY	0.323	0.870
	(0.759)	(0.645)
EQUITY_VOLATILITY	0.037***	0.036***
	(0.005)	(0.004)
EXCESS_RETURN	-0.006***	-0.005***
	(0.001)	(0.001)
RATED	-0.091	0.418**
	(0.247)	(0.193)
Constant	9.074***	4.226*
	(0.620)	(2.409)
Observations	1,725	1,881
Industry FE	YES	YES
Year FE	YES	YES
Kleibergen-Paap rk LM statistic (p-value)	0.002	0.000
Cragg-Donald Wald F statistic	15.904	15.487
Hansen test of over-identification (p-value)	0.361	0.980
R-squared	0.667	0.659

To provide further insight into this finding, we interact our extent of swapping into fixed and swapping into floating with our year dummies in a regression analysis. In the regression, we drop year dummies but include UK GDP growth to capture time effects. The results are reported in Table 2.10. We interact |SWAP_TO_FIXED| and |SWAP_TO_FLOATING| with year dummies in columns 1 and 2, respectively. In column 3, we report the p-value of a test that compares the equality of the interaction variables in columns 1 and 2. The results in column 3 indicate that there is no difference in the impact of swapping into fixed and swapping into floating on firm default risk during the period 2001 to 2010. However, our results show that the impact of swapping into fixed is stronger than swapping into floating for the period 2011– 2014. More importantly, whereas the coefficients estimated on the interaction term of swapping into fixed are significantly negative for this period, the corresponding coefficients for swapping into floating are not. This suggests that only firms swapping into fixed enjoyed a reduction in default risk during this period.

Table 2.10: Time variation of the impact of interest rate swap usage

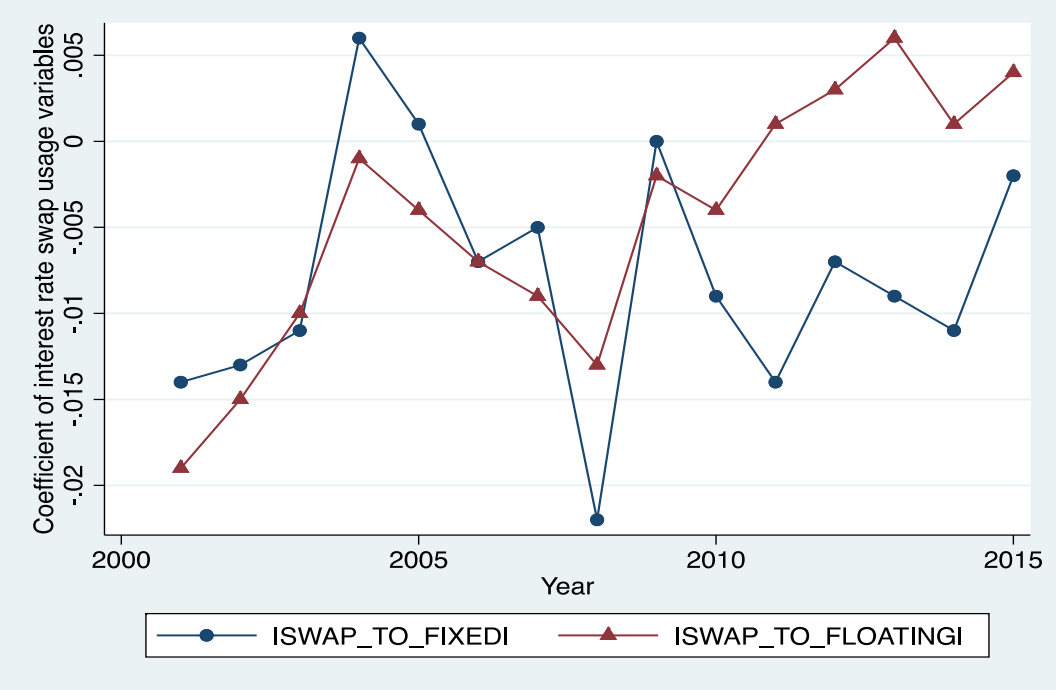
The table presents the results of the effects of interest rate swap usage on the default probability according to year, using a pooled OLS model. The sample consists of UK listed non-financial companies between 2001 and 2015. The dependent variable is EDF, which is the expected default frequency. In column 1, the |SWAP_VARIABLE| is |SWAP_TO_FIXED|. In column 2, the |SWAP_VARIABLE| is |SWAP_TO_FLOATING|. |SWAP_TO_FIXED| is calculated as the absolute value of the swap usage variable but only for those firms that are in net terms swapping to fixed and non-swap users. |SWAP_TO_FLOATING| is calculated as the absolute value of the swap usage variable but only for those firms that are in net terms swapping to floating and non-swap users. The standard errors, reported in parentheses, are adjusted for heteroskedasticity and clustering at the firm level. ***, **, * denote significance at the 1%, 5%, or 10% levels, respectively. The regressions include industry dummies.

	Dependent variable: EDF		Test difference in coefficients
	|SWAP_TO_FIXED|	|SWAP_TO_FLOATING|	(pvalue)
VARIABLES	(1)	(2)	(3)
|SWAP_VARIABLE| * 2001	-0.014***	-0.019***	0.289
	(0.003)	(0.005)	
|SWAP_VARIABLE| * 2002	-0.013**	-0.015*	0.787
	(0.006)	(0.008)	
|SWAP_VARIABLE| * 2003	-0.011***	-0.010*	0.844
	(0.004)	(0.005)	
|SWAP_VARIABLE| * 2004	0.006	-0.001	0.421
	(0.008)	(0.003)	
|SWAP_VARIABLE| * 2005	0.001	-0.004*	0.398
	(0.005)	(0.002)	
|SWAP_VARIABLE| * 2006	-0.007**	-0.007	0.988
	(0.003)	(0.004)	
|SWAP_VARIABLE| * 2007	-0.005	-0.009**	0.518
	(0.006)	(0.004)	
|SWAP_VARIABLE| * 2008	-0.022***	-0.013***	0.154
	(0.006)	(0.004)	
|SWAP_VARIABLE| * 2009	0.000	-0.002	0.719
	(0.007)	(0.003)	
|SWAP_VARIABLE| * 2010	-0.009*	-0.004	0.345
	(0.006)	(0.003)	
|SWAP_VARIABLE| * 2011	-0.014***	0.001	0.024**
	(0.004)	(0.006)	
|SWAP_VARIABLE| * 2012	-0.007***	0.003	0.011**
	(0.003)	(0.004)	
|SWAP_VARIABLE| * 2013	-0.009***	0.006	0.000***
	(0.002)	(0.004)	
|SWAP_VARIABLE| * 2014	-0.011***	0.001	0.003***
	(0.003)	(0.003)	
|SWAP_VARIABLE| * 2015	-0.002	0.004	0.199
	(0.004)	(0.004)	
	(Control variables included)		
Observations	1,725	1,881	
Industry FE	YES	YES	
Year FE	NO	NO	
R-squared	0.648	0.637	

We plot the coefficients on the interaction terms of swapping into fixed and swapping into floating in Figure 2.5. It is very clear to see that there is an obvious divergence after 2010 in the size and sign of the interaction terms associated with swapping into fixed and swapping into floating. These results corroborate our previous findings relating to the zero lower bound period.

Figure 2.5: The impact of interest rate swap usage over time

This figure plots the coefficients of |SWAP_TO_FIXED| and |SWAP_TO_FLOATING| estimated from time-varying regression model in Section 2.4.8.



2.5. Conclusion

The objective of this paper is to investigate the impacts of interest rate swaps use on the probability of default for a sample of UK non-financial firms between 2001 and 2015, which importantly includes several years where UK interest rates were very close to the zero lower bound. To the best of our knowledge, there has been no previous attempt to study the impact of the use of interest rate swaps or the direction of interest rate swaps by corporates on default risk.

Using data on firms' interest rate structure of debt before and after the effects of interest rate swaps, we construct a measure of the extent of swap usage, which also takes into account the direction of the interest rate swap. We show that a higher level of interest rate swap usage is associated with a larger reduction in the probability of default, which is consistent with the notion that more hedging results in greater risk

reduction. Our results show that on average swap direction does not matter as both swapping into fixed and swapping into floating generates a reduction in default risk. These findings are contrary to those reported in much of the extant literature (Faulkender, 2005; Chava and Purnanandam, 2007; Disatnik et al., 2014; and Ippolito et al., 2018).

We find that a failure to account for differences between small and large firms can lead to incomplete or misleading inferences of the impact of interest rate swap usage on a firm's default risk. Our results show that the use of interest rate swaps by small firms, irrespective of the direction of the swap, reduces credit risk. However, we find large firms that swap into floating rate debt increase their default risk.

In our paper, we also examine how economic policy uncertainty can affect the relationship between the use of interest rate swaps and the firm default risk. Our results show that the periods of heightened economic policy uncertainty reduce the effectiveness of swapping into floating in decreasing a firm's probability of default.

To the best of our knowledge, our study is the first to demonstrate that the recent zero lower bound interest rate period has important implications for the efficacy of swapping into fixed rate versus swapping into floating rate debt. Our results show that whereas swapping into fixed leads to a reduction in the probability of default both before and during the zero lower bound period, swapping into floating only reduces credit risk before this period. These findings are an important contribution of this paper to the corporate hedging and more specifically the interest rate risk management and interest rate swaps literature.

In conclusion, our empirical analysis suggests that for the majority of firms the direction of interest rate swap usage does not matter in a risk context, which contradicts many recent studies. However, we assert that the direction of interest rate swap usage does matter when differences in firm size are accounted for, when economic policy uncertainty is high, and when interest rates are at or very close to zero. As the overwhelming majority of firms in our sample seem to be using interest rate swaps for risk reduction, financial market regulators should look at exempting non-financials from the FTT. Overall, our analysis provides important new insights into the impact of interest rate swap strategies on firm default risk.

Appendix to "Chapter 2: Does the Direction of Interest Rate Swaps Matter?"

This Appendix contains additional information on the data used and some analysis. Appendix 2.1 provides an example of corporate risk management disclosures from an annual report. Appendix 2.2 provides some examples of fair value hedging sourced from UK annual reports. Finally, Appendix 2.3 provides univariate results and a correlation matrix for our empirical analysis.

Appendix 2.1: Example of Interest Rate Swap Annual Report Disclosures

Devro Plc Annual Report & Accounts 2004

Note that our comments on the annual report disclosures are in bold italic.

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Net debt at the year end amounted to £25.4 million, comprising gross debt of £36.4 million and cash and liquid resources of £11.0 million. Gearing was reduced to 34.9% (2003: 41.2%). The group's borrowing facility totals £52.9 million. Two interest rate swaps totalling £15 million are in place to provide protection against potential increases in interest rates. These swaps are for nominal amounts of £5 million and £10 million and expire on 15 July 2005 and 15 July 2006 respectively. At the year end, 41% (2003: 38%) of the group's borrowings were at fixed rates after taking account of the interest rate swaps.

From the above disclosure we can determine that the firm uses interest rate swaps which have a notional principal value of £15m, the firm swaps into fixed rate debt and the percentage of fixed rate debt after interest rate swaps is 41%.

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Interest rate risk profile of financial liabilities: The profile of the group's financial liabilities at 31 December 2004 was:

Currency	Floating rate £000	Fixed rate £000	Zero rate £000	Total £000
Sterling	14,250	15,000	-	29,250
Australian dollars	5,547	-	96	5,643
Euro	1,621	-	-	1,621
Other currencies	-	-	140	140
At 31 December 2004	**21,418**	**15,000**	**236**	**36,654**
Sterling	14,250	15,000	-	29,250
Australian dollars	7,917	-	73	7,990
Euro	2,315	-	-	2,315
Other currencies	-	-	132	132
At 31 December 2003	**24,482**	**15,000**	**205**	**39,687**

Floating rate financial liabilities bear interest at rates, based on relevant national LIBOR equivalents plus a margin as defined in the facility agreement, which are fixed in advance for periods of up to six months with the exception of the overdraft facility in Germany.

From the above table we can calculate the percentage of fixed or floating rate debt net of interest rate swaps. As at 31st December 2004 total floating rate borrowings after derivatives were £21.418m, fixed rate borrowings were £15m and borrowings at a zero interest rate were £0.236m, giving total borrowings amounting to £36.654m. Therefore, the percentage of floating rate borrowings was 58% and the percentage of fixed rate borrowings was 41%.

Appendix 2.2: Examples of Fair Value Hedging Sourced from UK Annual Reports

Rolls-Royce, 2008 Annual Report (page 64)

Interest rate risk – The Group's interest rate risk is primarily in relation to its fixed rate borrowings (fair value risk), floating rate borrowings, cash and cash equivalents (cash flow risk). Interest rate derivatives are used to manage the overall interest rate profile within the Group policy, which is to maintain a higher proportion of debt at floating fixed rates of interest as a natural hedge to the net cash position. These are designated as either fair value or cash flow hedges as appropriate.

Rio Tinto, 2012 Annual Report (page 189)

Interest rate risk refers to the risk that the value of a financial instrument or cash flows associated with the instruments will fluctuate due to changes in market interest rates. Rio Tinto's interest rate management policy is generally to borrow and invest at floating interest rates. This approach is based on historical correlation between interest rates and commodity prices. In some circumstances, a higher proportion of fixed rate funding may be considered appropriate.

United Utilities, 2014 Annual Report (page 145)

The group's policy is to structure debt in a way that best matches its underlying assets and cash flows. The group earns an economic return on its Regulatory Capital Value (RCV), comprising a real return through revenues, determined by the real cost of capital fixed by the regulator for each five-year regulatory pricing period, and an inflation return as an uplift to its RCV.

The preferred form of debt therefore is sterling index-linked debt which incurs fixed interest, in real terms, and forms a natural hedge of regulatory assets and cash flows.

Where conventional long-term debt is raised in a fixed-rate form, to manage exposure to long-term interest rates, the debt is generally swapped at inception to create a floating rate liability for the term of the liability through the use of interest rate swaps. These instruments are typically designated within a fair value accounting hedge.

Appendix 2.3: Univariate results and correlation matrix

Table OA2.1 presents tests for differences in mean and medians between interest rate swap users and non-users. Interest rate swap users possess on average significantly lower default probabilities, higher leverage and both lower equity volatility and liquidity than non-users. Interest rate swap users also have bigger assets than non-users.

Table OA2.2 provides a correlation matrix for the variables employed in our analysis. The correlation between the various proxies of interest rate swap usage and the probability of default are all negative and statistically sigificant at the 5 percent

level or better. Furthermore, all the correlation coefficients between the independent variables are lower than 0.7, suggesting that our model does not have a multicollinearity problem.

Table OA2.1: Univariate results

This table provides the information about the number of observations, mean, median and standard errors of the variables used in our regression models between interest rate swap users and interest rate swap non-users. The sample consists of UK listed non-financial companies between 2001 and 2015. EDF is the expected default frequency. FIRM_SIZE is the natural logarithm of the market value of assets (in million $). LEVERAGE is calculated as the ratio of total debt to the market value of assets. PROFITABILITY is calculated as the ratio of EBIT over total assets. LIQUIDITY is calculated as the ratio of cash and cash equivalent over total assets. EQUITY_VOLATILITY is the annualised standard deviation of monthly stock returns over the prior twelve months. EXCESS_RETURN is calculated as the difference between the stock's annual return and the value weighted FTSE all shares index annual return over the same period. RATED is a dummy variable that is equal 1 if the firm has long-term credit rating. Except for the extent of interest rate swap usage variables, the other continuous variables are winsorised at the 1st and 99th percentiles. Mean and median difference between interest rate swap users and interest rate swap non-users are calculated based on t-test equality of means and Wilcoxon rank sum test, respectively. ***, ** and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Interest rate swap users				Interest rate swap non-users					
	Obs	Mean (1)	Median (2)	Std. Dev.	Obs	Mean (3)	Median (4)	Std. Dev.	Mean difference (1)-(3)	Median difference (2)-(4)
EDF	1,114	1.218	0.524	1.944	1,217	1.781	0.782	2.568	-0.563***	-0.258***
FIRM_SIZE	1,114	7.098	7.027	1.602	1,217	6.204	6.111	1.538	0.895***	0.916***
LEVERAGE	1,114	0.276	0.240	0.183	1,217	0.181	0.118	0.190	0.096***	0.122***
PROFITABILITY	1,114	0.084	0.080	0.067	1,217	0.077	0.085	0.099	0.006**	-0.005
EQUITY_VOLATILITY	1,114	34.785	28.481	20.837	1,217	39.277	32.840	21.870	-4.492***	-4.359***
EXCESS_RETURN	1,114	7.106	3.755	40.399	1,217	7.367	3.060	44.896	0.261	-3.612
LIQUIDITY	1,114	0.071	0.053	0.066	1,217	0.113	0.080	0.104	-0.042***	-0.027***
RATED	1,114	0.207	0.000	0.406	1,217	0.071	0.000	0.258	0.136***	0.000

Table OA2.2: Correlation matrix

This table presents the pairwise correlation matrix of variables used in our regression models. The sample consists of UK listed non-financial companies between 2001 and 2015. EDF is the expected default frequency. |SWAP_USAGE| is calculated as the absolute value of the difference between the final floating rate debt percentage and the initial floating rate debt percentage. |SWAP_TO_FLOATING| is calculated as the absolute value of the swap usage variable but only for those firms that are in net terms swapping to floating and non-swap users. |SWAP_TO_FIXED| is calculated as the absolute value of the swap usage variable but only for those firms that are in net terms swapping to fixed and non-swap users. FIRM_SIZE is the natural logarithm of the market value of assets (in million $). LEVERAGE is calculated as the ratio of total debt to the market value of assets. PROFITABILITY is calculated as the ratio of EBIT over total assets. LIQUIDITY is calculated as the ratio of cash and cash equivalent over total assets. EQUITY_VOLATILITY is the annualised standard deviation of monthly stock returns over the prior twelve months. EXCESS_RETURN is calculated as the difference between the stock's annual return and the value weighted FTSE all shares index annual return over the same period. RATED is a dummy variable that is equal 1 if the firm has long-term credit rating. Except for the extent of interest rate swap usage variables, the other continuous variables are winsorised at the 1st and 99th percentiles.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) EDF	1.000										
(2) |SWAP_USAGE|	0.101	1.000									
(3) |SWAP_TO_FLOATING|	-0.117	1.000	1.000								
(4) |SWAP_TO_FIXED|	-0.066	1.000	n/a	1.000							
(5) FIRM_SIZE	-0.515	0.130	0.254	0.019	1.000						
(6) LEVERAGE	0.462	0.127	0.112	0.154	-0.020	1.000					
(7) PROFITABILITY	-0.494	0.033	0.029	0.030	0.369	-0.257	1.000				
(8) EQUITY_VOLATILITY	0.635	-0.077	-0.079	-0.069	-0.393	0.402	-0.434	1.000			
(9) EXCESS_RETURN	-0.275	0.012	0.009	0.011	0.079	-0.262	0.149	-0.154	1.000		
(10) LIQUIDITY	0.101	-0.152	-0.105	-0.175	-0.208	-0.282	-0.155	0.085	0.054	1.000	
(11) RATED	-0.104	0.069	0.215	-0.070	0.519	0.172	0.088	-0.097	-0.021	-0.089	1.000

Chapter 3: Creditor Rights and Corporate Hedging: Evidence from the Airline Industry

3.1. Introduction

The need to understand why nonfinancial corporations hedge has attracted the attention of many scholars from around the world. The majority of studies have investigated the determinants of hedging behaviour in a single country setting, such as for US firms (e.g., Nance et al., 1993; Geczy et al., 1997; Haushalter, 2000; Graham and Rogers, 2002; and Carter et al., 2006). However, only a handful have extended this analysis to incorporate firms from many countries (e.g., Bartram et al., 2009; Lel, 2012; Lievenbruck and Schmid, 2014; and Bartram, 2019). Country studies have the advantage of examining not only firm-specific factors but also country-level or institutional factors as potential drivers of the decision to hedge or use derivatives. Country factors have included variables such as the size of local derivative markets and country-level corporate governance mechanisms. An area that has received limited attention is the role that country creditor rights might play in influencing firms' financing policies, such as the hedging of financial price risks.

Bankruptcy laws in weak creditor rights countries focus on rehabilitating and reorganising debtors in distress. In this setting, bankruptcy laws, wherever possible, provide an opportunity for debtors to start over with the goal of preserving the going-concern value of firms in financial distress by reorganising rather than liquidating them. In essence, failing firms are given time to restructure their operations and finances under the protection of the bankruptcy court. Conversely, in strong creditor protector regimes, lenders are afforded greater rights through the court system to recover what they are owed. The rules governing bankruptcy are more severe with respect to the bankrupt party. In such a setting, managers and shareholders face a greater likelihood of losing control of a firm in financial distress as they can be forced by lenders to reorganize their firms. Ultimately, this could lead to the firm ceasing its operations and selling its assets to satisfy all or a portion of the firm's outstanding debt.

It follows that managers and shareholders of firms in countries granting creditors strong legal rights to recover what they are owed are likely to be more risk averse than those in countries with weaker creditor rights. In stronger creditor rights

countries, this might manifest itself in less risk taking by way of the firm's financing and investment policy, such as lowering leverage, avoiding profitable but risky projects and partaking in risk-reducing investments (e.g., Acharya et al., 2011; Cho et al., 2014; and Seifert and Gonenc, 2012). Firms might also reduce risk by hedging more of the firm's financial price exposure. In this chapter, we examine the link between creditor rights and firms' use of derivatives using a natural laboratory, namely airlines from around the world. A cross-country analysis provides a large cross-sectional variation in creditor rights and jet fuel hedging activities. It also allows us to exploit differences in country-level creditor rights that are exogenous to firms' jet fuel hedging policies.

Our airlines' hedging measure is the percentage of expected jet fuel hedge requirement for the next year. This data is sourced directly from the airlines' annual report. Focusing on airlines' jet fuel hedging practices brings several advantages for our study. Firstly, expenditure on jet fuel by airlines is a significant component of their operating costs. For example, the average proportion of jet fuel costs to total operating costs for our sample is 29%[34], which suggests that airlines have relatively high levels of exposure to jet fuel price volatility. This can have a considerable impact on airlines' profit margins. Secondly, we can avoid the complication of heterogeneity in a cross-industry sample by concentrating on the airline industry. Thirdly, a large proportion of airlines disclose in their annual reports their jet fuel hedging plans in the form of the percentage of the forthcoming year's expected jet fuel consumption that has been hedged. Our measure of hedging has a significant advantage over previous studies because it is a very precise indicator of the extent of hedging. The extent of jet fuel hedging employed in this study allows us to distinguish between airlines that hedge a small fraction of their jet fuel exposure and those that hedge a large proportion of their underlying exposure.

Creditor rights refer to the rights accorded to creditors against defaulting debtors in different legal institutions. La Porta et al. (1998) construct an index, namely the creditor rights index, to measure the power of creditors against defaulting debtors in 49 counties. Then Djankov et al. (2007) greatly expand this creditor rights index for 129 countries. Basically, this index ranges from 0 to 4, with a higher value suggesting stronger creditor rights. This creditor rights index is employed in many

[34] For US airlines jet fuel costs have accounted for between 15% (Carter et al., 2006) and 20% (Rampini et al., 2014) of operating costs.

empirical studies, such as Acharya et al. (2011), Cho et al. (2014), Houston et al. (2010). Using a sample consisting of airlines from 36 countries, this chapter provides comprehensive and robust evidence of the impact of creditor rights on corporate hedging behaviour. To the best of our knowledge, this study is the first to show that in countries with stronger creditor rights, firms hedge more of their key financial price exposure. Specifically, we find that a unit increase in the creditor rights index leads to an increase in airlines' jet fuel hedging ratio by around 7.5%. This impact is economically significant because this increase accounts for nearly a third (31.5%) of the mean proportion of jet fuel hedging in our sample. Furthermore, by examining each component of the creditor rights index, our results show that in settings where it is relatively easy during reorganisation for creditors to seize control of assets and/or remove senior executives from their posts, airlines are hedging a higher fraction of their jet fuel exposure. These results are consistent with the notion that managerial self-preservation is a potential factor driving our results.

A challenge with our empirical analysis that employs hand-collected data from annual reports is that we could not obtain these reports for a small number of the population of listed airlines and as a result there might be a selection bias. We address this selection bias by employing a Heckman regression model. Another concern is that because of omitted variables, creditor rights can be endogenous in our regression model. In order to mitigate this, we perform an instrumental variables approach using countries' level of ethnolinguistic fractionalisation and countries' latitude as the instrumental variables. The analysis of the Heckman regression model and the instrumental variables approach confirms the validity of our results. Furthermore, to strengthen the interpretation of our results, we employ a fractional regression model for our analysis. The result from the fractional regression model shows that the marginal effects of creditor rights on the extent of jet fuel hedging are stronger in strong creditor rights countries and weaker in weak creditor rights countries.

In an attempt to deal further with the endogenous challenges in our model and to strengthen our analysis, we employ a model that is akin to a difference-in-difference model. Specifically, we identify six creditor rights reforms during our sample period. There were three instances where the creditor rights index decreased, this being the case in Brazil, France, and Germany, as well as three instances where the creditor

rights index increased, these being in Italy, Spain, and India. Our results show that the change that increases the creditor rights index can lead to an increase in airlines' jet fuel hedging, which further corroborates our findings. In summary, our study contributes to the line of literature on the determinants of hedging by showing that creditor rights are an important determinant of hedging.

We expand our analysis by examining the impact of creditor rights on airlines' jet fuel hedging during the period of the financial crisis and during episodes of high jet fuel prices. We find that the positive impact of creditor rights on the extent of jet fuel hedging is weakened during the financial crisis, which we believe is due to a drop in the willingness of banks to act as counterparties to derivative transactions during this period. In contrast, the impact of creditor rights is strengthened during the period of high jet fuel prices, although this impact disappears during the financial crisis. Therefore an important contribution of our paper is that we are the first to show that the effects of creditor rights on firm hedging are dampened during periods of economy-wide financial distress.

This chapter extends the literature on the real effects of hedging. On the one hand, strong creditor rights can lead to a reduction in "value destroying" risk-taking behaviour that can allow borrowers to expropriate lenders. On the other hand, strong creditor rights can reduce "value enhancing" risk-taking activities that might be beneficial to all stakeholders or increase "value destroying" risk-reducing activities that might be detrimental to all claimholders. For example, Acharya et al. (2011) report that firms make diversifying acquisitions in order to deal with strong creditor rights, although they find that this adversely affects firms' performance. We show, for the first time, that hedging can ameliorate this adverse side effect of strong creditor rights. Put differently, hedging allows firms to engage in value-enhancing risk-taking activities that similar non-hedging firms cannot undertake in strong creditor rights countries. Specifically, we show that jet fuel hedging enables airlines to increase their leverage and investment in aircraft by around 17.9% and 55.3% in strong creditor rights countries, respectively.

Furthermore, to the best of our knowledge, although many studies document the role of hedging in reducing firms' financial risk exposure (e.g., Berghofer and Lucey, 2014; Treanor et al., 2014a; Treanor et al., 2014b; and Bartram, 2019) or cost of debt (e.g., Campello et al., 2011; and Chen and King, 2014), we are the first to provide evidence that hedging reduces default risk in countries with weak creditor rights,

such as the United States. We believe that using default risk instead of other risk measures, such as stock volatility or stock return sensitivity employed in previous studies (e.g., Bartram, 2019), is more pertinent to our analysis since default risk is directly related to control rights, which in turn are directly affected by creditor rights.

The remainder of this chapter proceeds as follows. Section 3.2 reviews the literature on the determinants of hedging and the impact of creditor rights on firms' financing and investment policies. Section 3.3 discusses our data and methodology. The empirical results of how airlines' hedging practices react to strong creditor rights are reported in section 3.4. Sections 3.5 to 3.7 provide further evidence of the effect of creditor rights on an airline's jet fuel hedging by incorporating the impact of creditor rights reforms, the impact of the financial crisis and the effect of high jet fuel prices on our analysis. Section 3.8 investigates the real effects of jet fuel hedging. Finally, Section 3.9 concludes.

3.2. Literature review

3.2.1. Overview of determinants of hedging

In the absence of market imperfections, Modigliani and Miller (1958) suggest that firms should not employ hedging strategy at the corporate level because investors can reproduce their desired hedging strategy by themselves. However, a large and growing body of literature relaxes the perfect capital market assumptions and attempts to provide an economic rationale for why firms hedge.

One of the key motivations for corporate hedging is related to financial distress costs. Smith and Stulz (1985) present an analysis in which hedging can lower the probability of financial distress by decreasing the volatility of a firm's cash flows, which in turn reduces the expected costs of financial distress and so increases firm value. Many papers use leverage as the proxy for the expected costs of financial distress (e.g., Lel, 2012). Under the assumption that firms with higher leverage may have a higher probability of facing financial distress, a firm with higher leverage has more incentives to hedge to avoid financial distress. The positive relationship between leverage and hedging is also associated with the argument that hedging can effectively increase a firm's debt capacity, by stabilising the fluctuation of income and/or reducing the likelihood of financial distress (Stulz, 1996; Ross, 1997; and Leland, 1998).

Another proxy for the expected financial distress costs is firm size. Warner (1977) finds that the ratio of direct legal costs from bankruptcy and reorganisation or liquidation over the market value of total assets is lower for larger firms, suggesting that smaller firms are more likely to hedge. However, Block and Gallagher (1986) argue that larger firms with the advantage of scale economies to establish the hedging programme are more likely to hedge. As a result, there are competing hypotheses about the impact of firm size on hedging. A firm with higher levels of cash holdings or liquidity is less likely to hedge because cash can be used to offset the adverse effects of financial price movements and in so doing reduce the likelihood of financial distress. Most empirical studies document a positive impact of firm size and leverage and a negative impact of liquidity on the hedging decision (e.g., Haushalter, 2000; Graham and Rogers, 2002; Judge, 2006; Carter et al., 2006; Bartram et al., 2009; Lel, 2012; Lievenbruck and Schmid, 2014; Bartram, 2019; Huang et al., 2019; and Liu et al., 2020).

The role of hedging in reducing the expected financial distress costs suggests that firms facing financial constraints may have incentives to hedge. Carter et al. (2006) treat firms as financially constrained if the firms have no credit ratings and find that firms without a credit rating are more likely to hedge. In addition, firms paying no dividend are argued to be financially constrained (Fazarri et al., 1998) and therefore have a higher incentive to hedge (Bartram et al., 2009).

The literature suggests that hedging can also bring benefits to firms' stakeholders by mitigating the underinvestment problem (Bessembinder, 1991; and Froot et al., 1993). Bessembinder (1991) shows that, by committing to a hedging strategy at the time of a financing decision, firms can make the value of debt less sensitive to any incremental investment and therefore shareholders can enjoy a larger proportion of the incremental benefit from the new investment. As a result, this suggests that the incentive to underinvest can be attenuated by hedging. Froot et al. (1993) also argue that hedging, by lowering the volatility in firm cash flows, enables firms to have sufficient internal funds to invest in profitable projects that might otherwise be rejected. The majority of empirical studies use the market-to-book ratio and capital expenditure over total assets to capture firm growth and investment opportunities, respectively, and find mixed evidence about their impact on hedging (e.g., Geczy et al., 1997; Haushalter, 2000; Graham and Roger, 2002; Carter et al., 2006; Bartram et al., 2009; Lievenbruck and Schmid, 2014; and Bartram, 2019).

Hedging can generate tax-reducing benefits by decreasing the volatility of income for firms with a convex effective tax function (Smith and Stulz, 1985). Graham and Smith (1999) show that net operating losses can increase the variability of firms' income and therefore increase their incentives to hedge. Many papers employ net operating loss carryforwards as a proxy for tax function convexity (e.g., Nance et al., 1993; Geczy et al., 1997; Judge, 2006). Nevertheless, only Judge (2006) reports that firms with tax loss carryforwards have a higher propensity to hedge.

Another motivation for hedging is related to agency costs between managers and shareholders. Stulz (1984) and Smith and Stulz (1985) show that risk-averse managers may find the volatility of corporate income costly if their compensation is related to the firm's profit outcomes. As managers cannot diversify the firms' diversifiable risks, they can choose to hedge to reduce the volatility of the firms' income, although this may not be aligned with the best interest of the firms' shareholders. However, this conflict of interest can be attenuated if the managers' compensation plan includes stock options, whose value increases with greater variability in the stock price, implying that the use of stock options in the manager compensation plan can lower the managers' incentive to hedge.

Tufano (1996), Geczy et al. (1997), and Haushalter (2000) measure the managers' exposure to the lack of wealth diversification by the natural log of the market value of common shares owned by officers and directors. Carter et al. (2006) use the ratio of shares owned by executives over total number of share outstanding to proxy for this exposure. While Tufano (1996) and Carter et al. (2006) find evidence that an increase in hedging is associated with an increase in managerial shareholdings, Geczy et al. (1997) and Haushalter (2000) find no evidence that managerial shareholdings have a significant impact on hedging.

There is mixed evidence of the relationship between managerial holdings of stock options and hedging. Tufano (1996) finds that an increase in managerial option ownership can induce firms to hedge less, whereas Bartram (2019) finds a positive relationship between ownership of stock options and hedging. Several studies find no significant relationship (e.g., Geczy et al., 1997; Haushalter, 2000; Carter et al., 2006; and Bartram et al., 2009).

3.2.2. Overview of creditor rights and hypothesis development

Creditor rights refer to the rights accorded to creditors against defaulting debtors in different legal institutions. Differences in creditor rights can lead to differences in firms' risk-taking activities because in a strong creditor rights setting there is more likely to be a transfer of control rights from firms' managers to creditors in the event that a firm fails to meet the terms and conditions of its debt contract than in a weak creditor rights one (Rajan and Zingales, 1995; Acharya et al., 2011; Vig, 2013; and Cho et al., 2014). Creditor rights can also exert a large influence on the probability of inefficient liquidation (Aghion et al., 1992).

Acharya et al. (2011) investigate the impact of creditor rights on corporate risk-taking behaviour. They show that firms are more likely to undertake risk-reducing activities, such as a diversifying acquisition, in stronger creditor rights countries than in weaker creditor rights countries. They find that this activity adversely affects firms' performance. Rajan and Zingales (1995), Vig (2013), Acharya et al. (2011) and Cho et al. (2014) find that firms are more likely to reduce leverage in countries with stronger creditor rights. Given that reducing leverage can lead to a shortage of funds for investing in new profitable investments, Acharya et al. (2011) and Cho et al. (2014) conclude that strong creditor rights not only generate benefits, such as those associated with a reduction in firms' "value destroying" risk-taking behaviour, but also incur costs, due to a reduction in "value enhancing" risk-taking activities. Other empirical studies have also documented both benefits and costs of strong creditor rights. For example, Bae and Goyal (2009) investigate how differences in creditor rights affect loan spreads to borrowers and find that stronger creditor rights lead to a reduction in loan spreads. Seifert and Gonenc (2012) indicate that stronger creditor rights are associated with a decrease in firms' R&D expenditure. They argue that this effect is harmful to the development of firms because successful R&D investments can help firms to develop better products at a lower cost resulting in an increase in firms' cash flows. Overall, the literature supports the argument that strong creditor rights induce firms to avoid risk-taking activities.

It follows that strong creditor rights induce firms to pursue risk-reducing activities either through their investment or financing strategies. A financing strategy that has received limited attention in this literature is that of hedging with derivatives. Several studies have documented that the use of derivatives reduces firm risk, the cost of debt and the cost of equity (e.g., Guay, 1999b; Hentschel and Kothari, 2001; Nguyen

and Faff, 2010; Bartram et al., 2011; Campello et al., 2011; Gay et al., 2011; Zhou and Wang, 2013; Berghofer and Lucey, 2014; Treanor et al., 2014a; Treanor et al., 2014b; Chen and King, 2014; Ahmed et al., 2018; and Bartram, 2019). As there are studies that show that hedging strategies reduce risk and that strong creditor rights can encourage firms to employ risk-reducing activities, it is surprising that there are very few studies that investigate the relationship between creditor rights and derivatives hedging. To the best of our knowledge, perhaps the most relevant studies in this context are Lel (2012) and Livenbruck and Smich (2014).

Lel (2012) studies how the strength of internal firm-level corporate governance and external country-level governance exerts an impact on firms' use of currency derivatives using a sample of firms from 30 countries. The strength of creditor rights in each country is employed as one of the proxies for the level of external corporate governance. This study used the ratio of gross notional amounts of currency derivatives over foreign sales to proxy for the extent of currency derivatives use and shows that the impact of creditor rights on the use of currency derivatives is insignificant. This finding could be due to the fact that the measure of derivatives use employed does not correctly capture the extent of foreign currency hedging. For example, the notional values of foreign currency derivatives will include currency swaps that might not be directly related to foreign sales. Furthermore, firms that use a variety of foreign currency derivatives can have an offsetting or an aggregated derivative position, which will result in further mismeasurement of the extent of hedging as employed by Lel (2012).

Livenbruck and Smich (2014) use a dummy variable to proxy for the hedging decision when investigating the impact of creditors' rights on hedging behaviour by firms in the energy utilities sector from all over the world. Similar to Lel (2012), they do not find a significant relationship between creditor rights and firm hedging. Although using a binary variable can avoid mismeasurement errors faced by the type of hedging measure employed by Lel (2012), it does not exhibit variation over time or account for variation between hedging firms at a given point in time and therefore reduces the power of any statistical analysis (Zhou, 2001).

Bartram (2019) studies the impact of derivatives on the risk of nonfinancial firms from around the world. Bartram (2019) does not examine the impact of creditor rights on the decision to hedge but suggests that the strength of creditor rights might impact the relationship between the use of derivatives and firm risk. He argues that

firms in countries with stronger creditor rights will reduce risk more through derivatives hedging than similar firms in countries with weaker creditor rights. However, contrary to predictions, Bartram (2019) finds that the use of derivatives reduces total risk more in the weaker creditor rights countries than in the stronger creditor rights countries. However, Bartram (2019) does not take account of the possibility that a risk-reducing hedging strategy in a strong creditor rights setting could facilitate a risk-increasing financial or investment strategy such that the net impact on firm risk is neutral. In his study, one of the key assumptions is that companies will hedge more in a stronger creditor rights country. By using a dataset with a very precise measure of the extent of hedging, we can test this.

Overall, in line with the argument that strong creditor rights induce firms to engage in risk-reducing activities and given that hedging is an effective tool to reduce firm risk, we expect that airlines will engage more in risk-reducing activities via jet fuel hedging instruments in countries with stronger creditor rights. We, therefore, develop the following hypothesis:

Hypothesis 3.1: Airlines in strong creditor right countries hedge jet fuel exposure more than those in weak creditor right countries.

Although the aforementioned literature suggests the adverse impact of strong creditor rights on firms' leverage and investment (e.g., Acharya et al., 2011; Cho et al., 2014; and Seifert and Gonenc, 2012), it does not identify any tools that can mitigate these negative effects. As hedging will increase a firm's debt capacity and so facilitate higher leverage (Stulz, 1996; Ross, 1997; Leland, 1998; and Graham and Rogers, 2002), we conjecture that an airline with a jet fuel hedging programme can mitigate the negative impact of strong creditor rights on its financial leverage. As a result, we develop our second hypothesis as follows:

Hypothesis 3.2: Jet fuel hedging can allow airlines to increase the leverage in strong creditor right countries more than in weak creditor rights countries.

In addition, firms with a hedging programme will enjoy a reduction in the volatility of their cash flows and a resulting decrease in the probability of financial distress (Smith and Stulz, 1985). Because the threat of losing control rights to lenders is stronger in strong creditor rights countries than in weak creditor rights countries, one might expect that the negative impact of jet fuel hedging on firm default risk will be greater in stronger creditor rights countries. This leads us to our third hypothesis:

Hypothesis 3.3: Jet fuel hedging can decrease airlines' default risk in strong creditor rights countries more than in weak creditor rights countries.

Finally, the underinvestment problem may be more severe in strong creditor rights countries since firms may bypass investment opportunities when facing strong creditor rights (e.g., Acharya et al., 2011; and Seifert and Gonenc, 2012). However, the extant literature documents that hedging can mitigate this underinvestment problem (Bessembinder, 1991; and Froot et al., 1993). Consequently, we formulate the following hypothesis:

Hypothesis 3.4: Jet fuel hedging can increase the airlines' investment in strong creditor right countries more than in weak creditor rights countries.

3.3. Data, methodology, and variable construction

3.3.1. Data

It is of vital importance to have international airlines in our sample. The variations in creditor rights of different countries where these airlines operate enable us to study the impact of creditor rights on hedging behaviours. Our sample of listed airlines from around the world is generated as follows. Firstly, we collect as many annual reports (10-K filings in the US) going back in time as far as we can for all of the public airlines listed on the S&P Capital IQ database. We require that airlines' annual reports are available in English. Secondly, the countries in which the airlines are based must be covered in Djankov et al. (2007) so that we have information about creditor rights. Our sample period is from 2002 to 2016. We start our sample from 2002 because we can gather only a few annual reports before this year.

We hand-collect information from annual reports on airlines' hedging practices focusing in particular on the extent of jet fuel hedging. In their annual reports many airlines provide data on the percentage of the next 12 months' expected jet fuel consumption that is hedged with commodity derivatives.[35] We also collect information about airlines' use of foreign exchange and interest rate derivatives.[36] Specifically, we identify the following key words and read the text around these key words to determine whether firms are using derivatives, which types of derivative and the extent

[35] In some cases airlines provide this data for each quarter of the forthcoming year. In such circumstances we calculate the arithmetic average to arrive at a jet fuel hedging ratio for the year.

[36] For US airlines, we can find most of the derivative and hedging information in Item 7A, Quantitative and qualitative disclosures about market risk. In the Appendix of this chapter, we provide a few examples of hedging and derivative use disclosures found in airlines' annual reports.

of jet fuel hedging: *risk management, financial risk, fuel hedge, fuel, hedge, derivative, foreign currency, exchange rate, interest rate, swap, option*. The financial data for our airlines is sourced from Capital IQ. Our initial sample comprises 1,061 firm-year observations. However, after we exclude firm-year observations that have missing data for any of the variables employed in our study, we arrive at a final sample of 79 airlines from 36 countries, which generates 689 firm-year observations. The number of countries in our sample is not much different from that of previous studies that also employ the creditor rights index constructed by Djankov et al. (2007). For example, the sample of Seifert and Gonenc (2012) includes 41 countries. We provide details of the airlines that make up our sample in the Appendix of this chapter.

3.3.2. Methodology

We explore the relationship between creditor rights and airlines' jet fuel hedging behaviour by regressing the following equation:

$$FUEL_HEDGE_{i,t} = \beta_0 + \beta_1 (CR_i) + \Psi (CONTROL_A_{i,t}) + \varepsilon_{i,t} \quad (3.1)$$

where i and t index airline i and time t, respectively. In Equation 3.1, the dependent variable is FUEL_HEDGE, which is the proxy for airlines' jet fuel hedging behaviour, and the independent variable is CR, which is the proxy for creditor rights. CONTROL_A is a set of control variables for Equation 3.1. We follow the extant literature on the determinants of hedging to choose the control variables. Specifically, in this model, we control for both firm-level factors, such as firm size (FIRM_SIZE), leverage (LEVERAGE), firm liquidity (LIQUIDITY), firm growth (MB), firms' capital expenditure (CAPEX), firms' dividend payout policy (DIVIDEND), credit ratings (RATED), net operating loss (NOL), CEO ownership (CEO_OWNERSHIP), and firms' executives stock option (EXE_STOCK_OPTION), and country-level factors, such as the rights of minority shareholders (ANTI_SELF), GDP per capita (GDPPPP), and inflation (INFLATION). The definition of these variables will be presented in Section 3.3.3.

We firstly estimate Equation 3.1 by using a pooled OLS model. In robustness tests, we use different econometric methods, such as a Tobit model, a Heckman model, or an instrumental variables technique, to estimate Equation 3.1. Additionally, as our jet fuel hedging variable ranges between from 0 to 1, we employ a fractional regression model in order to deal with the concern that the impact of creditor rights on jet fuel hedging may not be constant throughout its range (from 0

to 4) (Papke and Wooldridge, 1996; and Wooldridge, 2010). In particular, we run the following fractional regression model:

$$E(FUEL_HEDGE_{it}|CR_{it}, CONTROL_{it}) = \Phi(\beta_0 + \beta_1 CR_i + \beta_2 CONTROL_A_{i,t} + \varepsilon_{i,t}) \quad (3.2)$$

where $E(FUEL_HEDGE_{it}|CR_{it}, CONTROL_A_{it})$ is the mean of FUEL_HEDGE conditional on creditor rights and other control variables that are similar to those in Equation 3.1. By employing the fractional regression model, the predicted value of FUEL_HEDGE also varies from 0 to 1.

Moreover, we are able to identify some creditor rights reforms during our sample period.[37] To investigate the impact of these creditor rights reforms on airlines' jet fuel hedging behaviour, we estimate the following regression:

$$FUEL_HEDGE_{i,t} = \beta_0 + \beta_1 (\Delta CR_{i,t}) + \Psi (CONTROL_A_{i,t}) + \varepsilon_{i,t} \quad (3.3)$$

where $\Delta CR_{i,t}$ captures the change in creditor rights of country i over time, which equals 1 if the creditor rights increase, -1 if the creditor rights decrease, and 0 if the creditor rights do not change in year t. Similar to Equation 3.1, the dependent variable of Equation 3.3 is FUEL_HEDGE. In this equation, we also use the same set of control variables as employed in Equation 3.1. We include year fixed effects and use a firm fixed-effects model to estimate Equation 3.3, making the estimation similar to a difference-in-differences analysis as in Bertrand and Mullainathan (2003) and Cornaggia et al. (2015). Following Favara et al. (2017), in this analysis of creditor rights reforms, we restrict our sample period to three years before and after the change of creditor rights.

In this chapter, we also examine the impact of jet fuel prices on the relationship between creditor rights and jet fuel hedging. To investigate this, we estimate the following model:

$$FUEL_HEDGE_{i,t} = \beta_0 + \beta_1 (CR_i) + \beta_2 (JF_PRICE_{t-1}) + \beta_3 (CR_i * JF_PRICE_{t-1}) + \Psi(CONTROL_A_{i,t}) + \varepsilon_{i,t} \quad (3.4)$$

In Equation 3.4, the dependent variable is FUEL_HEDGE. The independent variables are CR and JF_PRICE, which proxy for creditor rights index and jet fuel prices, respectively. We lag by one year the JF_PRICE because airlines determine their jet fuel hedging policy based on the past movement of jet fuel prices. For example, the risk manager of an airline publishing its annual report in March 2016 (which provides information on the jet fuel hedging policy) may determine the jet

[37] Detailed discussion about the creditor rights reforms is presented in Section 3.5.

fuel hedging ratio based on the historic movement of jet fuel price in 2015. To investigate the impact of creditor rights on jet fuel hedging at different levels of the jet fuel price, we interact CR with JF_PRICE. CONTROL_A is a set of control variables that are similar to those in Equation 3.1.

$\varepsilon_{i,t}$ is the error term of the aforementioned models. Year dummy variables are included in our model to control for year fixed effects. All the airlines' variables, except the extent of jet fuel hedging, are winsorised at the 1st and 99th percentiles to control for the impact of outliers. Furthermore, standard errors are adjusted to deal with heteroskedasticity and are clustered at the firm level.

Next, we estimate Equations 3.5, 3.6, and 3.7 below to examine the impact of jet fuel hedging on airlines' leverage, default risk, and investment spending at different levels of creditor rights, respectively.

$$LEVERAGE_{i,t} = \gamma_0 + \gamma_1(FUEL_HEDGE_{it}) + \gamma_2(CR_i) + \gamma_3(FUEL_HEDGE_{i,t} * CR_i) + \gamma(CONTROL_B) + \kappa_{i,t} \quad (3.5)$$

$$PD_{i,t} = \lambda_0 + \beta_1(FUEL_HEDGE_{it}) + \lambda_2(CR_i) + \lambda_3(FUEL_HEDGE_{i,t} * CR_i) + \lambda(CONTROL_C) + \nu_{i,t} \quad (3.6)$$

$$N_AIR_{i,t} = \phi_0 + \phi_1(FUEL_HEDGE_{it}) + \phi_2(CR_i) + \phi_3(FUEL_HEDGE_{i,t} * CR_i) + \phi(CONTROL_D) + \pi_{i,t} \quad (3.7)$$

In Equations 3.5, 3.6, and 3.7, i and t index airline i and time t, respectively. The dependent variables in Equations 3.5, 3.6, and 3.7 are LEVERAGE, PD, and N_AIR, which proxy for airlines' leverage, default risk, and investment, respectively. The independent variables in these Equations are FUEL_HEDGE and CR. We generate the interaction term between the extent of jet fuel hedging and creditor rights in these equations to investigate the non-linear impact of a jet fuel hedging strategy on an airline's leverage, probability of default, and investment. In Equation 3.5, the selection of control variables is based on the study of Graham and Rogers (2002). Specifically, the control variables include firm size (FIRM_SIZE), firm growth (MB), firm profitability (PROFITABILITY), firm liquidity (LIQUIDITY), firms' tangible assets (TANGIBILITY), firms' dividend payout policy (DIVIDEND), firms' credit ratings (RATED), countries' GDP per capita (GDPPPP), and countries' inflation (INFLATION). The set of control variables for Equations 3.6 and 3.7 is based on the models in Campello et al. (2011) and Chen and King (2014) for the cost of debt and investment spending, respectively. In Equation 3.6, we control for firm size (FIRM_SIZE), firm leverage (LEVERAGE), firm growth (MB), firm

profitability (PROFITABILITY), firm liquidity (LIQUIDITY), firms' tangible assets (TANGIBILITY), firms' Zscore (ZSCORE), firms' credit ratings (RATED), countries' GDP per capita (GDPPPP), and countries' inflation (INFLATION). In Equation 3.7, the control variables include firm size (FIRM_SIZE), firm leverage (LEVERAGE), firm growth (MB), firm profitability (PROFITABILITY), firm liquidity (LIQUIDITY), firms' Zscore (ZSCORE), firms' dividend payout policy (DIVIDEND), firms' credit ratings (RATED), countries' GDP per capita (GDPPPP), and countries' inflation (INFLATION). The definition of the control variables in Equations 3.5, 3.6, and 3.7 is provided in Section 3.3.3.

Lastly, $\nu_{i,t}$, $\kappa_{i,t}$, and $\pi_{i,t}$, are the error terms of Equations 3.5, 3.6, and 3.7, respectively. We also include year dummy variables when estimating Equations 3.5, 3.6, and 3.7. All the airlines' financial variables, except the extent of jet fuel hedging, are winsorised at the 1st and 99th percentiles. Furthermore, the standard errors are adjusted for heteroskedasticity and auto-correlation using the method of Newey and West (1994).[38]

3.3.3. Variable construction

3.3.3.1. Jet fuel hedging variable

In this chapter, we use the percentage of projected jet fuel hedge requirement for next year as the proxy for the airlines' jet fuel hedging variable. This information is collected directly from the airlines' annual report. We refer to this variable as the extent of jet fuel hedging.

3.3.3.2. Firm-level variables

In this section, we present the construction of firm-level variables mentioned in Section 3.3.2. FIRM_SIZE is measured as the natural logarithm of the market value of total assets (in $million). The leverage ratio of companies (LEVERAGE) is equal to the total debt divided by the market value of total assets. The quick ratio (LIQUIDITY) is measured by the sum of total cash and short-term investment and account receivables divided by total current liabilities.

[38] In unreported analysis, our results estimated from Equations 3.5 and 3.6 do not change if the standard errors are clustered at the firm level. Regarding the results estimated from Equation 3.7, the coefficient ϕ_3 is marginally significant.

The other firm-level variables in our model are firms' growth, which is computed as the ratio of the market value of equity over the book value of equity (MB), and the firms' capital expenditure, which is calculated as the ratio of capital expenditure over the market value of total assets (CAPEX). We also use the ratio of net property, plant, and equipment to the book value of total assets to proxy for firms' tangible assets (TANGIBILITY). Additionally, firm profitability is calculated as earnings before interest and taxes divided by total assets (PROFITABILITY).

Firms' dividend payout policy is proxied by a dummy variable, which is equal to 1 if an airline pays dividends and zero otherwise (DIVIDEND). The proxy for firms' credit rating is also a dummy variable that takes the value of 1 if an airline has a credit rating and zero otherwise (RATED). Another dummy variable is used to proxy for the firms' net operating loss (NOL). This variable captures the convexity of firms' tax functions and takes the value of 1 if an airline reports net operating loss and zero otherwise.

We employ two variables to proxy for the characteristics of airlines' managers, which are CEO_OWNERSHIP and EXE_STOCK_OPTION. CEO_OWNERSHIP is used as a proxy for the CEO exposure due to the lack of managerial diversification and is calculated as the percentage of CEO share ownership in the airlines. EXE_STOCK_OPTION controls the managerial ownership of stock options and is an indicator variable that takes the value of one if stock options are reported in the airlines' annual reports and zero otherwise.

In Equation 3.6, PD is a measure of firms' default risk or probability of default. This is calculated by using Merton's (1974) structural model of credit risk.[39] ZSCORE is an accounting based measure predicting bankruptcy of firms, which is computed based on Altman's (1968) formula.[40] Finally, in Equation 3.7, N_AIR is calculated as the number of aircraft owned by airlines scaled by the total assets.

3.3.3.3. Country-level and macroeconomics-level variables

The main independent variable in this chapter is creditor rights (CR). CR_i is measured as the creditor rights index of the country where the airline i has its headquarters. The creditor rights index, which originated from La Porta et al. (1998)

[39] Detailed information of how PD is calculated can be found in Baldassarri and Chen (2016).

[40] The formula for Altman Zscore is as follow: Zscore = 1.2*Working capital/Total assets + 1.4*Retained earnings/Total assets + 3.3*Earnings before interest and taxes/Total assets + 0.6*Market value of equity/Book value of total liabilities + 1.0*Total sales/Total asstes.

and is updated by Djankov et al. (2007), measures the relative strength of lenders to borrowers. This index is computed as the sum of the four following legal indicators: Restrictions On Reorganisation (REORG), No Automatic Stay (AUTOSTAY), Secured Creditor Paid First (SECURED), and No Management Stay (MANAGES). Each of the indicators equals one if the country has the bankruptcy code that is related to the indicator and provides protection to the creditors, and zero otherwise. The creditor rights index, thus, ranges from 0 for poor creditor rights countries to 4 for strong creditor rights countries.

In line with previous empirical studies investigating the impact of creditor rights on firms' financing and investment policies (e.g., Acharya et al., 2011; and Cho et al., 2014), this chapter uses the anti-self-dealing index (ANTI_SELF), which is constructed by Djankov, La Porta, Lopez-de-Silanes, and Shleifer (2008), to capture the impact of the minority shareholder rights on airlines' extent of jet fuel hedging. This index measures the minority shareholder protection against self-dealing transactions that benefit controlling shareholders at the expense of minority shareholders. A high score of the index is associated with strong protection for minority shareholders against self-dealing transactions of controlling shareholders.

We also include GDPPPP and INFLATION to capture the effects of time-varying country-specific factors because the variation in these factors over time might be directly related to derivative usage (Bartram et al., 2009; Lel, 2012; and Lievenbruck and Schmid, 2014). GDPPPP is the natural logarithm of GDP per capita, and INFLATION is the annual growth rate of the GDP implicit deflator. GDPPPP and INFLATION are gathered from the World Bank Database. Finally, in Equation 3.4, JF_PRICE is the US Gulf Coast Kerosene-type jet fuel spot price, which is collected from US Energy Information Administration (EIA).[41] We standardise JF_PRICE to interpret our results. All variables employed in this study are defined in Table 3.1.

[41] The website of US Energy Information Administration is https://www.eia.gov

Table 3.1: Variable definition and sources

This table provides the definition and sources of all variables employed in our paper.

Variable	Definition	Source
Company variables		
FUEL_HEDGE	The percentage of next year required jet fuel hedge.	Annual report
CPDERIVATIVE	This variable equals one if the airlines report to use commodity (jet fuel) derivative, and zero if the airlines do not use any derivative instrument.	Annual report
FXDERIVATIVE	This variable equals one if the airlines report to use foreign exchange derivative, and zero if the airlines do not use any derivative instrument.	Annual report
IRDERIVATIVE	This variable equals one if the airlines report to use interest rate derivative, and zero if the airlines do not use any derivative instrument.	Annual report
FIRM_SIZE	The natural logarithm of the market value of total assets, which equals the market value of equity plus the book value of total debt.	CAPIQ
LEVERAGE	The total debt divided by the market value of total assets	CAPIQ
LIQUIDITY	The sum of total cash and short-term investment and account receivables divided by total current liabilities.	CAPIQ
CAPEX	Capital expenditure over the market value of total assets	CAPIQ
MB	The market value of equity divided by the book value of equity.	CAPIQ
DIVIDEND	This variable equals one if the airlines pay dividends and zero otherwise.	CAPIQ

RATED	This variable equals one if the airlines have credit rating and zero otherwise.	CAPIQ
PROFITABILITY	Earnings before interest and taxes divided by total assets.	CAPIQ
TANGIBILITY	The ratio of net property, plant and equipment to the book value of total assets.	CAPIQ
NOL	This variable equals one if the airlines have net operating loss and zero otherwise.	CAPIQ
CEO_OWNERSHIP	The percentage share ownership of airlines' CEO.	CAPIQ
EXE_STOCK_OPTION	This variable equals one if executives stock options are reported in the annual reports and zero otherwise.	Annual report
ZSCORE	The accounting based measure predicting bankruptcy of firms is computed based on Altman (1968) formula.	CAPIQ
PD	Probability of default measured by using Merton's (1974) structural model of credit risk.	CAPIQ
ACCOUNTING	This variable equals one if the firm uses international accounting standard IFRS or US-GAAP, and zero otherwise.	CAPIQ
N_AIR	The number of aircraft owned by airlines scaled by the total assets.	CAPIQ
NUM_AIR_HEDGE	The percentage of firms in each country and in each year which use jet fuel hedging derivatives.	Annual report
JF_PRICE	The US Gulf Coast Kerosene-type jet fuel spot prices.	US Energy Information Administration
HO_PRICE	Heating oil prices.	US Energy Information Administration

Country variables		
CR	Creditor right index is the sum of four binary indicator variables RES_ORG, AUTO_STAY, SEC_FIRST, and MANAGE_STAY.	Djankov et al. (2007)
RES_ORG - Restriction on reorganisation	This variable equals one if there are restrictions, such as creditor consent or minimum dividends, for a debtor to file for reorganisation, and zero otherwise.	Djankov et al. (2007)
AUTO_STAY - No automatic stay	This variable equals one if secured creditors are able to seize their collateral after reorganisation is approved. For example, there is no automatic stay or assets freeze. This variable equals zero if the country law does not stipulate this regulation.	Djankov et al. (2007)
SEC_FIRST - Secured creditors paid first	This variable equals one if secured creditors are paid first as opposed to the other creditors such as government or workers, and zero otherwise.	Djankov et al. (2007)
MANAGE_STAY - No management stay	This variable equals one if management does not retain administration of its property pending the resolution of the reorganisation, and zero otherwise.	Djankov et al. (2007)
ANTI_SELF	The anti-self-dealing index is an index of the strength of minority shareholder protection against self-dealing by the controlling shareholder.	Djankov, La Porta, Lopez-de-Silanes, and Shleifer (2008)
LEGAL_INDEX	The strength of legal rights index measures the degree to which collateral and bankruptcy laws protect the rights of borrowers and lenders and thus facilitate lending.	World Bank Doing Business database
GDPPPP	Natural logarithm of GDP per capita	World Bank database
INFLATION	The annual growth rate of the GDP implicit deflator	World Bank database

EFL	Ethnolinguistic fractionalisation.	Alesina et al. (2003)
LATITUDE	The countries' latitude, scaled to take a value between zero and one.	La Porta et al. (1999)
LEGAL1	This variable equals one if the legal origin of the company law or commercial code of the country is English, and zero otherwise.	Djankov et al. (2007)
LEGAL2	This variable equals one if the legal origin of the company law or commercial code of the country is French, and zero otherwise.	Djankov et al. (2007)
LEGAL3	This variable equals one if the legal origin of the company law or commercial code of the country is German, and zero otherwise.	Djankov et al. (2007)
LEGAL4	This variable equals one if the legal origin of the company law or commercial code of the country is Nordic, and zero otherwise.	Djankov et al. (2007)
LEGAL5	This variable equals one if the legal origin of the company law or commercial code of the country is Socialist, and zero otherwise.	Djankov et al. (2007)
DER_MK_RANK	Derivative market rank. This is the inverse ranking of the size of the derivative market. The size of the derivative market is measured as the sum of the average daily turnover of foreign exchange and interest rate derivatives scaled by GDP.	Bank for International Settlements.
RULE_OF_LAW	Rule of law.	La Porta et al. (1998)
DEBT_ENFORCEMENT	Debt enforcement index.	Djankov, Hart, McLiesh, and Shleifer (2008)

JUDICIAL_EFFICIENCY	Efficiency of the judicial system.	La Porta et al. (1998)
PROPERTY_RIGHT	Property rights.	Miller and Kim (2016)
LTO	Long-term orientation index.	Hofstede (2001)
UAI	Uncertainty aversion index.	Hofstede (2001)
PDI	Power distance index.	Hofstede (2001)
MAS	Masculinity index.	Hofstede (2001)
IND	Individual index.	Hofstede (2001)

3.4. How do airlines react to creditor rights?

3.4.1. Univariate analysis

Panels A and B of Table 3.2 contain descriptive statistics for company and country characteristics of the variables used in this chapter, respectively. We find that the percentage of the projected consumption of jet fuel in the forthcoming year that is hedged ranges from 0% to 95% with a mean of approximately 23%. Berghofer and Lucey (2014) report a similar mean percentage of around 24% for their sample of international airlines. We also observe that the creditor rights index in our sample varies from the lowest creditor rights index (zero) to the highest creditor rights index (four).

Table 3.2: Summary statistics

This table shows the summary statistics for the variables used in this chapter. The sample consists of 79 airlines from 36 countries during the period from 2002 to 2016. FUEL_HEDGE is the percentage of next year required jet fuel hedge. FIRM_SIZE is the natural logarithm of the market value of total assets. LEVERAGE is the ratio of total debt divided by the market value of total assets. LIQUIDITY is the ratio of the sum of total cash and short-term investment and account receivables dividend to total current liabilities. MB is the market value of equity divided by the book value of equity. CAPEX is the ratio of capital expenditure over the market value of total assets. DIVIDEND is a dummy variable taking the value of one if the airlines pay dividends and zero otherwise. RATED is a dummy variable taking the value of one if the airlines have credit rating and zero otherwise. NOL is a dummy variable taking the value of one if the airlines have net operating loss and zero otherwise. CEO_OWNERSHIP is the percentage share ownership of airlines' CEO. EXE_STOCK_OPTION is a dummy variable taking the value of one if executive stock options are reported in the annual reports and zero otherwise. PROFITABILITY is calculated as the ratio of earnings before interest and taxes over total assets. TANGIBILITY is the ratio of net property, plant and equipment to the book value of total assets. ZSCORE is the accounting based measure predicting bankruptcy of firms, calculated based on Altman (1968) formula. PD is the probability of default, measured by using Merton's (1974) structural model of credit risk. N_AIR is the number of aircraft owned by airlines scaled by the total assets. CR is the creditor right index. ANTI_SELF is the anti-self-dealing index. DER_MK_RANK is the derivative market rank, which is calculated as the inverse ranking of the size of the derivative market. RULE_OF_LAW is the rule of law. DEBT_ENFORCEMENT is the debt enforcement index. JUDICIAL_EFFICIENCY measures the efficiency of the judicial system. PROPERTY_RIGHT is the property rights index. LTO is the long-term orientation index. UAI is the uncertainty aversion index. PDI is the power distance index. MAS is the masculinity index. IND is the individual index. GDPPPP is the natural logarithm of GDP per capita. INFLATION is the annual growth rate of the GDP implicit deflator.

Variable	Obs	Mean	Std. Dev.	Min	Max
PANEL A: COMPANY CHARACTERISTICS					
FUEL_HEDGE	689	0.238	0.267	0.000	0.950
FIRM_SIZE	689	7.552	1.709	3.262	10.467
LEVERAGE	689	0.507	0.256	0.000	0.966
LIQUIDITY	689	0.815	0.475	0.113	2.750
MB	689	1.749	2.719	-6.052	19.249
CAPEX	689	0.116	0.097	0.000	0.483
DIVIDEND	689	0.424	0.495	0.000	1.000
RATED	689	0.226	0.419	0.000	1.000

NOL	689	0.669	0.471	0.000	1.000
CEO_OWNERSHIP	256	2.602	7.630	0.000	46.61
EXE_STOCK_OPTION	689	0.567	0.496	0.000	1.000
PROFITABILITY	689	0.046	0.078	-0.217	0.277
TANGIBILITY	687	0.532	0.191	0.017	0.855
ZSCORE	679	1.655	1.287	-1.230	6.690
PD	658	0.045	0.111	0.001	1.000
N_AIR	544	0.076	0.123	0.009	0.705
PANEL B: COUNTRY CHARACTERISTICS					
CR	689	1.817	1.057	0.000	4.000
ANTI_SELF	689	0.597	0.196	0.160	1.000
DER_MK_RANK	656	16.134	9.483	1.000	36.000
RULE_OF_LAW	624	8.435	2.129	2.080	10.000
DEBT_ENFORCEMENT	647	0.537	0.241	0.000	1.000
JUDICIAL_EFFICIENCY	624	8.779	1.801	3.25	10.000
PROPERTY_RIGHT	689	70.508	22.762	20.000	95.000
LTO	494	42.028	28.952	0.000	118.000
UAI	627	55.668	19.483	8.000	112.000
PDI	627	46.499	16.818	11.000	104.000
MAS	627	54.946	15.741	5.000	95.000
IND	627	67.743	26.128	11.000	91.000
GDPPPP	689	10.064	1.108	6.477	11.485
INFLATION	689	3.012	3.373	-5.256	37.574

In order to investigate the impact of creditor rights and other characteristics on an airline's jet fuel hedging strategy, we firstly compare the mean and the median of these factors between the jet fuel derivative users and non-users based on an equality of means t-test and a Wilcoxon rank-sum test, respectively. The results, reported in Table 3.3, show that the mean of creditor rights is significantly higher for jet fuel derivative users, suggesting that airlines tend to use jet fuel hedging in countries with strong creditor rights. This supports our hypothesis 3.1. In contrast, airlines that use jet fuel derivatives are located more in the countries that have a lower anti-self-dealing index. This implies that the jet fuel hedging strategy may benefit controlling shareholders more than minor shareholders.

Table 3.3: Univariate results

This table provides information about the number of observations, mean, median, and standard errors of the independent and control variables used in Equation 3.1 between jet fuel derivative user and jet fuel derivative non-user. The sample consists of 79 airlines from 36 countries during the period from 2002 to 2016. CR is the creditor right index. ANTI_SELF is the anti-self-dealing index. FIRM_SIZE is the natural logarithm of the market value of total assets. LEVERAGE is the ratio of total debt divided by the market value of total assets. LIQUIDITY is the ratio of the sum of total cash and short-term investment and account receivables dividend to total current liabilities. MB is the market value of equity divided by the book value of equity. CAPEX is the ratio of capital expenditure over the market value of total assets. DIVIDEND is a dummy variable taking the value of one if the airlines pay dividends and zero otherwise. RATED is a dummy variable taking the value of one if the airlines have credit rating and zero otherwise. NOL is a dummy variable taking the value of one if the airlines have net operating loss and zero otherwise. CEO_OWNERSHIP is the percentage share ownership of airlines' CEO. EXE_STOCK_OPTION is a dummy variable taking the value of one if executive stock options are reported in the annual reports and zero otherwise. GDPPPP is the natural logarithm of GDP per capita. INFLATION is the annual growth rate of the GDP implicit deflator. The mean and median difference between the variables of jet fuel derivative users and non-users is calculated based on t-test equality of means and median test equality of medians, respectively. ***, ** and * indicate significance at the 1%, 5%, and 10% level (one-side), respectively.

	Jet fuel derivative user				Jet fuel derivative non-user					
	Obs	Mean	Median	Std. Dev.	Obs	Mean	Median	Std. Dev.	Mean difference	Median difference
		(1)	(2)			(3)	(4)		(1)-(3)	(2)-(4)
CR	383	1.869	1.000	1.146	306	1.752	1.000	0.932	0.118*	0.000
ANTI_SELF	383	0.543	0.630	0.215	306	0.665	0.650	0.143	-0.122***	-0.020***
FIRM_SIZE	383	8.074	8.282	1.378	306	6.900	7.243	1.856	1.174***	1.039***
LEVERAGE	383	0.497	0.497	0.238	306	0.519	0.556	0.277	-0.021	-0.059**
LIQUIDITY	383	0.820	0.742	0.424	306	0.810	0.717	0.533	0.009	0.025
MB	383	1.793	1.266	2.576	306	1.695	1.274	2.891	0.097	-0.008
CAPEX	383	0.118	0.098	0.094	306	0.114	0.092	0.100	0.004	0.006
DIVIDEND	383	0.420	0.000	0.494	306	0.428	0.000	0.496	-0.008	0.000
RATED	383	0.352	0.000	0.478	306	0.069	0.000	0.253	0.284***	0.000
NOL	383	0.705	1.000	0.457	306	0.624	1.000	0.485	0.081**	0.000
CEO_OWNERSHIP	124	0.693	0.034	3.377	132	4.395	0.382	9.794	-3.702***	-0.348***
EXE_STOCK_OPTION	383	0.572	1.000	0.495	306	0.562	1.000	0.497	0.010	0.000
GDPPPP	383	10.230	10.629	0.868	306	9.857	10.640	1.322	0.373***	-0.011
INFLATION	383	2.547	1.962	2.595	306	3.595	2.309	4.077	-1.049***	-0.347***

With respect to the other firm characteristics, Table 3.3 shows that there is a significant difference in firm size between the jet fuel derivative users and non-users based on both t-test equality of means and Wilcoxon rank-sum test. Specifically, the former has bigger assets than the latter. This result is consistent with the notion that the set-up of a jet fuel hedging programme is more costly for small companies. However, jet fuel derivative users have fewer tangible assets than the non-users, which supports the idea that firms with higher financial distress costs are more likely to hedge. Another significant aspect of the difference between the users and the non-users is related to whether the airlines have credit ratings. In contrast with our conjecture that the non-user will be the one having a credit rating, the results indicate that the proportion of rated airlines is higher in the user group. A possible explanation for this result is that the rated airlines may want to maintain their ratings.

Table 3.3 also provides univariate evidence of executives' incentives to use jet fuel hedging. We find that executives in airlines with jet fuel hedging programs have a lower percentage of share ownership and they appear to have more stock options. Table 3.4 reports a pairwise correlation matrix of the variables used in our Equation 3.1. It is apparent from this table that all the correlation values between variables are below 0.7, suggesting that our estimation model is not likely to have a multicollinearity problem.

Table 3.4: Correlation matrix

This table presents the correlation matrix of variables used in Equation 3.1. The sample consists of 79 airlines from 36 countries during the period from 2002 to 2016. FUEL_HEDGE is the percentage of next year required jet fuel hedge. CR is the creditor right index. ANTI_SELF is the anti-self-dealing index. FIRM_SIZE is the natural logarithm of the market value of total assets. LEVERAGE is the ratio of total debt divided by the market value of total assets. LIQUIDITY is the ratio of the sum of total cash and short-term investment and account receivables dividend to total current liabilities. MB is the market value of equity divided by the book value of equity. CAPEX is the ratio of capital expenditure over the market value of total assets. DIVIDEND is a dummy variable taking the value of one if the airlines pay dividends and zero otherwise. RATED is a dummy variable taking the value of one if the airlines have credit rating and zero otherwise. NOL is a dummy variable taking the value of one if the airlines have net operating loss and zero otherwise. CEO_OWNERSHIP is the percentage share ownership of airlines' CEO. EXE_STOCK_OPTION is a dummy variable taking the value of one if executive stock options are reported in the annual reports and zero otherwise. GDPPPP is the natural logarithm of GDP per capita. INFLATION is the annual growth rate of the GDP implicit deflator.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1) FUEL_HEDGE	1.000														
(2) CR	0.137	1.000													
(3) ANTI_SELF	-0.264	0.191	1.000												
(4) FIRM_SIZE	0.335	-0.149	-0.165	1.000											
(5) LEVERAGE	-0.052	-0.151	-0.189	0.160	1.000										
(6) LIQUIDITY	0.021	-0.091	0.024	-0.149	-0.475	1.000									
(7) MB	-0.029	-0.011	0.117	0.134	-0.320	0.082	1.000								
(8) CAPEX	0.041	0.018	0.067	-0.099	0.040	-0.043	-0.092	1.000							
(9) DIVIDEND	0.090	0.224	0.085	0.134	-0.224	0.045	0.078	0.025	1.000						
(10) RATED	0.273	-0.218	-0.047	0.425	-0.008	-0.046	0.128	0.056	-0.078	1.000					
(11) NOL	0.102	-0.049	-0.139	0.073	0.002	0.028	0.035	-0.076	0.016	-0.025	1.000				
(12) CEO_OWNERSHIP	-0.239	-0.146	-0.031	-0.405	-0.013	0.097	-0.025	-0.185	-0.221	-0.122	0.046	1.000			
(13) EXE_STOCK_OPTION	-0.112	-0.123	0.246	-0.010	-0.228	0.259	0.178	0.034	-0.099	0.276	-0.085	0.068	1.000		
(14) GDPPPP	0.154	-0.219	0.136	-0.104	-0.245	0.314	0.053	0.098	-0.204	0.274	0.101	0.062	0.354	1.000	
(15) INFLATION	-0.160	0.104	-0.171	-0.056	0.130	-0.116	-0.039	-0.049	0.014	-0.141	-0.130	-0.018	-0.159	-0.572	1.000

3.4.2. Multivariate analysis

3.4.2.1. Main results

The first set of our analysis investigates how airlines react to the local creditor protection environment. Table 3.5 presents the estimated results of Equation 3.1 using a pooled OLS regression model. The dependent variable in this regression is the percentage of next year's expected jet fuel consumption that is hedged.

Table 3.5: The impact of creditor rights on jet fuel hedging

This table provides results of pooled OLS regression of Equation 3.1. The sample consists of 79 airlines from 36 countries during the period from 2002 to 2016. FUEL_HEDGE is the percentage of next year required jet fuel hedge. CR is the creditor right index. RES_ORG equals one if there are restrictions, such as creditor consent or minimum dividends, for a debtor to file for reorganisation, and zero otherwise. AUTO_STAY equals one if secured creditors are able to seize their collateral after reorganisation is approved and equals zero if the country law does not stipulate this regulation. SEC_FIRST equals one if secured creditors are paid first as opposed to the other creditors such as government or workers, and zero otherwise. MANAGE_STAY equals one if management does not retain administration of its property pending the resolution of the reorganisation, and zero otherwise. ANTI_SELF is the anti-self-dealing index. FIRM_SIZE is the natural logarithm of the market value of total assets. LEVERAGE is the ratio of total debt divided by the market value of total assets. LIQUIDITY is the ratio of the sum of total cash and short-term investment and account receivables dividend to total current liabilities. MB is the market value of equity divided by the book value of equity. CAPEX is the ratio of capital expenditure over the market value of total assets. DIVIDEND is a dummy variable taking the value of one if the airlines pay dividends and zero otherwise. RATED is a dummy variable taking the value of one if the airlines have credit rating and zero otherwise. NOL is a dummy variable taking the value of one if the airlines have net operating loss and zero otherwise. CEO_OWNERSHIP is the percentage share ownership of airlines' CEO. EXE_STOCK_OPTION is a dummy variable taking the value of one if executive stock options are reported in the annual reports and zero otherwise. GDPPPP is the natural logarithm of GDP per capita. INFLATION is the annual growth rate of the GDP implicit deflator. The dependent variable in this regression is the percentage of next year required jet fuel hedge. Year dummy variables are included in the regressions but not reported. The robust standard errors are clustered at the firm level. ***, ** and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Dependent variable: FUEL_HEDGE					
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
CR	0.075***	0.132**				
	(0.027)	(0.051)				
RE_ORG			0.036			
			(0.063)			
AUTO_STAY				0.171***		
				(0.047)		
SECURED_FIRST					-0.046	
					(0.072)	
MANAGE_STAY						0.162***
						(0.050)
ANTI_SELF	-0.379***	-0.424	-0.328**	-0.284**	-0.281*	-0.304**
	(0.140)	(0.270)	(0.138)	(0.128)	(0.164)	(0.130)
FIRM_SIZE	0.047***	0.068***	0.043***	0.043***	0.042***	0.050***
	(0.013)	(0.024)	(0.015)	(0.013)	(0.015)	(0.013)
LEVERAGE	-0.078	-0.111	-0.135*	-0.087	-0.145*	-0.101
	(0.081)	(0.095)	(0.081)	(0.079)	(0.085)	(0.080)
LIQUIDITY	0.020	-0.056*	-0.001	0.010	-0.006	0.016
	(0.048)	(0.033)	(0.050)	(0.047)	(0.050)	(0.048)
MB	-0.007*	-0.011*	-0.009*	-0.008*	-0.008*	-0.006
	(0.004)	(0.005)	(0.005)	(0.004)	(0.005)	(0.004)

CAPEX	0.116	0.394**	0.128	0.154	0.141	0.120
	(0.130)	(0.189)	(0.145)	(0.134)	(0.139)	(0.131)
DIVIDEND	0.021	0.035	0.041	0.025	0.042	0.013
	(0.038)	(0.044)	(0.038)	(0.038)	(0.038)	(0.040)
RATED	0.112**	0.111*	0.101*	0.105**	0.096*	0.100**
	(0.050)	(0.063)	(0.054)	(0.049)	(0.054)	(0.049)
NOL	0.011	-0.027	0.009	0.008	0.007	0.009
	(0.030)	(0.043)	(0.035)	(0.030)	(0.035)	(0.031)
CEO_OWNERSHIP		0.002				
		(0.004)				
EXE_STOCK_OPTION	-0.082*	-0.067	-0.090**	-0.082**	-0.089**	-0.075*
	(0.042)	(0.052)	(0.044)	(0.041)	(0.043)	(0.040)
GDPPPP	0.054**	0.011	0.048*	0.035	0.040	0.038
	(0.023)	(0.029)	(0.028)	(0.024)	(0.026)	(0.024)
INFLATION	-0.006	-0.020***	-0.006	-0.010**	-0.007*	-0.006
	(0.004)	(0.007)	(0.004)	(0.004)	(0.004)	(0.004)
Constant	-0.523*	-0.301	-0.288	-0.254	-0.162	-0.319
	(0.302)	(0.467)	(0.372)	(0.300)	(0.330)	(0.304)
Observations	689	256	689	689	689	689
Year fixed effects	YES	YES	YES	YES	YES	YES
R-squared	0.345	0.503	0.278	0.358	0.278	0.347

As can be seen from column 1, the coefficient on the creditor rights index is positive and significant at the 1 percent level, suggesting that a higher creditor rights index has a positive impact on the fraction of jet fuel hedged. If the creditor rights index increases by a unit, the expected percentage of jet fuel hedged could increase by approximately 7.5%. This result implies that the impact of creditor rights is economically significant as this increase accounts for nearly a third (31.5%) of the mean proportion of jet fuel hedging. In column 2, the result remains qualitatively unchanged when we include the percentage of CEO share ownership. The number of observations, however, drops significantly due to the limited availability of this information. As a result, we do not include this variable in subsequent regressions.

In order to delineate more thoroughly the relative importance of creditor rights on airlines' jet fuel hedging behaviour, we investigate the impact of each component of creditor rights index on the extent of jet fuel hedging. The results are reported in columns 3, 4, 5, and 6 for RE_ORG - Restriction on reorganisation, AUTO_STAY - No automatic stay, SECURED_FIRST - Secured creditors paid first, and MANAGE_STAY - No management stay, respectively. We find that two out of four components have a significant impact on the hedging strategy. The first component having a significant impact on airlines' hedging behaviour is "No automatic stay", which captures the ability of the secured creditors to seize the companies' collateral after reorganisation is approved. Another important component is "No management

stay", which indicates whether the companies' management runs the business during the reorganisation. The common features of these two components are that they relate directly to whether the management of the companies retains control when their firms fall into administration. Our results suggest that airlines hedge more in those jurisdictions where it is more likely that the airlines' management will lose control of their firms when they undergo reorganisation. On the whole, our findings support hypothesis 3.1 and are consistent with the view that companies undertake more risk-reducing activities in the stronger creditor rights countries (e.g., Acharya et al., 2011; and Cho et al., 2014).

With regard to control variables, we find some interesting results. The anti-self-dealing index exerts a significantly negative impact on the extent of jet fuel hedging in all specifications in Table 3.5. Our finding is consistent with that of Acharya et al. (2011), who find that in countries with strong shareholder rights companies undertake a higher proportion of same industry mergers, which implies less operational hedging and therefore less risk reduction. We also find strong evidence of the economies of scale argument for hedging as the estimated coefficient on firm size is always positive and significant at the 1 percent level. This result is consistent with most empirical studies of hedging such as Haushalter (2000), Judge (2006), Lel (2012), and Lievenbruck and Schmid (2014).

What is surprising is that the coefficient on the credit ratings dummy variable is positive and significant in all specifications, which implies that rated airlines hedge more of their jet fuel exposure than unrated ones. A possible explanation for this may be because the rated airlines, especially the non-U.S. airlines, need to maintain their credit ratings to facilitate access to funding sources from capital markets.[42] Finally, we find that the coefficient on EXE_STOCK_OPTION is significantly negative in five out of six specifications, suggesting that when airline executives possess stock options airlines hedge less of their jet fuel exposure, which is consistent with Tufano (1996).

3.4.2.2. Robustness tests: controlling for omitted variables

In this section, we carry out a battery of robustness tests. We begin by including indicator variables for a country's legal origin when estimating Equation 3.1. La

[42] Aviation finance: Fasten your seatbelts (PWC report), January 2013, https://www.pwc.com/im/en/publications/assets/shipping-aircraft-space/pwc-aviation-finance-fastern-your-seat-belts-pdf.pdf

Porta et al. (1997), La Porta et al. (1998), and Djankov et al. (2007) argue that a country's legal origin can be a significant determinant of investor protection law. They find that common law countries have stronger creditor rights than civil law countries, implying that legal protection for lenders is better in common law countries rather than in civil law countries. Following Djankov et al. (2007), we identify five legal origins, these being English, French, German, Nordic, and Socialist. We include four dummy variables related to a country's legal origin in the estimation reported in column 1 of Table 3.6 to account for differences in countries' legal origin. The omitted legal origin dummy variable is the one for Socialist origin. We find that our results are qualitatively similar to our previous results in Table 3.5.

Table 3.6: Robustness tests: Controlling for omitted variables

This table provides results when we include more country-related variables in Equation 3.1. The sample consists of 79 airlines from 36 countries during the period from 2002 to 2016. FUEL_HEDGE is the percentage of next year required jet fuel hedge. CR is the creditor right index. LEGAL_INDEX is the strength of legal rights index. ANTI_SELF is the anti-self-dealing index. FIRM_SIZE is the natural logarithm of the market value of total assets. LEVERAGE is the ratio of total debt divided by the market value of total assets. LIQUIDITY is the ratio of the sum of total cash and short-term investment and account receivables dividend to total current liabilities. MB is the market value of equity divided by the book value of equity. CAPEX is the ratio of capital expenditure over the market value of total assets. DIVIDEND is a dummy variable taking the value of one if the airlines pay dividends and zero otherwise. RATED is a dummy variable taking the value of one if the airlines have credit rating and zero otherwise. NOL is a dummy variable taking the value of one if the airlines have net operating loss and zero otherwise. EXE_STOCK_OPTION is a dummy variable taking the value of one if executive stock options are reported in the annual reports and zero otherwise. GDPPPP is the natural logarithm of GDP per capita. INFLATION is the annual growth rate of the GDP implicit deflator. LEGAL1 equals one if the legal origin of the company law or commercial code of the country is English, and zero otherwise. LEGAL2 equals one if the legal origin of the company law or commercial code of the country is French, and zero otherwise. LEGAL3 equals one if the legal origin of the company law or commercial code of the country is German, and zero otherwise. LEGAL4 equals one if the legal origin of the company law or commercial code of the country is Nordic, and zero otherwise. DER_MK_RANK is the derivative market rank, which is calculated as the inverse ranking of the size of the derivative market. RULE_OF_LAW is the rule of law. DEBT_ENFORCEMENT is the debt enforcement index. JUDICIAL_EFFICIENCY measures the efficiency of the judicial system. PROPERTY_RIGHT is the property rights index. LTO is the long-term orientation index. UAI is the uncertainty aversion index. PDI is the power distance index. MAS is the masculinity index. IND is the individual index. The dependent variable in this regression is the percentage of next year required jet fuel hedge. Year dummy variables are included in the regressions but not reported. The robust standard errors are clustered at the firm level. ***, ** and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Dependent variable: FUEL_HEDGE								
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
CR	0.087***	0.076***	0.066**	0.079***	0.085***	0.069***	0.091***	0.078**	
	(0.029)	(0.027)	(0.025)	(0.026)	(0.024)	(0.025)	(0.031)	(0.031)	
LEGAL_INDEX									0.063**
									(0.029)
ANTI_SELF	-0.329*	-0.507***	-0.548***	-0.406***	-0.410***	-0.406***	-0.334*	-0.345**	-0.207
	(0.183)	(0.130)	(0.120)	(0.120)	(0.124)	(0.117)	(0.169)	(0.162)	(0.203)
FIRM_SIZE	0.059***	0.054***	0.058***	0.060***	0.061***	0.052***	0.049***	0.076***	0.046***
	(0.013)	(0.012)	(0.012)	(0.013)	(0.013)	(0.012)	(0.018)	(0.014)	(0.014)
LEVERAGE	-0.049	-0.117	-0.113	-0.111	-0.109	-0.094	-0.120	0.070	-0.109
	(0.078)	(0.080)	(0.079)	(0.076)	(0.080)	(0.081)	(0.078)	(0.103)	(0.085)
LIQUIDITY	0.013	0.001	-0.006	0.003	0.003	0.015	-0.037	0.096	0.002
	(0.047)	(0.047)	(0.048)	(0.046)	(0.047)	(0.046)	(0.037)	(0.057)	(0.046)
MB	-0.008*	-0.007*	-0.006	-0.010**	-0.010**	-0.008*	-0.009**	-0.002	-0.009*
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.007)	(0.005)

CAPEX	0.071	0.043	0.133	0.168	0.149	0.092	0.203	0.120	0.071
	(0.127)	(0.128)	(0.130)	(0.116)	(0.118)	(0.127)	(0.143)	(0.153)	(0.143)
DIVIDEND	0.018	0.030	0.037	0.039	0.038	0.024	-0.013	0.009	0.031
	(0.036)	(0.039)	(0.038)	(0.040)	(0.040)	(0.037)	(0.037)	(0.037)	(0.039)
RATED	0.100*	0.079	0.070	0.075	0.069	0.091*	0.144***	0.061	0.089
	(0.050)	(0.050)	(0.049)	(0.049)	(0.050)	(0.049)	(0.051)	(0.056)	(0.056)
NOL	0.016	0.008	0.012	0.010	0.010	0.021	-0.007	0.071*	0.008
	(0.029)	(0.033)	(0.033)	(0.031)	(0.031)	(0.032)	(0.036)	(0.039)	(0.035)
EXE_STOCK_OPTION	-0.082*	-0.055	-0.035	-0.065*	-0.064	-0.081**	-0.009	-0.075*	-0.077*
	(0.042)	(0.037)	(0.035)	(0.038)	(0.038)	(0.038)	(0.041)	(0.041)	(0.046)
GDPPPP	0.048**	0.030	0.036	0.064	0.035	0.000	-0.025	0.062***	0.023
	(0.021)	(0.030)	(0.024)	(0.044)	(0.032)	(0.035)	(0.043)	(0.021)	(0.027)
INFLATION	-0.008**	-0.009**	-0.009**	-0.010**	-0.010**	-0.004	-0.005	-0.006	-0.005
	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)	(0.007)	(0.004)	(0.004)
LEGAL1	0.080							0.181	-0.059
	(0.148)							(0.139)	(0.158)
LEGAL2	0.116							0.132	0.079
	(0.143)							(0.134)	(0.147)
LEGAL3	-0.030							-0.002	-0.022
	(0.144)							(0.134)	(0.158)
LEGAL4	0.200							0.231	0.122
	(0.155)							(0.152)	(0.153)
DER_MK_RANK		-0.004							
		(0.003)							
DEBT_ENFORCEMENT			0.207**						
			(0.096)						
RULE_OF_LAW				-0.019					
				(0.021)					
JUDICIAL_EFFICIENCY					-0.001				
					(0.018)				
PROPERTY_RIGHTS						0.004**			
						(0.001)			
LTO							0.003		
							(0.002)		
UAI							-0.001		
							(0.003)		

PDI							-0.011*		
							(0.006)		
MAS							0.001		
							(0.002)		
IND							-0.002		
							(0.002)		
Constant	-0.677**	-0.131	-0.411	-0.494	-0.350	-0.223	0.663	-1.095***	-0.258
	(0.335)	(0.415)	(0.315)	(0.386)	(0.324)	(0.351)	(0.734)	(0.319)	(0.366)
Observations	689	656	647	624	624	689	452	486	689
Year fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES
R-squared	0.377	0.370	0.395	0.403	0.398	0.374	0.530	0.438	0.306

In a series of further robustness tests we include other country-level variables that may affect the hedging behaviour of airlines. Firstly, we add derivative market rank (DER_MK_RANK), which is calculated in a manner similar to Bartram (2019), to control for the ability to access derivative markets. A higher derivative market rank refers to better access to derivative markets and thus we expect a positive relationship between DER_MK_RANK and FUEL_HEDGE. Secondly, we include a debt enforcement index (DEBT_ENFORCEMENT) that measures the strictness of the enforcement of debt contracts in default, the rule of law (RULE_OF_LAW) that measures the law and order tradition in the country, and an investor protection index that measures the efficiency of the judicial system (JUDICIAL_EFFICIENCY). The data for the debt enforcement index is sourced from Djankov, Hart, McLiesh, and Shleifer (2008) and the data for the other two variables is obtained from La Porta et al. (1998). The aforementioned three variables assess the degree of law enforcement in a country and a higher value of these variables is associated with a stricter degree of law enforcement, which may imply stronger creditor rights. As a result, we conjecture positive coefficients for the DEBT_ENFORCEMENT, RULE_OF_LAW and JUDICIAL_EFFICIENCY.

We also control for property rights in our model by using a property rights index (PROPERTY_RIGHTS), which is collected from Miller and Kim (2016). This index measures the degree to which a country's laws protect private property rights and a higher level of this index implies better enforcement of those laws. We, thus, predict a positive coefficient on PROPERTY_RIGHTS. Regressions that include the aforementioned country-level variables are reported in columns 2 to 6 of Table 3.6. The results relating to creditor rights are again qualitatively similar to those in Table 3.5. With respect to these new country-level variables, we find two cases whose coefficient is significantly positive, these being DEBT_ENFORCEMENT and PROPERTY_RIGHTS. These findings suggest that both creditor rights and the ability to enforce those rights seem to be important determinants of jet fuel hedging.

Our results remain unchanged when we include Hofstede's (2001) culture-based variables in our model.[43] The coefficient on creditor rights, which is presented in column 7 of Table 3.6, is still positive and significant at the 1 percent level. This result contradicts that found by Lievenbruck and Schmid (2014), who find that the

[43] We include long-term orientation index (LTO), uncertainty aversion index (UAI), power distance index (PDI), masculinity index (MAS), and individual index (IND) in our regression.

impact of creditor rights on hedging by firms in the energy utilities sector is insignificant after capturing the impact of culture-based variables. Regarding these cultural variables, only the power distance index (PDI) is significantly related to the extent of jet fuel hedging with a negative coefficient. The high PDI implies that "national elites hold relatively authoritarian views and that authority is based on traditional rather than on secular argument" (Mihet, 2013, page 116). Therefore, the companies' managers may be less likely to be accused of potential negative outcomes in countries with a high PDI. As a result, managers may feel it is not necessary to hedge or perhaps hedge less in these countries, which potentially explains the negative relationship between the PDI and the extent of jet fuel hedging. Lievenbruck and Schmid (2014) also find a negative impact of PDI on hedging in some specifications.

U.S. firms make up around 30 percent of our sample firm-year observations. In light of this we re-estimate Equation 3.1 excluding all the observations for US airlines. The results are reported in column 8 of Table 3.6. The coefficient on creditor rights is still positive and significant at the 5 percent level, suggesting that our results are not driven by US airlines.

Finally, in column 9 of Table 3.6 we address the concern that the creditor rights do not change over time. We replace our creditor rights variable with an alternative measure, namely the strength of legal rights index (LEGAL_INDEX), which is available for the period 2005 to 2016 from the World Bank Doing Business database. This index ranges between 0 to 10 for the period 2005 - 2014 and between 0 to 12 for the period 2015 – 2016 and measures "the degree to which collateral and bankruptcy laws protect the rights of borrowers and lenders and thus facilitate lending."[44] The higher the index is, the better the laws are designed to expand access to credit. We follow Qi et al. (2016) and divide this index by 2.5 during the period 2005–2014 and divide by 3 for the years 2015 and 2016 to normalise this index to the range of 0 and 4 and so make it comparable to the Djankov et al. (2007) creditor rights measure. Due to the unavailability of the strength of legal rights index before 2005, we use 2005 values of this index for the years 2002, 2003, and 2004.

Column 9 of Table 3.6 shows that the coefficient on LEGAL_INDEX is positive and significant at the 5 percent level, suggesting that airlines hedge more of their jet

[44] https://data.worldbank.org/indicator/IC.LGL.CRED.XQ

fuel exposure when the rights of lenders increase. In unreported analysis, the result remains qualitatively unchanged when we replace the legal rights index with the creditor rights index for the years 2002, 2003, and 2004.

It follows that our robustness results provide strong confirmation that a higher degree of creditor rights protection leads to more jet fuel hedging. Furthermore, using the smallest and largest creditor rights coefficients in Table 3.6, these robustness tests show that a unit increase in the creditor rights index will increase the extent of jet fuel hedging by an amount between 6.6% and 9.1%, which represents between 27.7% and 38.2% of the mean of the extent of jet fuel hedging in our sample. These results provide further corroboration that the impact of creditor rights on the extent of jet fuel hedging is economically significant.

3.4.2.3. Robustness tests: alternative estimation methods

In this section, we subject our data to a range of alternative estimation methods. The results are reported in Table 3.7. Firstly, we estimate Equation 3.1 using a Tobit regression with a left-censoring limit of 0 and a right-censoring limit of 1. It is arguable that Tobit regression methodology is suitable given that our dependent variable is zero for a nontrivial part of the population but positive for the remaining part of the population (Verbeek, 2017). Column 1 of Table 3.7 shows that the coefficient on creditor rights is 0.113 and significant at the 1 percent level in the Tobit model, implying that creditor rights exert a positive impact on the extent of jet fuel hedging.

Table 3.7: Robustness test: Alternative estimation methods

This table provides results when we employ different estimation methods to estimate Equation 3.1. The sample consists of 79 airlines from 36 countries during the period from 2002 to 2016. FUEL_HEDGE is the percentage of next year required jet fuel hedge. CR is the creditor right index. ANTI_SELF is the anti-self-dealing index. FIRM_SIZE is the natural logarithm of the market value of total assets. LEVERAGE is the ratio of total debt divided by the market value of total assets. LIQUIDITY is the ratio of the sum of total cash and short-term investment and account receivables dividend to total current liabilities. MB is the market value of equity divided by the book value of equity. CAPEX is the ratio of capital expenditure over the market value of total assets. DIVIDEND is a dummy variable taking the value of one if the airlines pay dividends and zero otherwise. RATED is a dummy variable taking the value of one if the airlines have credit rating and zero otherwise. NOL is a dummy variable taking the value of one if the airlines have net operating loss and zero otherwise. EXE_STOCK_OPTION is a dummy variable taking the value of one if executive stock options are reported in the annual reports and zero otherwise. GDPPPP is the natural logarithm of GDP per capita. INFLATION is the annual growth rate of the GDP implicit deflator. The dependent variable in this regression is the percentage of next year required jet fuel hedge. Column 1 runs Tobit regression with the right-censoring limit of 0 and left-censoring limit of 1. Column 2 presents the results from Heckman regression. Column 3 employs an instrumental variables technique, in which ETHNIC and LATITUDE are instrumental variables for CR. Year dummy variables are included in the regressions but not reported. The robust standard errors are clustered at the firm level. ***, ** and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Dependent variable: FUEL_HEDGE		
	TOBIT	HECKMAN	IV-GMM
VARIABLES	(1)	(2)	(3)
CR	0.113***	0.072**	0.101***
	(0.041)	(0.033)	(0.034)
ANTI_SELF	-0.664***	-0.385**	-0.402***
	(0.199)	(0.158)	(0.137)
FIRM_SIZE	0.089***	0.045**	0.049***
	(0.024)	(0.023)	(0.013)
LEVERAGE	-0.163	-0.075	-0.053
	(0.151)	(0.079)	(0.093)
LIQUIDITY	0.026	0.020	0.028
	(0.090)	(0.047)	(0.051)
MB	-0.010	-0.007*	-0.007*
	(0.008)	(0.004)	(0.004)
CAPEX	0.236	0.108	0.112
	(0.226)	(0.165)	(0.129)
DIVIDEND	0.011	0.024	0.014
	(0.067)	(0.052)	(0.039)
RATED	0.168**	0.116*	0.119**
	(0.079)	(0.063)	(0.048)
NOL	0.021	0.10	0.011
	(0.053)	(0.032)	(0.029)
EXE_STOCK_OPTION	-0.107	-0.083***	-0.079*
	(0.069)	(0.044)	(0.043)
GDPPPP	0.095**	0.055*	0.059**
	(0.046)	(0.027)	(0.023)
INFLATION	-0.012	-0.006	-0.006
	(0.009)	(0.005)	(0.004)
Constant	-1.237**	-0.519*	-0.638*
	(0.578)	(0.296)	(0.353)
Observations	689	882	689
Year fixed effects	YES	YES	YES
Kleibergen-Paap rk LM statistic (p-value)			0.000
Cragg-Donald Wald F statistic			103.685
Hansen statistic (pvalue)			0.677
R-squared			0.337
Pseudo R-squared	0.325		
Log pseudolikelihood	-312.38	-371.00	

Next, we attempt to control for sample selection bias using a Heckman regression model. There might be selection bias because we could not observe the extent of jet fuel hedging for all airlines in our sample, especially as some airlines do not apply international accounting standards. In addition to all the independent variables of the outcome equation of the Heckman model, we include an instrument, a dummy variable that indicates whether the airlines use an international accounting standard (IFRS or US-GAAP), to the selection equation of the Heckman model. The dependent variable in the selection equation is a binary variable that equals 1 if we can observe FUEL_HEDGE and zero otherwise. The results are illustrated in column 2 of Table 3.7 and show that the coefficient on the creditor rights is still positive and significant at the 5 percent level.

There is a possibility that the creditor rights variable is endogenous in our regression model, therefore we employ an instrumental variables technique to estimate Equation 3.1. Our instrumental variable needs to possess the property that any change in the instrumental variable is exogenously associated with the variation in creditor rights and that this change does not directly lead to a variation in the extent of jet fuel hedging. The academic literature that brings together the themes of law, institutions and finance reveals some potential candidates for our instrumental variables. In our study, we employ two instrumental variables for creditor rights. The first instrumental variable is ethnolinguistic fractionalisation (EFL), which measures the probability that two randomly selected individuals from a given country belong to different ethnolinguistic groups. There is widespread evidence that countries with a high EFL tend to adopt institutions that allow one powerful group to expropriate resources from others (e.g., La Porta et al., 1999; Beck et al., 2003; Alesina et al., 2003; and Beck et al., 2006). As a result, lenders may be less protected in those countries, implying that those countries are likely to have weak creditor rights. In addition, because EFL does not have a direct impact on airlines' hedging behaviour, it is arguable that EFL may be a good instrumental variable for creditor rights. In our study, the data for EFL is collected from Alesina et al. (2003).

Our next instrumental variable is the geographic latitude of the countries in our sample. According to endowment theory (Acemoglu et al., 2001; and Beck et al., 2003) there is a close relationship between geographical endowment and political and financial institutional development. Beck et al. (2003) find that legal systems in countries closer to the equator provide a lower degree of protection of property

rights, implying that geographic latitude may be linked to creditor rights. Moreover, in a manner similar to EFL, geographic latitude does not exert any direct impact on an airline's jet fuel hedging strategy. It follows that a country's latitude may also be a potential instrumental variable for creditor rights. La Porta et al. (1999) report a scaled measure of a country's latitude, which takes a value between zero and one. We employ this scaled latitude measure as an instrumental variable for creditor rights.

Column 3 of Table 3.7 presents the results from the instrumental variables estimator implemented using the General Method of Moment (IV-GMM). The results show that the coefficient on creditor rights continues to be positive and highly significant at the 1 percent level, confirming the positive impact of creditor rights on the extent of jet fuel hedging. The post-estimation tests for the instrumental variables estimation confirm the validity of our instrumental variables. The first post-estimation test is the underidentification test. The Kleibergen-Paap rk LM statistic is 15.441 and significant at the 1 percent level, suggesting that our excluded instruments (EFL and LATITUDE) are correlated with the endogenous variable (CR).

The second post-estimation test is the weak identification test. The Cragg-Donald Wald F statistic is 103.69, which is much higher than 10. Therefore, we can argue that our instrumental variables are not weakly correlated with the creditor rights. The third post-estimation test is to check whether the instruments are valid instruments based on the Sargan-Hansen test. Our Hansen J statistic is 0.174 with a p-value of 0.6766, proving that we cannot reject the null hypothesis that our instrumental variables are valid instruments. All in all, our results from the instrumental variables analysis are valid and in strong accordance with our previous results.

Finally, as mentioned in Section 3.3.2, we employ a fractional regression model in order to deal with the concern that the impact of creditor rights on jet fuel hedging may not be constant throughout its range (from 0 to 4). In Panel A of Table 3.8, we present the results from the fractional regression model. The coefficient on creditor rights is positive and significant at the 1 percent level, suggesting that an increase in the extent of jet fuel hedging is associated with an increase in creditor rights. In addition, Panel B reports the marginal effects of creditor rights at each level of 0, 1, 2, and 3 on the extent of hedging, corresponding to the effects of creditor rights when the creditor rights index rises from 0 to 1, from 1 to 2, from 2 to 3, and from 3 to 4,

respectively. We do not report the marginal effects of creditor rights when the creditor rights index equals 4 because 4 is the maximum value of the creditor rights index and therefore the creditor rights index cannot increase from 4 to 5. We find that the magnitude of the marginal effect is greater at higher levels of creditor rights and the difference is economically significant. For example, when the creditor rights index increases from 0 to 1, the extent of jet fuel hedging increases by 4.7%. However, an increase from 3 to 4 of the creditor rights index generates a 7.7% increase in the extent of jet fuel hedging, which is approximately 1.6 times higher than the increase generated going from a creditor rights index of 0 to 1. This provides more evidence that airlines hedge more of their jet fuel exposure in stronger creditor rights countries. To sum up, our results from a range of econometric methods demonstrate a remarkable level of consistency in the impact of creditor rights on the extent of airlines' jet fuel hedging.

Table 3.8: Robustness test: Fractional regression model

This table provides results when we employ a fractional regression model to estimate Equation 3.2. The sample consists of 79 airlines from 36 countries during the period from 2002 to 2016. FUEL_HEDGE is the percentage of next year required jet fuel hedge. CR is the creditor right index. ANTI_SELF is the anti-self-dealing index. FIRM_SIZE is the natural logarithm of the market value of total assets. LEVERAGE is the ratio of total debt divided by the market value of total assets. LIQUIDITY is the ratio of the sum of total cash and short-term investment and account receivables dividend to total current liabilities. MB is the market value of equity divided by the book value of equity. CAPEX is the ratio of capital expenditure over the market value of total assets. DIVIDEND is a dummy variable taking the value of one if the airlines pay dividends and zero otherwise. RATED is a dummy variable taking the value of one if the airlines have credit rating and zero otherwise. NOL is a dummy variable taking the value of one if the airlines have net operating loss and zero otherwise. EXE_STOCK_OPTION is a dummy variable taking the value of one if executive stock options are reported in the annual reports and zero otherwise. GDPPPP is the natural logarithm of GDP per capita. INFLATION is the annual growth rate of the GDP implicit deflator. In Panel A, the dependent variable in this regression is the percentage of next year required jet fuel hedge. Year dummy variables are included in the regressions but not reported. In Panel B, the results show the marginal effects of the creditor right index on the percentage of next year required fuel hedge at each level from 0 to 3. The robust standard errors are clustered at the firm level. ***, ** and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Panel A: Fractional Regression	Panel B: Marginal effects	
	Dependent variable:		
VARIABLES	FUEL_HEDGE	At:	dy/dx
CR	0.246***	CR = 0	0.047***
	(0.0862)		(0.010)
ANTI_SELF	-1.246***	CR = 1	0.058***
	(0.431)		(0.017)
FIRM_SIZE	0.192***	CR = 2	0.068***
	(0.0501)		(0.025)
LEVERAGE	-0.287	CR = 3	0.077**
	(0.322)		(0.030)
LIQUIDITY	0.127		
	(0.186)		
MB	-0.0242		
	(0.0168)		
CAPEX	0.510		
	(0.487)		
DIVIDEND	0.0714		
	(0.135)		
RATED	0.333**		
	(0.165)		
NOL	0.0605		
	(0.117)		
EXE_STOCK_OPTION	-0.309**		
	(0.145)		
GDPPPP	0.206**		
	(0.100)		
INFLATION	-0.0232		
	(0.0184)		
Constant	-3.871***		
	(1.252)		
Observations	689		
Year fixed effects	YES		
Pseudo R-squared	0.130		
Log pseudolikelihood	-328.93		

3.4.2.4. Robustness tests: using binary measures of hedging

A potential drawback of using the extent of jet fuel hedging data is that we lose about 10 percent of our sample, comprising firms that indicate they hedge their jet fuel exposure but do not disclose data on the extent of jet fuel hedging. Therefore, as a robustness test we investigate the impact of creditor rights on the decision to hedge and consequently employ a binary dependent variable, indicating whether an airline uses a particular derivative instrument or not. We use a logistic regression model to estimate our model. The first binary dependent variable we use is CPDERIVATIVES, which equals 1 if an airline uses commodity (jet fuel) derivatives, and zero if the airline does not use any derivative instrument. Similarly, we construct additional binary variables labelled as FXDERIVATIVES and IRDERIVATIVES corresponding to the use of foreign exchange and interest rate derivatives, respectively.

The results from the logistic regression are reported in Table 3.9. In column 1, the dependent variable is CPDERIVATIVES. The significantly positive coefficient on the creditor rights variable suggests that airlines are more likely to use commodity derivatives in stronger creditor rights countries. Our findings remain unchanged when we use FXDERIVATIVES as a dependent variable in column 2 and IRDERIVATIVES in column 3.[45] On the whole, our robustness results indicate that airlines have a higher propensity to employ derivative hedging strategies when they face stronger creditor rights. This further supports the notion that the strength of creditor rights is an important driver of airlines' risk management activities.

[45] In unreported analysis, we use a binary variable that equals 1 if the airline companies use any derivative instruments and 0 otherwise. The results are similar to those in Table 3.9.

Table 3.9: Robustness tests: Using binary measures of hedging

This table provides results from logistic regression when we estimate Equation 3.1 with the dependent variable as the dummy variables. The sample consists of 79 airlines from 36 countries during the period from 2002 to 2016. Columns 1, 2, and 3 use CPDERIVATIVE, FXDERIVATIVE, and IRDERIVATIVE as dependent variables, respectively. CPDERIVATIVE quals one if the airlines report to use commodity (jet fuel) derivative, and zero if the airlines do not use any derivative instrument. FXDERIVATIVE quals one if the airlines report to use foreign exchange derivative, and zero if the airlines do not use any derivative instrument. IRDERIVATIVE quals one if the airlines report to use interest rate derivative, and zero if the airlines do not use any derivative instrument. FUEL_HEDGE is the percentage of next year required jet fuel hedge. CR is the creditor right index. ANTI_SELF is the anti-self-dealing index. FIRM_SIZE is the natural logarithm of the market value of total assets. LEVERAGE is the ratio of total debt divided by the market value of total assets. LIQUIDITY is the ratio of the sum of total cash and short-term investment and account receivables dividend to total current liabilities. MB is the market value of equity divided by the book value of equity. CAPEX is the ratio of capital expenditure over the market value of total assets. DIVIDEND is a dummy variable taking the value of one if the airlines pay dividends and zero otherwise. RATED is a dummy variable taking the value of one if the airlines have credit rating and zero otherwise. NOL is a dummy variable taking the value of one if the airlines have net operating loss and zero otherwise. EXE_STOCK_OPTION is a dummy variable taking the value of one if executive stock options are reported in the annual reports and zero otherwise. GDPPPP is the natural logarithm of GDP per capita. INFLATION is the annual growth rate of the GDP implicit deflator. LEGAL1 equals one if the legal origin of the company law or commercial code of the country is English, and zero otherwise. LEGAL2 equals one if the legal origin of the company law or commercial code of the country is French, and zero otherwise. LEGAL3 equals one if the legal origin of the company law or commercial code of the country is German, and zero otherwise. LEGAL4 equals one if the legal origin of the company law or commercial code of the country is Nordic, and zero otherwise. Year dummy variables are included in the regressions but not reported. The robust standard errors are clustered at the firm level. ***, ** and * indicate significance at the 1%, 5%, and 10% level, respectively.

	DEPENDENT VARIABLE		
	CPDERIVATIVE	FXDERIVATIVE	IRDERIVATIVE
VARIABLES	(1)	(2)	(3)
CR	1.449***	2.217***	0.648*
	(0.331)	(0.413)	(0.389)
ANTI_SELF	-2.978*	-2.835	1.545
	(1.621)	(2.405)	(2.179)
FIRM_SIZE	0.987***	1.123***	0.766***
	(0.190)	(0.237)	(0.200)
LEVERAGE	-1.944*	-1.197	1.347
	(1.066)	(1.218)	(1.021)
LIQUIDITY	-0.595	0.320	0.337
	(0.631)	(0.631)	(0.521)
MB	-0.075	-0.026	0.076*
	(0.051)	(0.055)	(0.046)
CAPEX	1.358	0.100	1.295
	(1.652)	(1.750)	(1.950)
DIVIDEND	-0.340	0.320	-0.302
	(0.498)	(0.525)	(0.432)
RATED	0.778	0.871	-0.723
	(0.670)	(0.745)	(0.657)
NOL	0.005	-0.334	-0.214
	(0.453)	(0.629)	(0.552)
EXE_STOCK_OPTION	0.615	0.195	-0.921*
	(0.457)	(0.474)	(0.541)
GDPPPP	0.169	0.099	0.170
	(0.250)	(0.268)	(0.233)
INFLATION	-0.174***	-0.168**	-0.119*

	(0.060)	(0.066)	(0.066)
LEGAL1	-0.360	-1.064	-1.969**
	(1.087)	(0.961)	(0.890)
LEGAL2	1.873	1.276	0.220
	(1.396)	(1.356)	(1.031)
LEGAL3	-1.004	-2.072**	-2.517**
	(1.142)	(1.053)	(1.019)
LEGAL4	2.274	1.892	1.577
	(1.479)	(1.296)	(1.326)
Constant	-7.751**	-9.326**	-8.340**
	(3.928)	(4.454)	(3.590)
Observations	758	702	674
Year fixed effects	YES	YES	YES
Pseudo R-squared	0.407	0.464	0.276
Log Pseudolikelihood	-249.04	-216.42	-337.05

3.5. The impact of creditor rights reforms on airlines' jet fuel hedging

We extend our analysis by investigating the impact of an exogenous change in creditor rights on airlines' jet fuel hedging practices. The bankruptcy law reforms in Brazil, France, Italy, Spain, Germany, and India are well documented in previous studies (Rodano et al., 2016; Ponticelli and Alencar, 2016; Favara et al., 2017; Canipek et al., 2018; and Mohanty and Sundaresan, 2018). In Brazil, the government was inspired by Chapter 7 and 11 of the US bankruptcy code and introduced a new bankruptcy law that added the term "automatic stay" to the Brazilian bankruptcy code in 2005. This change allowed debtors to initiate debt negotiation more easily and therefore reduced its score of creditor rights by one point. Similarly, the reform in France in 2005 was also inspired by Chapter 11 of the US bankruptcy code. France added to its bankruptcy code the practice of reorganisation that allows management to retain control of distressed companies. As a result, this reform decreased the French creditor rights index (see Rodano et al., 2016, for a detailed discussion).

In Germany, the changes in the bankruptcy code were stipulated in the Act for the Further Facilitation of the Restructuring of Companies in 2012. Before the adoption of this Act, secured creditors had strong liquidation rights and the incumbent management could be dismissed immediately from the company upon a bankruptcy filing. However, the adoption of this Act permitted management to keep their position and continue to manage the company despite the attempts of secured creditors to recover their loans. This Act, therefore, led to the decline of creditor rights in Germany (see Canipek et al. (2018) for a detailed discussion).

In contrast to the above countries that have witnessed a decrease in creditor rights, some other countries have experienced an increase in creditor rights. For example, Italy amended its bankruptcy code in 2006 to facilitate debt renegotiations. Rodano et al. (2016) present evidence showing that this legal change, which represents a major improvement of the creditor rights in Italy, led to an increase in the value of restructured debt. In addition, Djankov et al. (2007) document that creditor rights in Spain increased in 2004.[46] Finally, in 2016, the Indian Parliament introduced the new Insolvency and Bankruptcy Code that could reduce significantly the time it took to decide whether a company defaulted. Hence, this code led to an increase of creditor rights in India. To sum up, we document that creditor rights decreased in Brazil (2005), France (2005), and Germany (2012) while they increased in Italy (2005), Spain (2004), and India (2016). We regress Equation 3.3 to investigate the impact of these creditor rights reforms on the extent of jet fuel hedging. Our results are reported in Table 3.10.

Table 3.10: The impact of creditor rights reforms

This table provides estimation results of Equation 3.3 by a fixed-effects model. In this analysis, we restrict our sample period to three years before and after the change of creditor rights. FUEL_HEDGE is the percentage of next year required jet fuel hedge. ΔCR equals 1 if the creditor rights increase, -1 if the creditor rights decrease, and 0 if the creditor rights do not change in year t. ANTI_SELF is the anti-self-dealing index. FIRM_SIZE is the natural logarithm of the market value of total assets. LEVERAGE is the ratio of total debt divided by the market value of total assets. LIQUIDITY is the ratio of the sum of total cash and short-term investment and account receivables dividend to total current liabilities. MB is the market value of equity divided by the book value of equity. CAPEX is the ratio of capital expenditure over the market value of total assets. DIVIDEND is a dummy variable taking the value of one if the airlines pay dividends and zero otherwise. RATED is a dummy variable taking the value of one if the airlines have credit rating and zero otherwise. NOL is a dummy variable taking the value of one if the airlines have net operating loss and zero otherwise. EXE_STOCK_OPTION is a dummy variable taking the value of one if executive stock options are reported in the annual reports and zero otherwise. GDPPPP is the natural logarithm of GDP per capita. INFLATION is the annual growth rate of the GDP implicit deflator. The dependent variable in this regression is the percentage of jet fuel consumption hedged. Year dummy variables are included in the regressions but not reported. The robust standard errors are clustered at the firm level. ***, ** and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Dependent variable: FUEL_HEDGE	
	Full sample	Affected countries
VARIABLES	(1)	(2)
ΔCR	0.066*	0.121***
	(0.039)	(0.022)
FIRM_SIZE	0.020	0.109
	(0.017)	(0.067)
LEVERAGE	0.006	0.490
	(0.048)	(0.311)
LIQUIDITY	-0.017	0.367***
	(0.034)	(0.058)

[46] Djankov et al. (2007) also document that the creditor rights in Russia increased in 2004. However, our sample does not record any Russian airlines that experienced this event.

MB	0.002	-0.016***
	(0.003)	(0.004)
CAPEX	-0.007	0.008
	(0.121)	(0.115)
DIVIDEND	0.019	-0.090***
	(0.026)	(0.016)
RATED	0.035	
	(0.046)	
NOL	-0.032	0.058
	(0.024)	(0.037)
EXE_STOCK_OPTION	-0.019	
	(0.043)	
GDPPPP	-0.086	0.446**
	(0.060)	(0.167)
INFLATION	-0.005*	0.051*
	(0.003)	(0.026)
Constant	1.019	-5.574**
	(0.647)	(1.987)
Observations	492	33
Year fixed effects	YES	YES
R-squared	0.079	0.957

In column 1, we estimate Equation 3.3 for the full sample during the period three years before and after the change of creditor rights. The coefficient on ΔCR is positive and significant at the 10 percent level, suggesting that a reform that increases creditor rights leads to an increase in the extent of jet fuel hedging. In column 2 of Table 3.10, we estimate Equation 3.3 for only the affected countries. The result in column 2 of Table 3.10 also shows a significantly positive estimated coefficient on ΔCR, which is approximately twice as much as the one in column 1. Overall, the analysis in this section provides further support for our previous findings that strong creditor rights can enhance the motivation to undertake more jet fuel hedging.

3.6. The effects of the financial crisis

Our sample period includes the 2007–2009 financial crisis. During this period many firms suffered from economic distress leading to financial distress. The path to financial distress is likely to be accelerated in a stronger creditor rights environment, which might make it more difficult to access derivative instruments because of the concerns related to heightened counterparty risk. Using the period from 2002 to 2016, our paper can investigate the impact of creditor rights on the extent of fuel hedging in the context of the 2007–2009 financial crisis. During the financial crisis

years, airlines may not have been able to hedge because hedging was costly, especially for those in financial distress. Tokic (2012) documents that many airlines bore losses stemming from their hedging strategies in 2008, which increased the concerns of derivative counterparties.

Table 3.11 shows the results of the effects of the financial crisis on the relationship between creditor rights and jet fuel hedging. We define the financial crisis period as the period from 2007 to 2009. In columns 1 and 2 of Table 3.11, we regress Equation 3.1 for the crisis and non-crisis periods, respectively. The creditor rights coefficient is significantly positive in both columns, suggesting a positive impact of creditor rights on the extent of jet fuel hedging in both the crisis and non-crisis periods. However, the creditor rights coefficient in the non-crisis period is approximately 1.6 times higher than the coefficient in the crisis period. This suggests that the economic impact of creditor rights on jet fuel hedging was stronger in the non-crisis period.

Table 3.11: The effects of the financial crisis

This table provides results investigating the effects of the financial crisis on the relationship between creditor rights and the extent of jet fuel hedging. The sample consists of 79 airlines from 36 countries during the period from 2002 to 2016. FUEL_HEDGE is the percentage of next year required jet fuel hedge. CR is the creditor right index. YEAR_CRISIS is a dummy variable that equals one for the year from 2007 to 2009, and zero otherwise. ANTI_SELF is the anti-self-dealing index. FIRM_SIZE is the natural logarithm of the market value of total assets. LEVERAGE is the ratio of total debt divided by the market value of total assets. LIQUIDITY is the ratio of the sum of total cash and short-term investment and account receivables dividend to total current liabilities. MB is the market value of equity divided by the book value of equity. CAPEX is the ratio of capital expenditure over the market value of total assets. DIVIDEND is a dummy variable taking the value of one if the airlines pay dividends and zero otherwise. RATED is a dummy variable taking the value of one if the airlines have credit rating and zero otherwise. NOL is a dummy variable taking the value of one if the airlines have net operating loss and zero otherwise. EXE_STOCK_OPTION is a dummy variable taking the value of one if executive stock options are reported in the annual reports and zero otherwise. GDPPPP is the natural logarithm of GDP per capita. INFLATION is the annual growth rate of the GDP implicit deflator. The dependent variable in this regression is the percentage of next year required jet fuel hedge. In column 1, the period covers the financial crisis period (2007-2009). In column 2, the period covers the non-financial crisis period. In column 3, the period includes both the financial crisis and non-financial crisis. Year dummy variables are included in the regressions but not reported. The robust standard errors are clustered at the firm level. ***, ** and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Dependent variable: FUEL_HEDGE		
	Crisis	Non crisis	Full sample
VARIABLES	(1)	(2)	(3)
CR	0.052*	0.083***	0.083***
	(0.027)	(0.029)	(0.029)
CR * YEAR_CRISIS			-0.029*
			(0.017)
ANTI_SELF	-0.276**	-0.439***	-0.383***
	(0.126)	(0.159)	(0.141)
FIRM_SIZE	0.061***	0.040***	0.048***
	(0.014)	(0.014)	(0.013)
LEVERAGE	-0.089	-0.099	-0.086
	(0.098)	(0.092)	(0.081)
LIQUIDITY	-0.014	0.031	0.018
	(0.062)	(0.050)	(0.049)
MB	-0.003	-0.011**	-0.007*
	(0.005)	(0.004)	(0.004)
CAPEX	0.174	0.127	0.127
	(0.143)	(0.163)	(0.129)
DIVIDEND	0.040	0.020	0.023
	(0.049)	(0.043)	(0.038)
RATED	0.098	0.118**	0.112**
	(0.060)	(0.054)	(0.050)
NOL	0.014	0.006	0.008
	(0.038)	(0.037)	(0.030)
EXE_STOCK_OPTION	-0.068*	-0.087*	-0.082*
	(0.040)	(0.047)	(0.043)
GDPPPP	0.055*	0.054**	0.055**
	(0.032)	(0.023)	(0.023)
INFLATION	-0.011	-0.004	-0.006
	(0.009)	(0.004)	(0.004)
Constant	-0.662*	-0.427	-0.536*
	(0.386)	(0.326)	(0.304)
Year fixed effects	YES	YES	YES
Observations	215	474	689
R-squared	0.463	0.321	0.348

To explore further the impact of the financial crisis we generate a financial crisis dummy variable, which equals one for years 2007, 2008, and 2009, and zero otherwise. Our model also includes an interaction term between the aforementioned financial crisis dummy variable and creditor rights variable. The results, which are presented in column 3 of Table 3.11, show that the coefficient on the interaction term is significantly negative. This means that although we have shown that stronger creditor rights can lead to an increase in the extent of jet fuel hedging, the effect was weakened during the financial crisis period. This might have been because during the financial crisis years there was dislocation in the derivatives markets, giving rise to a period of heightened derivative counterparty credit risk. Banks operating under these stressful conditions were less willing to act as counterparties in derivative transactions, leading to higher costs of derivative hedging. This had an adverse effect on non-financial firms' ability to hedge. Given that airlines operate in a cyclical industry they are particularly vulnerable during economic downturns, which would amplify the deterioration in their counterparty credit risk. This would have hindered their attempts to hedge more of their jet fuel exposure during this period of the financial crisis. In sum, the unwillingness of banks to be a counterparty is amplified in high creditor rights countries because of the higher risk of going into liquidation, resulting in the weaker impact of creditor rights on the extent of jet fuel hedging during the financial crisis period.

3.7. The impact of jet fuel prices on airlines' extent of jet fuel hedging

While the previous section investigates the impact of creditor rights on airlines' jet fuel hedging ratio in the context of the financial crisis, this section focuses on the impact of creditor rights when jet fuel prices are rising. An increase in jet fuel prices can eat into an airlines' free cash flow, thereby reducing its liquidity and increasing its likelihood of default. In an attempt to stabilise the volatility of its cash flow an airline might increase its jet fuel hedging ratio, which could also stem the reduction of their cash flow. However, an increase in jet fuel prices can also lead to a reduction in an airline's jet fuel hedging ratio because hedging with derivatives at higher jet fuel prices will require an airline to put up more collateral. If an airline cannot generate enough free cash flow to put up as collateral, they will struggle to find a derivative counterparty willing to sell it protection and hence may end up hedging less, simply because the supply of derivatives has dried up. Since we have previously

shown that airlines hedge more of their jet fuel exposure in stronger creditor rights countries and a prolonged increase of jet fuel prices exposes airlines to a greater threat of bankruptcy, we predict that the impact of creditor rights on the extent of jet fuel hedging will be stronger during a period of increasing or high jet fuel prices. The fact that our sample period includes some spikes in jet fuel prices allows us to test this prediction. We estimate Equation 3.4 to investigate the impact of creditor rights and high jet fuel prices on jet fuel hedging.

Table 3.12 shows the results estimated from a pooled OLS regression model for Equation 3.4. We still find a significantly positive coefficient on the creditor rights variable in column 1, which confirms our previous finding that stronger creditor rights can lead to a higher extent of jet fuel hedging. We also find a negative and significant association between jet fuel prices and jet fuel hedging, suggesting that airlines hedge a lower percentage of their jet fuel exposure when the jet fuel price increases. A potential explanation for this is that risk managers may take the view that jet fuel prices are more likely to fall when they are at relatively high levels and consequently hedge less of their jet fuel exposure. The key variable of interest is the interaction term between creditor rights and the jet fuel price (CR * JF_PRICE). Our results show that the coefficient on this interaction term is positive and significant at the 5 percent level, confirming our prediction above that the impact of creditor rights on the extent of jet fuel hedging is stronger during periods of higher jet fuel prices. In terms of economic significance, we find a one standard deviation increase in the price of jet fuel leads to an increase of 9.6%[47] in the extent of jet fuel hedging when the creditor rights index increases from 0 to 4, which is equal to approximately 42% of the mean of the extent of jet fuel hedging in our sample.

[47] 9.6% = 0.024 * (4 - 0), where 0.024 is the coefficient estimated on the interaction term between CR and JF_PRICE in column 1 of Table 3.12.

Table 3.12: The impact of jet fuel price on the airlines' extent of jet fuel hedging

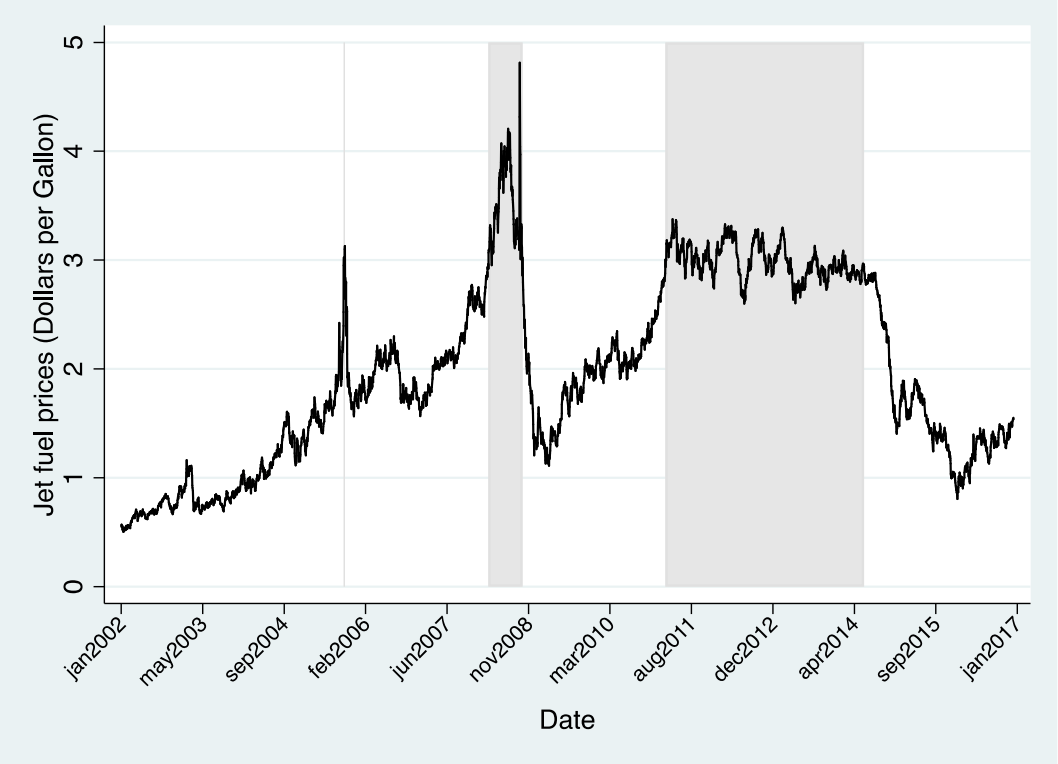
This table provides results of pooled OLS regression of Equation 3.4. The sample consists of 79 airlines from 36 countries during the period from 2002 to 2016. FUEL_HEDGE is the percentage of next year required jet fuel hedge. CR is the creditor right index. JF_PRICE is the US Gulf Coast Kerosene-type jet fuel spot price. HO_PRICE is the heating oil price. ANTI_SELF is the anti-self-dealing index. FIRM_SIZE is the natural logarithm of the market value of total assets. LEVERAGE is the ratio of total debt divided by the market value of total assets. LIQUIDITY is the ratio of the sum of total cash and short-term investment and account receivables dividend to total current liabilities. MB is the market value of equity divided by the book value of equity. CAPEX is the ratio of capital expenditure over the market value of total assets. DIVIDEND is a dummy variable taking the value of one if the airlines pay dividends and zero otherwise. RATED is a dummy variable taking the value of one if the airlines have credit rating and zero otherwise. NOL is a dummy variable taking the value of one if the airlines have net operating loss and zero otherwise. EXE_STOCK_OPTION is a dummy variable taking the value of one if executive stock options are reported in the annual reports and zero otherwise. GDPPPP is the natural logarithm of GDP per capita. INFLATION is the annual growth rate of the GDP implicit deflator. The dependent variable in this regression is the percentage of next year required jet fuel hedge. The period of crisis is from 2007 to 2009. Year dummy variables are included in the regressions but not reported. The robust standard errors are clustered at the firm level. ***, ** and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Dependent variable: FUEL_HEDGE					
	Full sample	Crisis	No crisis	Full sample	Crisis	No crisis
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
CR	0.071***	0.050*	0.079***	0.071***	0.051*	0.078***
	(0.025)	(0.027)	(0.028)	(0.025)	(0.027)	(0.028)
JF_PRICE	-0.041*	0.005	-0.044*			
	(0.023)	(0.028)	(0.026)			
CR * JF_PRICE	0.024**	0.013	0.026*			
	(0.011)	(0.012)	(0.013)			
HO_PRICE				-0.043*	0.006	-0.044*
				(0.024)	(0.029)	(0.026)
CR * HO_PRICE				0.025**	0.013	0.026**
				(0.012)	(0.012)	(0.013)
ANTI_SELF	-0.377***	-0.276**	-0.437***	-0.377***	-0.275**	-0.438***
	(0.139)	(0.126)	(0.159)	(0.139)	(0.126)	(0.159)
FIRM_SIZE	0.046***	0.061***	0.039***	0.046***	0.061***	0.039***
	(0.013)	(0.014)	(0.014)	(0.013)	(0.014)	(0.014)
LEVERAGE	-0.073	-0.088	-0.091	-0.074	-0.088	-0.091
	(0.081)	(0.098)	(0.092)	(0.081)	(0.098)	(0.092)
LIQUIDITY	0.023	-0.014	0.036	0.023	-0.014	0.036
	(0.049)	(0.062)	(0.050)	(0.049)	(0.062)	(0.049)
MB	-0.007*	-0.003	-0.011**	-0.007*	-0.003	-0.011**
	(0.004)	(0.005)	(0.004)	(0.004)	(0.005)	(0.004)
CAPEX	0.095	0.172	0.095	0.095	0.172	0.095
	(0.124)	(0.143)	(0.155)	(0.124)	(0.143)	(0.155)
DIVIDEND	0.022	0.040	0.022	0.023	0.040	0.022
	(0.038)	(0.049)	(0.042)	(0.038)	(0.049)	(0.042)
RATED	0.118**	0.098	0.127**	0.119**	0.098	0.127**
	(0.050)	(0.060)	(0.053)	(0.050)	(0.060)	(0.053)
NOL	0.014	0.014	0.010	0.013	0.014	0.010
	(0.030)	(0.038)	(0.035)	(0.029)	(0.038)	(0.035)
EXE_STOCK_OPTION	-0.083*	-0.068*	-0.089*	-0.083*	-0.068*	-0.089*
	(0.042)	(0.040)	(0.047)	(0.042)	(0.040)	(0.047)
GDPPPP	0.052**	0.054	0.051**	0.052**	0.054	0.051**
	(0.022)	(0.032)	(0.023)	(0.022)	(0.032)	(0.023)
INFLATION	-0.007*	-0.011	-0.005	-0.007*	-0.011	-0.005
	(0.004)	(0.009)	(0.004)	(0.004)	(0.009)	(0.004)
Constant	-0.492*	-0.633	-0.394	-0.491	-0.634	-0.392
	(0.295)	(0.383)	(0.318)	(0.295)	(0.382)	(0.318)
Observations	689	215	474	689	215	474
Year fixed effects	YES	YES	YES	YES	YES	YES
R-squared	0.353	0.464	0.331	0.353	0.464	0.332

Figure 3.1 shows a plot of the price of jet fuel between 2002 and 2016. The graph shows that there were significant peaks and troughs in the price of jet fuel during the period of our study. In particular, there were peaks before, during, and after the financial crisis. Given this volatility, we extend the above analysis by examining the impact of high jet fuel prices conditional on the financial crisis. Specifically, we estimate Equation 3.4 for the years of the financial crisis and for the years outside this period.

Figure 3.1: Jet fuel prices during period 2002 - 2016

This figure shows a plot of jet fuel prices. Data is daily and covers for the period from 2002 to 2016. The data is sourced from US Energy Information Administration. Gray bars indicate the periods of high jet fuel prices (jet fuel prices are higher than their 75th percentile).



Column 2 of Table 3.12 presents the results for years of the financial crisis and shows that whereas the estimated coefficient on the creditor rights is significantly positive, its interaction term with jet fuel prices is insignificant. This implies that although creditor rights still exert a positive impact on the extent of jet fuel hedging, the impact is independent of the jet fuel price. In contrast, the estimated coefficient on the interaction term between creditor rights and jet fuel prices is significantly positive during the non-crisis period (column 3). In effect, we find that the impact of

creditor rights on the jet fuel hedging ratio is stronger when jet fuel prices are high during the non-crisis years, but this is not the case during the financial crisis years.

A possible explanation for this is that after the financial crisis there was a recovery in economic growth leading to an increase in the demand for airline services, which allowed airlines to gradually increase their ticket prices. At the same time, the global economic recovery led to an increase in oil prices and consequently the price of jet fuel. This period of rising jet fuel prices coincided with improving economic conditions in the airline industry (free cash flows increasing and airlines returning to profitability). This set of circumstances (improving profits and/or cash flows) enabled airlines to hedge their jet fuel exposures at a time of rising prices, resulting in those airlines in stronger creditor rights countries hedging more than those in lower creditor rights countries.

In a robustness test, we replace jet fuel prices in Equation 3.4 with heating oil prices (HO_PRICE), on which airlines usually base to hedge the fluctuation of jet fuel prices. We gather the data of heating oil prices from EIA. The results employing heating oil prices are presented in columns 4, 5, and 6 of Table 3.12 and are qualitatively similar to those using jet fuel prices. In summary our findings suggest that the positive relationship between creditor rights and the extent of jet fuel hedging is amplified during periods of high or increasing jet fuel prices, but only when those periods occur outside the financial crisis years (i.e. when there is no economy-wide economic distress).

3.8. The real effects of jet fuel hedging

So far this paper has focused on how airlines react to stronger creditor rights. We show that airlines operating in countries with strong creditor rights hedge a higher percentage of their jet fuel exposure. Although the studies of Acharya et al. (2011), Cho et al. (2014), and Seifert and Gonenc (2012) provide empirical evidence of the adverse consequences on firms' leverage, investment and ultimate performance stemming from strong creditor rights, they fail to identify any strategies that might mitigate these negative effects. In Section 3.2.2, we predict that employing a jet fuel hedging strategy can mitigate these negative effects. Specifically, we predict that a jet fuel hedging programme can allow airlines to increase more leverage, reduce more default risk, and increase more investment in stronger creditor rights countries.

Therefore, in this section, we will investigate this prediction by estimating the models in Equations 3.5, 3.6, and 3.7.

3.8.1. Estimation results of creditor rights and the role of hedging

Table 3.13 presents the results from pooled OLS regressions of Equations 3.5, 3.6, and 3.7. The key variable of interest is the interaction term between the extent of jet fuel hedging and creditor rights. In column 1 of Table 3.13, the dependent variable is LEVERAGE, which is measured as the book value of total debt divided by the market value of the total assets. The results in column 1 show that the coefficient on FUEL_HEDGE is significantly negative. However, we should not interpret this result as the causal relationship. We observe this result perhaps because the leverage of airlines is very high in weak creditor rights countries. The mean and median of the airlines' leverage in the countries with a creditor rights index of 0 is around 0.65 and 0.70, compared with approximately 0.35 and 0.33 in the countries with a creditor rights index of 4, respectively. As a result, it is difficult for airlines in weak creditor rights countries to increase their leverage even when they undertake more jet fuel hedging.

Table 3.13: The impact of jet fuel hedging on leverage, financial risk, and investment

This table provides pooled OLS results showing the role of jet fuel hedge in ameliorating the adverse effects of strong creditor rights. The sample consists of 79 airlines from 36 countries during the period from 2002 to 2016. FUEL_HEDGE is the percentage of next year required jet fuel hedge. CR is the creditor right index. FIRM_SIZE is the natural logarithm of the market value of total assets. LEVERAGE is the ratio of total debt divided by the market value of total assets. LIQUIDITY is the ratio of the sum of total cash and short-term investment and account receivables dividend to total current liabilities. MB is the market value of equity divided by the book value of equity. DIVIDEND is a dummy variable taking the value of one if the airlines pay dividends and zero otherwise. RATED is a dummy variable taking the value of one if the airlines have credit rating and zero otherwise. PROFITABILITY is calculated as the ratio of earnings before interest and taxes over total assets. TANGIBILITY is the ratio of net property, plant and equipment to the book value of total assets. ZSCORE is the accounting based measure predicting bankruptcy of firms, calculated based on Altman (1968) formula. PD is the probability of default, measured by using Merton's (1974) structural model of credit risk. N_AIR is the number of aircraft owned by airlines scaled by the total assets. GDPPPP is the natural logarithm of GDP per capita. INFLATION is the annual growth rate of the GDP implicit deflator. The dependent variables are the book value of total debt scaled by the market value of total assets in column 1, the probability of default in column 2, and the number of aircraft scaled by the book value of total assets in column 3. Year dummy variables are included in the regressions but not reported. The standard errors are adjusted for heteroskedesticity and auto-correlation using method of Newey and West (1994). ***, ** and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Dependent variable		
	LEVERAGE	PD	N_AIR
VARIABLES	(1)	(2)	(3)
FUEL_HEDGE	-0.227***	-0.112***	-0.157***
	(0.069)	(0.025)	(0.042)
CR	-0.067***	-0.023***	-0.025*
	(0.012)	(0.007)	(0.013)
FUEL_HEDGE * CR	0.097***	0.040***	0.046**
	(0.029)	(0.012)	(0.022)
FIRM_SIZE	0.016***	-0.009***	-0.041***
	(0.006)	(0.002)	(0.005)
LEVERAGE		0.019	0.024
		(0.022)	(0.047)
MB	-0.016***	-0.003***	-0.000
	(0.004)	(0.001)	(0.002)
PROFITABILITY	-1.125***	-0.420***	-0.175
	(0.139)	(0.065)	(0.172)
LIQUIDITY	-0.115***	-0.023***	-0.067***
	(0.021)	(0.008)	(0.015)
TANGIBILITY	0.277***	-0.067***	
	(0.054)	(0.021)	
ZSCORE		-0.002	0.042***
		(0.006)	(0.016)
RATED	-0.020	0.009	0.005
	(0.023)	(0.007)	(0.009)
DIVIDEND	-0.081***		0.009
	(0.017)		(0.008)
GDPPPP	-0.023**	-0.025***	0.013***
	(0.009)	(0.007)	(0.004)
INFLATION	0.001	0.004**	-0.003**
	(0.002)	(0.002)	(0.001)
Constant	0.796***	0.487***	0.293***
	(0.119)	(0.098)	(0.073)
Observations	687	655	536
Year fixed effects	YES	YES	YES
R-squared	0.561	0.440	0.512

Rajan and Zingales (1995), Acharya et al. (2011), Vig (2013), and Cho et al. (2014) show that stronger creditor rights can lead to lower corporate leverage. Consistent with their findings, we document a negative impact of creditor rights on airlines' leverage. However, more importantly we find a significantly positive coefficient on the interaction term between FUEL_HEDGE and CR, which indicates that the negative impact of creditor rights on an airline's leverage can be partially or completely offset by an airline's jet fuel hedging activities. For example, when the creditor rights index equals 4, the total coefficient on FUEL_HEDGE can be positive,[48] fully offsetting the negative impact of creditor rights. In other words, jet fuel hedging can boost airlines' leverage in strong creditor right countries. Thus, this result supports hypothesis 3.2 and is consistent with previous evidence that hedging can increase a firm's leverage (Graham and Rogers, 2002).

Although jet fuel hedging allows airlines to increase leverage, they can increase leverage only when lenders are also willing to provide debt. We propose two mechanisms explaining why lenders can provide debt to airlines that implement a jet fuel hedging programme: a signalling mechanism and a diversification mechanism. Houston et al. (2010) suggest that stronger creditor rights can promote banks' risk-taking behaviour, implying that banks are willing to provide credit to riskier companies in creditor-friendly countries. However, the banks may still impose some form of credit rationing and therefore limit access to debt finance for some companies. The signalling mechanism argues that the extent of jet fuel hedging as reported in an airline's annual report can play a role as a signal to assure lenders that the airline will act in a manner based on the lenders' best interest. As a result, lenders are willing to provide debt to those airlines that promise to hedge jet fuel next year. This argument is also in line with the notion that hedging can mitigate the effect of credit rationing as proposed by Holmstrom and Tirole (2000).

The diversification mechanism follows the framework of Tirole (2010) that demonstrates that cross-hedging between independent projects can boost companies' leverage. If we consider hedging activities as an individual project, we can make an assumption that a hedging gain or loss is independent of the airlines' operating profit. Nevertheless, banks will not provide debt unless the airlines have enough net worth to ensure that they will not misbehave and get private benefits at the expense of the

[48] The coefficient of CR is 0.161 (= 4*0.097 - 0.227) when the creditor rights index equals 4.

banks. This can explain our previous result that the airlines in countries with weak creditor rights cannot increase leverage even when they employ a jet fuel hedging strategy. The leverage of those airlines is so high that the net worth of those companies cannot pass the minimum requirement of the lenders. When creditor rights increase, we find that leverage decreases and thus a jet fuel hedging strategy can boost the leverage of those airlines as a result of reducing the minimum net worth requirement of the lenders. To sum up, jet fuel hedging can help to increase airlines' leverage in stronger creditor rights countries. If airlines move from countries with a creditor rights index of 0 to those with an index of 4, an increase in jet fuel hedging can help to increase leverage by approximately 17.9%.[49]

With regard to airlines' default risk, the coefficient on FUEL_HEDGE is significantly negative in column 2 of Table 3.13, suggesting that the marginal effects of jet fuel hedging on default risk are significantly negative when creditor rights are weak, such as in the United States. This result is in line with studies of US firms showing that hedging behaviour can reduce the cost of debt (e.g., Campello et al., 2011; and Chen and King, 2014). The result also supports the finding of Bartram (2019), who shows that derivative users enjoy a higher reduction in their stock return volatility in low creditor rights countries.

Additionally, the coefficient on creditor rights is also significantly negative in column 2, indicating that the marginal effect of creditor rights on airlines' default risk is negative at low levels of jet fuel hedging. Due to the threat of losing control rights to lenders, those airlines with low jet fuel hedge ratios might reduce default risk via other methods and therefore ultimately can end up with lower default risk. This result lends support to findings that stronger creditor rights may lead to lower corporate risk-taking activities (Acharya et al., 2011; and Cho et al., 2014). The coefficient on the interaction term between FUEL_HEDGE and CR is significantly positive, implying that the negative impact of jet fuel hedging on default risk in weak creditor rights countries may disappear in strong creditor rights countries. This evidence contradicts hypothesis 3.3. It also suggests that the effects of jet fuel hedging and creditor rights on financial risk are substitutes. The negative coefficients on FUEL_HEDGE and CR in column 2 of Table 3.13 support this substitution effect.

[49] It is equal to the ratio of 0.089 over 0.497, where 0.089 (= 0.229 * 0.097 * 4) is the increase of the leverage due to the increase of the creditor right index for the airlines with the average jet fuel hedge level and 0.497 is the mean of the leverage.

For example, in column 2, the aggregate coefficient on FUEL_HEDGE can increase from -0.112 to 0.048[50] if the creditor rights index increases from 0 to 4, implying that the negative impact of jet fuel hedging on an airline's probability of default in countries with weak creditor rights might disappear in countries with strong creditor rights. However, the increase of creditor rights enhances its negative impact on the probability of default, which can offset the decreasing impact of jet fuel hedging in the strong creditor rights countries.

We now investigate whether a jet fuel hedging strategy can increase an airline's investment spending. The dependent variable in column 3 of Table 3.13 is N_AIR, measured as the ratio of the number of aircraft in an airline's fleet scaled by total assets. Similar to column 1, the coefficient on FUEL_HEDGE in column 3 is significantly negative. However, again we should not interpret this result as a causal relationship. This result may simply reflect the fact that airlines in countries with a creditor rights index of 0 have extremely high leverage and therefore cannot access debt markets for financing in order to increase investment in aircraft even when they use a jet fuel hedging strategy. Column 3 also shows that the coefficient on creditor rights is significantly negative. This implies that when the jet fuel hedging ratio is extremely low, the marginal effects of creditor rights on the number of aircraft in an airline's fleet is negative. This result is consistent with Seifert and Gonenc (2012) who find that R&D expenditure falls in strong creditor rights countries.

Column 3 also reports a significantly positive coefficient on the interaction term between FUEL_HEDGE and CR. This suggests that jet fuel hedging can increase an airline's number of aircraft in strong creditor rights countries, implying that jet fuel hedging can reduce the underinvestment problem in those countries. This can be explained because jet fuel hedging helps airlines to access debt markets in strong creditor rights countries, enabling these airlines to finance investment in new aircraft. As a result, this evidence supports hypothesis 3.4. The economic impact of jet fuel hedging on investment is also significant. Our result shows that by employing a jet fuel hedging strategy, an airline with an average jet fuel hedging ratio (0.229) can increase its investment, measured by the number of aircraft in the airline's fleet over

[50] 0.048 = -0.112 + 4 * 0.040, where -0.112 and 0.040 are the coefficients estimated on FUEL_HEDGED and its interaction with CR in column 2, respectively.

total assets, by 55.3% if the creditor rights index increases from 0 to 4.[51] This finding is consistent with the evidence of Campello et al. (2011) and Chen and King (2014), who also demonstrate that hedging can increase investment spending.

3.8.2. Robustness results of creditor rights and the role of hedging

In this section, we attempt to address the concern that jet fuel hedging policy may be endogenous in our estimation because of reverse causality and/or omitted variables. Here, we employ a two-stage least squares instrumental variables approach to deal with this concern. We use the percentage of airlines that use jet fuel hedging derivatives in each country as the instrumental variable for the extent of jet fuel hedging for a specific year, and we expect a positive relation between the percentage of firms in each country that use jet fuel hedging derivatives and the extent of jet fuel hedging. As it is arguable that the percentage of airlines that hedge jet fuel in each country does not have a direct impact on airlines' leverage, default risk, and investment spending, the percentage of airlines that hedge jet fuel in each country is a possible candidate for being an instrument of the airline's jet fuel hedging policy.

In the first stage, the extent of jet fuel hedging and its interaction with creditor rights are regressed on the instrumental variables (the percentage of airlines with jet fuel hedging in each country and in each year and its interaction with creditor rights) and all of the independent variables in the second stage regression. Then the "predicted extent of jet fuel hedging" and the "predicted interaction term between the extent of jet fuel hedging with creditor rights" from the first-stage regression can be used in the second-stage regression for each specification. We report the results estimated from the IV technique in Table 3.14. As reported after each specification, the Kleibergen-Paap rk LM statistic is significant at the 1 percent level and the Cragg-Donald Wald F statistic is much higher than 10, suggesting that our instrument is valid and relevant in explaining the variation in the airlines' jet fuel hedging strategy.

[51] It is equal to the ratio of 0.042 over 0.076, where 0.042 (= 0.046 * 0.0.229 * 4) is the increase of the investment in the number of aircraft scaled by the total assets due to the increase of creditor rights index for the airlines with the average fuel hedge level and 0.076 is the mean of the number of aircraft scaled by total assets.

Table 3.14: Robustness test of the impact of jet fuel hedging on leverage, financial risk, and investment - Two-stage least squares approach

This table provides the two-stage least squares' results showing the role of jet fuel hedge in ameliorating the adverse effects of strong creditor rights. The sample consists of 79 airlines from 36 countries during the period from 2002 to 2016. FUEL_HEDGE is the percentage of next year required jet fuel hedge. CR is the creditor right index. FIRM_SIZE is the natural logarithm of the market value of total assets. LEVERAGE is the ratio of total debt divided by the market value of total assets. LIQUIDITY is the ratio of the sum of total cash and short-term investment and account receivables dividend to total current liabilities. MB is the market value of equity divided by the book value of equity. DIVIDEND is a dummy variable taking the value of one if the airlines pay dividends and zero otherwise. RATED is a dummy variable taking the value of one if the airlines have credit rating and zero otherwise. PROFITABILITY is calculated as the ratio of earnings before interest and taxes over total assets. TANGIBILITY is the ratio of net property, plant and equipment to the book value of total assets. ZSCORE is the accounting based measure predicting bankruptcy of firms, calculated based on Altman (1968) formula. PD is the probability of default, measured by using Merton's (1974) structural model of credit risk. N_AIR is the number of aircraft owned by airlines scaled by the total assets. GDPPPP is the natural logarithm of GDP per capita. INFLATION is the annual growth rate of the GDP implicit deflator. The dependent variables are the book value of total debt scaled by the market value of total assets in column 1, the probability of default in column 2, and the number of aircraft scaled by the book value of total assets in column 3. Year dummy variables are included in the regressions but not reported. The standard errors are adjusted for heteroskedesticity and auto-correlation using method of Newey and West (1994). ***, ** and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Dependent variable		
	LEVERAGE	PD	N_AIR
VARIABLES	(1)	(2)	(3)
FUEL_HEDGED	-0.219*	-0.396***	-0.244***
	(0.115)	(0.090)	(0.092)
CR	-0.093***	-0.064***	-0.048*
	(0.023)	(0.018)	(0.025)
FUEL_HEDGED * CR	0.155***	0.166***	0.100*
	(0.058)	(0.045)	(0.051)
FIRM_SIZE	0.008	-0.006**	-0.042***
	(0.008)	(0.003)	(0.006)
LEVERAGE		-0.005	0.015
		(0.028)	(0.047)
MB	-0.015***	-0.004***	-0.000
	(0.004)	(0.001)	(0.002)
PROFITABILITY	-1.043***	-0.547***	-0.193
	(0.140)	(0.094)	(0.178)
LIQUIDITY	-0.126***	-0.042***	-0.075***
	(0.022)	(0.012)	(0.017)
ZSCORE		0.008	0.043***
		(0.008)	(0.016)
TANGIBILITY	0.284***	-0.097***	
	(0.058)	(0.025)	
RATED	-0.031	0.011	0.004
	(0.024)	(0.009)	(0.009)
DIVIDEND	-0.079***		0.011
	(0.019)		(0.009)
GDPPPP	-0.029***	-0.028***	0.010**
	(0.010)	(0.008)	(0.005)
INFLATION	0.001	0.004**	-0.003**
	(0.003)	(0.002)	(0.001)
Constant	0.934***	0.607***	0.372***
	(0.153)	(0.126)	(0.111)
Observations	687	655	536
Year fixed effects	YES	YES	YES
Kleibergen-Paap rk LM statistic (p-value)	0.000	0.000	0.002
Cragg-Donald Wald F statistic	64.286	54.860	24.717
R-squared	0.546	0.309	0.498

As can be seen from column 1 of Table 3.14, the empirical results for airlines' leverage are robust. We find that the coefficients on FUEL_HEDGE, CR, and their interaction term remain unchanged. The significantly negative coefficient on creditor rights indicates that airlines' leverage decreases when creditor rights are stronger. However, the significantly positive coefficient on its interaction term with jet fuel hedging suggests that the drop in leverage due to stronger creditor rights is lessened when airlines increase the amount of jet fuel hedging.

Regarding airlines' default risk, column 2 of Table 3.14 reports the results of a regression of an airline's default risk on jet fuel hedging, creditor rights, and the interaction term between them. Results in column 2 confirm the negative impact of jet fuel hedging on an airline's default risk in low creditor rights countries as well as the negative impact of creditor rights on the default risk of airlines with a low jet fuel hedging ratio. In addition, we also confirm that by increasing the extent of jet fuel hedging, airlines are able to conduct more risk-taking activities in strong creditor rights countries. With respect to airlines' investment spending, column 3 of Table 3.14 shows that the estimated coefficient on the interaction term between the extent of jet fuel hedged and creditor rights variables is still significantly positive. This confirms our previous result that jet fuel hedging can help airlines to invest in more aircraft in stronger creditor rights countries.

Overall, our results provide strong evidence that jet fuel hedging can help airlines to increase leverage, to bear default risk to a greater extent, and to invest in more aircraft in stronger creditor rights countries. Based on the extant literature on hedging (e.g., Smith and Stulz, 1985; Graham and Roger, 2002; Campello et al., 2011; Chen and King, 2014; and Bartram, 2019), we explain these results by the following framework. Firstly, jet fuel hedging has a first-order effect in that it reduces an airline's default risk. This reduction in default risk has second-order effects that allow an airline to increase leverage, to bear more default risk, and to invest more in fixed capital investment. Our paper extends the study of Acharya et al. (2011), Cho et al. (2014), and Seifert and Gonenc (2012) to the extent that we show for the first time that hedging can be an effective tool to ameliorate the adverse effects of strong creditor rights. Our findings also imply that the impact of hedging on a firm's leverage, default risk, and investment may vary between countries due to different levels of creditor rights.

3.9. Conclusion

A large body of literature has focused on the determinants of hedging (e.g., Smith and Stulz, 1985; Nance et al., 1993; Haushalter, 2000; Judge, 2006; Bartram et al., 2009; Lel, 2012; Lievenbruck and Schmid, 2014; and Bartram, 2019) and several studies have investigated the impact of creditor rights on a firm's financial policy (e.g., Houston et al., 2010; Acharya et al., 2011; and Cho et al., 2014). Given that financial hedging is an important component of a firm's financial policy, it is surprising that very few studies have examined the relationship between creditor rights and hedging, and that those that do find no evidence of any relationship between them (e.g., Lel, 2012; and Lievenbruck and Schmid, 2014). In our view this does not mean that this question is not worthy of further examination. It is entirely conceivable that the design and data employed by previous studies may not have been ideal for the purposes of testing for this relationship. For example, in a cross-industry study there could be too much firm-level heterogeneity to detect a meaningful hedging–creditor rights relationship (e.g., Lel, 2012). Secondly, the measure of hedging may be such that it does not effectively differentiate between firms that have a light-touch approach to hedging and those that hedge extensively (e.g., Lievenbruck and Schmid, 2014).

In this study, we identify an industry that has a clearly identifiable hedgeable risk, one where creditor rights seem to be relevant and one where we can obtain a very precise measure of the extent of hedging. The setting for our study is the international airline industry, where many airlines operate under different creditor rights jurisdictions. International airlines are exposed to interest rate and foreign exchange rate volatility, but the exposure that gives them most concern is that associated with fluctuations in jet fuel prices. In most cases, airlines' financial statements disclose data on the extent to which they hedge their exposure to jet fuel price volatility. Consequently, we believe the airline industry provides an ideal laboratory to effectively assess the impact of creditor rights on the hedging behaviour of firms across countries.

For a sample consisting of 79 airlines from 36 countries for the period from 2002 to 2016, we find that the strength of creditor rights exerts a positive impact on the percentage of jet fuel that airlines hedge. This result is robust to many different specifications and econometric methods as well as to an estimation that is akin to a difference-in-difference model. In addition, we find that the impact of creditor rights

is weakened during the financial crisis period but strengthened during times of high jet fuel prices. Our paper also sheds new light on the role of hedging in attenuating the adverse effects of strong creditor rights. Specifically, our results imply that a hedging strategy enables a firm to boost its leverage, to take greater risk, and to increase investment in strong creditor rights countries.

We believe our findings have implications for policymakers and future research. Our results show that derivatives hedging by firms in strong creditor rights countries generates several key benefits. Therefore, derivatives market regulators should be aware that policies like the financial transactions tax that could potentially discourage the use of derivatives for hedging could bring about adverse unintended consequences for firms in strong creditor rights countries. Scholars that are interested in quantifying the real effects of hedging should pay attention to an international country setting because differences in legal frameworks such as creditor rights can impact these real effects.

Appendix to "Chapter 3: Creditor Rights and Corporate Hedging: Evidence from The Airline Industry"

This Appendix provides additional information on the data used in our study. Appendix 3.1 presents some examples of jet fuel hedging management and derivative uses in annual report disclosures. In this appendix, our analysis will be presented in bold italic words. Appendix 3.2 provides a list of airlines employed in our sample.

Appendix 3.1: Example of jet fuel hedging management and derivatives uses in annual report disclosures

1. JetBlue Airways Corporation, Fiscal Year 2011

ITEM 7A. QUANTITATIVE AND QUALITATIVE DISCLOSURES ABOUT MARKET RISK (page 49)

Aircraft fuel. Our results of operations are affected by changes in the price and availability of aircraft fuel. To manage the price risk, we use crude or heating oil option contracts or jet fuel swap agreements. Market risk is estimated as a hypothetically 10% increase in the December 31, 2011 cost per gallon of fuel. Based on projected 2012 fuel consumption, such an increase would result in an increase to aircraft fuel expense of approximately $175 million in 2012, compared to an estimated $130 million for 2011 measured as of December 31, 2010. As of December 31, 2011, we had hedged approximately 27% of our projected 2012 fuel requirements. All hedge contracts existing at December 31, 2011 settle by December 31, 2012. We expect to realize approximately $6 million in losses during 2012 currently in other comprehensive income related to our outstanding fuel hedge contracts.

From the disclosure above, we can identify JetBlue Airways Corporation's extent of jet fuel hedging (FUEL_HEDGE) of 27 percent in 2011. In addition, the dummy variable CPDERIVATIVE will be equal 1 for this airline in this year.

Note 13. Financial Derivative Instrument and Risk Management (page 78)

Interest rate swaps: The interest rate swap agreements we had outstanding as of December 31, 2011 effectively swap floating rate debt for fixed rate debt, taking

advantage of lower borrowing rates in existence at the time of the hedge transaction as compared to the date our original debt instruments were executed. As of December 31, 2011, we had $363 million in notional debt outstanding related to these swaps, which cover certain interest payments through August 2016. The notional amount decreases over time to match scheduled repayments of the related debt.

From the disclosure above, we can confirm that JetBlue Airways Corporation used interest rate swaps, which is interest rate derivative, in 2011. Therefore, the dummy variable IRDERIVATIVE will be equal 1 for this airline in this year.

Because this airline did not provide any information of foreign exchange derivative, we assume that this airline did not employ any foreign exchange derivative in 2011, which results in the dummy variable FXDERIVATIVE taking the value of 0 in this year.

2. Lufthansa Group, Fiscal Year 2014

Principles of hedging policy (page 208)

As an aviation group with worldwide operations, the Lufthansa Group is exposed to exchange rate, interest rate and fuel price movement risk, as well as to credit and liquidity risks. It is Company policy to limit these risks by systematic financial management.

Market risk

The major market and price risks to which the Lufthansa Group is exposed are exchange rate fluctuation between the euro and other currencies, interest rate fluctuations in international money and capital markets, and price fluctuations in the crude oil and oil products markets. Hedging policy for limiting these risks is laid down by the Executive Board and documented by internal Group guidelines. It also provides for the use of financial derivatives. The corresponding financial transactions are concluded only with first-rate counterparties.

Foreign exchange risk

For US dollars, Lufthansa is mainly in a net payer position as regards currency risks from its operating business, as fuel payments are dollar-denominated. For other currencies there is always a net surplus. The main risks in this respect stem from the Chinese renminbi, the Swiss franc, the pound sterling, the Japanese yen, and the Indian rupee. Depending on market liquidity, currency risks from projected

operational exposure are hedged gradually over a period of 24 months by means of futures contracts. The target hedging level is defined in the Group's internal guidelines.

At the end of 2014, exposure from operations for the next 24 months was as follows:

in million	USD	CNY	JPY	GBP	INR
Exposure (currency)	-6,536	10,794	156,583	862	65,593
Exposure (EUR at spot rate)	-5,383	1,432	1,078	1,107	855
Hedges (currency)	2,749	-4,172	-71,607	-341	-13,027
Hedging level	42%	39%	46%	39%	20%

50 percent of the currency risks from capital expenditure are hedged when the contract is signed. The hedging level is increased it, over the lifetime of the contract, the exchange rate goes significantly above or below that used to calculate the investment. In the last 24 months before payment, the hedging level is increased in semi-annual steps of 10 percent, to reach 90 percent at the end. Spread options and futures are used as hedging instrument.

At year end 2014, exposure for capital expenditure was as follow:

in millions	2015	2016	2017	2018
Exposure from net capital expenditure (USD)	-2,319	-1,134	-380	-952
Exposure from net capital expenditure (EUR at spot rate)	-1,085	-933	-313	-783
Hedges (USD)	1,172	777	258	433
Hedging level	89%	69%	68%	46%

in millions	2019	2020	2021	2022	2023-25
Exposure from net capital expenditure (USD)	-1,457	-1,863	-1,817	-1,804	-3,483
Exposure from net capital expenditure (EUR at spot rate)	-1,199	-1,533	-1,495	-1,484	-2,865
Hedges (USD)	703	1,142	1,031	1,552	2,736
Hedging level	48%	61%	57%	86%	79%

From the disclosure above, we can confirm that Lufthansa Group used future foreign exchange contracts and spread options in 2014. Therefore, the dummy variable FXDERIVATIVE will take the value of 1 in this year.

Interest rate risk

Lufthansa aims to finance 85 percent of its financial liabilities at floating rates of interest. The proportion recognises the need to both minimise long-term interest expense and reduce earnings volatility.

At the end of 2014, the ratio of floating to fixed interest rates for long-term borrowing was as follows:

Exposure in €m	2015	2016	2017	2018	2019
Fixed	1,083	800	646	360	308
Floating	4,748	4,279	3,254	2,416	1,990
Floating/fixed ratio	81%	84%	83%	87%	87%

Exposure in €m	2020	2021	2022	2023	2024	2025
Fixed	294	247	247	250	173	47
Floating	1,037	799	503	356	191	123
Floating/fixed ratio	78%	76%	67%	59%	52%	72%

In contrast, foreign currency risks from financial liabilities are always hedged to 100 percent by means of cross currency swaps. These hedging transactions are treated almost exclusively as trading in accordance with IAS 39.

Because this airline did not provide any information of interest rate derivative and the purpose of cross currency swaps is to manage foreign currency risks, we assume that this airline did not employ any interest rate derivative in 2014, which results in the dummy variable IRDERIVATIVE taking the value of 0 in this year. In addition, the disclosure above mentions that Lufthansa Group managed the interest rate risk by aiming to finance 85 percent of its financial liabilities at floating rates of interest. Our results do not change if we assume that cross currency swaps relates to fixed and floating rate swap and therefore the dummy variable IRDERIVATIVE would take the value of 1.

Fuel price risk

In 2014, fuel costs accounted for 21.5 percent of the Lufthansa Group's operating expenses (previous year: 22.5 percent). Significant changes in fuel prices can therefore have a considerable effect on the Group's result.

Fuel price risk is generally limited by the use of crude oil hedges. The hedging level and the time horizon depend on the risk profile, which is derived from the business model of a Group company. As a rule, up to 5 percent of exposure is hedged monthly for up to 24 months by spread options and other combinations of hedges. This means that the maximum hedging level reached is 85 percent.

Deviations from the rule-based hedging policy described above are permitted within the scope of a pre-defined system of limits.

From a year-end perspective, fuel exposure was as follows:

Fuel exposure			
		2015	2016
Fuel requirement	in 1,000 tonnes	8,981	9,497
Hedges	in 1,000 tonnes	6,644	3,404
Hedging level	in %	74.0%	35.8%

From the disclosure above, we can identify Lufthansa Group's extent of jet fuel hedging of 74 percent in 2014. In addition, the dummy variable CPDERIVATIVE will be equal 1 for this airline in this year.

Appendix 3.2: List of airlines employed in our study

Name	Country	Creditor rights	Covered period
Qantas	Australia	3	2005-2016
Regional Express Airlines	Australia	3	2006-2016
Virgin Australia Airlines	Australia	3	2005-2006
Austrian Airlines	Austria	3	2005, 2008
GOL Linhas	Brazil	1	2004-2016
Air Canada	Canada	1	2006-2016
Chorus Aviation Inc.	Canada	1	2011-2016
Discovery Air Inc.	Canada	1	2007-2016
Exchange Income Corporation	Canada	1	2004-2016
WestJet	Canada	1	2002-2016
Latam	Chile	2	2002-2016
Air China	China	2	2012-2016
China Airlines	China	2	2010, 2016
China Eastern Airlines	China	2	2003, 2007-2016
China Southern Airlines	China	2	2003-2004, 2008-2016
Hainan Airlines	China	2	2002-2014
Avianca Holdings	Colombia	0	2013-2016
Atlantic Airways	Denmark	3	2008-2013
Cimber Sterling Group A/S	Denmark	3	2010-2011
Finnair	Finland	1	2002-2016
Air France-KLM	France	0	2005-2010, 2013-2016
Air Berlin	Germany	3	2006-2016
Lufthansa	Germany	3	2002-2016
Aegean Airlines	Greece	1	2007-2016
Cathay Pacific	Hong Kong	4	2005-2010
Jet Airways	India	2	2005-2016
Kingfisher Airlines Limited	India	2	2009-2013
Aer Lingus	Ireland	1	2006-2014
RyanAir	Ireland	1	2004
El Al	Israel	3	2005-2016
Meridiana	Italy	2	2005-2012
All Nipon Airways	Japan	2	2005-2016
Japan Airlines	Japan	2	2013-2016
Kenya Airways	Kenya	4	2008-2016
AirAsia	Malaysia	3	2010-2016
AirAsia X	Malaysia	3	2015-2016
Grupo Aeromexico SAB de CV	Mexico	0	2011-2016
Norwegian Air Shuttle	Norway	2	2004-2005, 2010, 2014-2016
Pakistan International	Pakistan	1	2004-2015
Copa Holdings	Panama	4	2005-2016
Aeroflot	Russia	2	2012-2015
UTair Aviation JSC	Russia	2	2010-2016
Skywest Airlines Ltd	Singapore	3	2007-2010
1Time Holdings Ltd.	South Africa	3	2007-2011
Comair	South Africa	3	2002-2016
Asiana Airlines	South Korea	3	2002-2014
Korean Air	South Korea	3	2003-2004, 2007, 2016
Iberia	Spain	2	2002-2010
SAS	Sweden	1	2002-2016
Swiss International Air Lines	Switzerland	1	2004-2005
EVA Air	Taiwan	2	2007, 2010
Thai Airways	Thailand	2	2002-2016
Pegasus Airlines	Turkey	2	2013-2016

Turkish Airlines	Turkey	2	2002-2015
Air Partner	United Kingdom	4	2002-2016
Flybe	United Kingdom	4	2011-2016
Hangar8 plc	United Kingdom	4	2011-2014
easyJet	United Kingdom	4	2002, 2006-2016
Air Transport Services Group	United States	1	2005-2016
Alaska Airlines	United States	1	2002-2016
Allegiant Air	United States	1	2006-2016
American Airlines	United States	1	2013-2016
Atlas Air	United States	1	2004-2016
Delta Air Lines	United States	1	2008-2011
ExpressJet	United States	1	2002-2009
Frontier Airlines	United States	1	2002-2009
Great Lakes Aviation	United States	1	2004-2014
Gulfstream International Airline	United States	1	2007-2009
Hawaiian Airlines	United States	1	2002-2016
JetBlue	United States	1	2002-2016
Mesa Airlines	United States	1	2002-2008
Northwest Airlines	United States	1	2007
Pinnacle Airlines	United States	1	2003-2011
Republic Airways	United States	1	2004-2015
SkyWest Airlines	United States	1	2002-2016
Southwest Airlines	United States	1	2002-2016
Spirit Airlines	United States	1	2011-2016
US Airways	United States	1	2005-2012
United Continental	United States	1	2006-2016

Chapter 4: CEO Inside Debt and Corporate Hedging Decisions: Evidence from the Use of Interest Rate Swaps

4.1. Introduction

Recently, a considerable line of literature has focused on the importance of managerial pension benefits and deferred compensation (inside debt) in the design of a managerial compensation contract.[52] The term "inside debt" was first used by Jensen and Meckling (1976). They define inside debt as the debt held by managers and suggest that inside debt can mitigate the conflict between companies' managers and their debt holders. Basically, pension benefits and deferred compensation plans represent a company's fixed obligations to make future payments at or after a manager's retirement so long as the company is solvent and a large part of pension benefits and deferred compensation are typically unfunded and unsecured, making them resemble unsecured debt financing. Sundaram and Yermack (2007) and Wei and Yermack (2011) point out that pension benefits and deferred compensation account for a significant proportion of the overall CEO compensation package. For example, Sundaram and Yermack (2007) show that the mean (median) value of the ratio of CEO inside debt value over the value of the CEO's equity portfolio is 17 percent (7 percent) and the corresponding number in Wei and Yermack (2011) is 22 percent (15 percent).

Up until recently, empirical studies examining the role of CEO inside debt have been scant due to the unavailability of inside debt data. However, new disclosure rules instigated by the Security and Exchange Commission in August 2006 required greater disclosure of executive compensation and benefits, which included a report on the present value of executives' accumulated benefits under pension and deferred compensation plans. The availability of pension benefits and deferred compensation data has facilitated the emergence of empirical studies investigating the impact of inside debt in the CEO compensation structure on managerial incentives. Most studies find that CEO inside debt can reduce the agency costs of debt by alleviating the conflict between companies' managers and their debt holders, which is consistent with the arguments of Jensen and Meckling (1976) and Edmans and Liu (2011).

[52] See, for example, Sundaram and Yermack (2007), Edmans and Liu (2011), Wei and Yermack (2011), Cassell et al. (2012), Anantharaman et al. (2014), Phan (2014), Dang and Phan (2016), Colonnello et al. (2017), and Freund et al. (2018).

These papers argue that inside debt encourages managers to follow conservative financing and investment policies and therefore helps to align the incentives of managers with those of debt holders. For example, Sundaram and Yermack (2007) find that CEO inside debt is negatively associated with firms' default risk. Wei and Yermack (2011) show that companies with substantial CEO inside debt holdings tend to have lower bond and stock price volatility and smaller credit default swap spreads, which implies a lower likelihood of financial distress. Similarly, Cassell et al. (2012) and Phan (2014) find that CEO inside debt is associated with less risky corporate decisions. Other recent studies also present evidence that suggests a negative relationship between CEO inside debt and firms' risk (Anantharaman et al., 2014; Dang and Phan, 2016; and Colonnello et al., 2018). Liu et al. (2014) find that CEO inside debt has a positive relationship with cash holdings, suggesting risk-averse behaviour. Erkan and Nguyen (2020) find evidence indicating that CEOs with high inside debt can increase the dividend payout when their firms experience the problems of overinvestment, which suggests that CEO inside debt can reduce the agency problems between managers and shareholders.

It should be noted that the main prediction of the aforementioned studies is based on the premise that inside debt is able to align the incentives of managers and bondholders. However, whether this assumption is valid or not depends on whether the payoffs to managerial inside debt resemble the payoffs to unsecured debt financing. If inside debt can be withdrawn before CEOs' retirement, the payoffs to the inside debt are insured against default risk. Consequently, these CEOs do not face the risk of losing their inside debt if the firm goes bankrupt, and therefore this type of inside debt will not exert any impact on firms' financing and investment decisions (Anantharaman et al., 2014; and Colonnello et al., 2017). Anantharaman et al. (2014) find that only supplemental executive retirement plans (SERPs), whose payoff structure is similar to one of unsecured debt financing, are negatively related to both the costs of debt and the number of restrictive debt covenants. Colonnello et al. (2017) define non-protected (unsecured) CEO inside debt as the sum of SERPs and deferred compensation plans. They show that only the non-protected CEO inside debt holdings are able to decrease credit default swap spreads, assets volatility, and yield spreads.

Inside debt is a part of managers' wealth portfolio that also includes equity-based components. There are many examples of studies that examine the link between

equity-based compensation and firms' risk-taking behaviour. This includes several studies that examine the relationship between CEO equity-based incentives and the corporate hedging decision (e.g., Knopf et al., 2002; Borokhovich et al., 2004; and Bakke et al., 2016). However, hitherto, there have been no studies that investigate the relationship between CEO inside debt holdings and non-financial companies' hedging behaviour. Given the relative importance of inside debt in managers' wealth portfolio, this is a serious omission. This study attempts to fill this gap. In this paper, we investigate the impact of CEO inside debt on the corporate hedging decision, proxied by the use of interest rate swaps by US non-financial firms. On one hand, CEO inside debt holdings could have a positive impact on firms' hedging decision to use interest rate swaps. A major number of studies find that the use of financial derivatives in general and of interest rate swaps in particular can reduce firms' risk (e.g., Smith and Stulz, 1985; Froot et al., 1993; Guay, 1999b; Hentschel and Kothari, 2001; Purnanandam, 2008; Nguyen and Faff, 2010; Bartram et al., 2011; and Bartram, 2019). As firms with high CEO inside debt holdings tend to follow conservative corporate policies to minimise their risk, these firms are more likely to use interest rate swaps for hedging purposes.

On the other hand, holding large CEO inside debt can reduce the motivation for hedging by financial derivatives. Hedging theory suggests that one of the motivations for using financial derivatives is to reduce firms' financial distress (Smith and Stulz, 1985). As firms with high CEO inside debt holdings are positively associated with cash holdings (Liu et al., 2014) and negatively associated with default risk (Sundaram and Yermack, 2007), these firms are argued to have lower financial distress. As a result, these firms have less incentive to hedge by financial derivatives, suggesting that large CEO inside debt holdings can discourage the use of interest rate swaps for hedging purposes. The other motivation for hedging by financial derivatives is to reduce asymmetric information between shareholders and potential bondholders (Mayers and Smith, 1987; and Bessembinder, 1991). Since CEO inside debt can align the benefits of the CEO with the benefits of the bondholders, thereby mitigating this problem, the motivation for hedging by financial derivatives is also decreased for firms with high CEO inside debt holdings. This line of argument predicts a negative relationship between CEO inside debt holdings and the use of interest rate swaps for hedging purposes.

Our sample consists of 912 US firms during the periods from 2006 to 2014. We begin our analysis by examining the relationship between CEO inside debt and the likelihood of a firm to hedge using interest rate swaps. We find that firms with more CEO inside debt are less likely to use interest rate swaps. In our paper, we also attempt to construct variables that can proxy for protected and non-protected CEO inside debt. While protected CEO inside debt is funded and secured, the non-protected one is not. Our result indicates that the negative association between CEO inside debt and the likelihood of using interest rate swaps exists only if the CEO inside debt is non-protected. We proceed to demonstrate that an increase in CEO inside debt also reduces the extent to which a firm hedges using interest rate swaps. Again, we show that only non-protected CEO inside debt can do this. In economic terms, a one standard deviation increase in the proxy of our non-protected CEO inside debt decreases our measure of interest rate swap usage by around 5.94%. This result is robust when we employ a Tobit regression model and an instrumental variables technique.

Furthermore, we investigate whether our findings above are conditional on financial constraints. Whereas the impact of CEO inside debt on firms' financing and investment decisions is weakened for financially constrained companies (Liu et al., 2014; and Dang and Phan, 2016), hedging by financial derivatives is argued to be more valuable for financially constrained companies (Froot et al., 1993; and Kuersten and Linde, 2011). As a result, we expect that the negative effect of non-protected CEO inside debt on the corporate hedging by interest rate swaps should be weaker for financially constrained companies than for financially unconstrained companies. Using Whited and Wu's (2006) index and firms' net worth as measures of financial constraints, we find evidence supporting this argument.

We next examine the negative impact of CEO inside debt on corporate hedging via interest rate swaps during the periods of high and low interest rate uncertainty. Bretscher et al. (2018) point out that hedging by interest rate swaps helps firms to navigate the adverse impact of interest rate uncertainty on their investment. As a result, we predict that the negative relationship between non-protected CEO inside debt and the corporate hedging via the use of interest rate swaps is weakened during the period of heightened interest rate uncertainty since firms have strong incentives to use interest rate swaps for hedging purposes during this period. Using an index proxied for the uncertainty of interest rate, which is sourced from Choi et al. (2017),

we divide our sample into two sub-sample periods, one being associated with the periods of low interest rate uncertainty and one being associated with the periods of high interest rate uncertainty. Our results show that although non-protected CEO inside debt leads to a reduction in interest rate swap usage in both periods of low and high interest rate uncertainty, the economic impact of non-protected CEO inside debt on interest rate swap usage is much stronger during the periods of low interest rate uncertainty compared to those of high interest rate uncertainty.

Finally, we revisit the relationship between CEO inside debt and firms' default risk, measured by distance to default. Our result indicates that only non-protected CEO inside debt reduces firms' default risk. This result is in line with the notion that only non-protected CEO inside debt can align the benefits of managers and debt holders (Anantharaman et al., 2014; and Colonnello et al., 2017). The model of Edmans and Liu (2011) suggests that this effect of inside debt is weakened when companies are in the state of low default risk. According to hedging theory, the use of financial derivatives in general and of interest rate swaps in particular can decrease the likelihood of bankruptcy (Smith and Stulz, 1985; Froot et al., 1993; and Purnanandam, 2008). There are some empirical studies that provide evidence supporting this (e.g., Guay, 1999b, Hentschel and Kothari, 2001; Bartram et al., 2011; and Bartram, 2019). This suggests that we can test the prediction of Edmans and Liu's (2011) model using a setting that incorporates the use of CEO inside debt with the use of interest rate swaps for hedging purposes. Our results show that the negative effect of non-protected CEO inside debt on companies' default risk is dampened when the companies increase hedging using interest rate swaps. In economic terms, a one percentage point increase in the extent of interest rate swap usage can reduce the negative impact of non-protected CEO inside debt on firms' default risk by around 18.52%. This result also helps to explain why firms with high CEO inside debt holdings use fewer interest rate swaps. In essence, these firms use fewer interest rate swaps to avoid the detrimental effects of hedging via interest rate swaps on the role of CEO inside debt in reducing firms' default risk.

Our paper contributes to the literature in several ways. First, we investigate the impact of CEO inside debt on corporate hedging by interest rate swaps using a setting of non-financial companies.[53] Moreover, our paper distinguishes between the

[53] Belkhir and Boubaker (2013) examine the relationship between CEO inside debt and the banks' hedging decisions by interest rate derivatives. In Section 4.1, our result suggests that the

impacts of protected and non-protected inside debt on corporate hedging behaviours. There are only two studies examining protected and non-protected CEO inside debt (Anantharanman et al., 2014; and Colonnello et al., 2017). Our analysis differs from these two papers in that we investigate the impact of the protected and non-protected inside debt on the corporate hedging whereas they focus on the relationship between the two types of inside debt and credit default swap spreads or cost of debt. Additionally, by showing that only non-protected CEO inside debt exerts a negative impact on the corporate hedging by interest rate swaps, our findings add to an established body of literature documenting various determinants of the corporate hedging by financial derivatives (e.g., Nance et al., 1993; Geczy et al., 1997; Judge, 2006; and Bartram et al., 2009), a growing line of literature on the relationship between managerial compensation and the corporate hedging decisions (e.g., Knopf et al., 2002; Borokhovich et al., 2004; and Bakke et al., 2016), as well as an ever-emerging strand of literature on the role of inside debt in adjusting firms' investment and financial policies (e.g., Phan, 2014; Liu et al., 2014; and Dang and Phan, 2016).

Second, our paper complements and extends the study of Sundaram and Yermack (2007) when showing a negative impact of inside debt on firms' default risk, measured by distance to default, for a larger sample of firms and a longer sample period. Furthermore, we show that only non-protected CEO inside debt has this effect. This result is consistent with the evidence that a high amount of total CEO inside debt in general and of non-protected CEO inside debt in particular can lead to a reduction in credit default swap spreads, costs of debt, and assets volatility (Wei and Yermack, 2011; Cassell et al., 2012; Anantharaman et al., 2014; Dang and Phan, 2016; Colonnello et al., 2017; and Freund et al., 2018).

Finally, we find evidence that the impact of CEO inside debt on companies' default risk is weakened when the companies hedge using interest rate swaps. Given that hedging by interest rate swaps can reduce firms' probability of default, this empirical evidence supports the prediction of Edmans and Liu's (2011) model that inside debt is less valuable when the companies have a lower likelihood of default.

The rest of our paper is organised as follows. Section 4.2 provides a literature review on CEO inside debt and its relation with the corporate use of interest rate

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characteristics of CEO inside debt are totally different between financial and non-financial firms, which emphasises the necessity to investigate this relationship in the context of non-financial firms.

swaps. Section 4.3 presents our data, our empirical models, and the construction of our variables. Section 4.4 reports our empirical results. Section 4.5 concludes.

4.2. Literature review and hypothesis development

4.2.1. Overview of CEO inside debt

In a novel paper, Jensen and Meckling (1976) mention the existence of agency costs of equity and agency costs of debt in a company. While the former stems from the conflict of interests between companies' managers and their equity holders, the latter is a result of the conflict between companies' managers and their debtholders. In essence, agency costs of equity stem from the fact that a manager can keep only a small portion of returns that are generated from her full efforts. In contrast, agency costs of debt, which are well known as "asset substitution" or "risk-shifting", occur because a manager tends to increase a firm's risk in order to benefit the firm's shareholders at the cost of the firm's debtholders. To reduce these agency costs, Jensen and Meckling (1976) suggest that a company should design an executive compensation contract that aligns the interests of the manager with both the equity holders (through an equity-based compensation) and the debtholders (through an inside debt-based compensation). Comparing with the vast majority of studies examining the impact of an equity-based compensation on managers' risk-taking behaviour (e.g., Guay, 1999a; Rajgopal and Shevlin, 2002; Coles et al., 2006; Lewellen, 2006; Low, 2009; Hayes et al., 2012; Gormley et al., 2013; Milidonis and Stathopoulos, 2014; and Kim et al., 2017), the number of studies that investigate the effect of an inside debt-based compensation is limited.

One of the first studies that mention inside debt is Jensen and Meckling (1976). They suggest that an inexpensive way to align the benefits of a company's manager and its debtholders is to grant the manager a ratio of inside debt-based over equity-based compensation that is similar to the company's debt over equity ratio. However, Edmans and Liu (2011) prove that this compensation contract is typically inefficient. They show that a compensation contract with an equity-based compensation bias can be optimal if a manager exerts a greater effort that is commensurate with her risk-shifting behaviour, whereas a compensation contract with an inside debt-based compensation bias can be optimal if a manager's effort can bring her a relatively high payoff in bankruptcy. Although the studies of Jensen and Meckling (1977) and Edmans and Liu (2011) have different implications for an optimal inside debt ratio,

they both share a common argument that managerial inside debt is a useful tool to alleviate the agency costs of debt.

There are some empirical studies that examine inside debt and its effects on firms' risk or firms' financing and investment decisions (e.g., Sundaram and Yermack, 2007; Wei and Yermack, 2011; Cassel et al., 2012; Anantharaman et al., 2014; Colonnello et al., 2017). In virtually all of these studies, inside debt is divided into two main components that are pension benefits and deferred compensation. These components of a manager's compensation contract are broadly structured in such a way that a solvent firm has a fixed obligation to pay the manager an amount of money at or after her retirement. However, these components are generally unfunded and unsecured, making the managers face the risk that the payment cannot be paid if the company is in insolvency. As a result, managerial inside debt resembles debt financing and an inside debt holder has concave claims that are similar to the claims of an unsecured creditor.

The study of Sundaram and Yermack (2007) is one of the first empirical studies showing a negative relationship between CEO inside debt and firms' risk, measured by distance to default. However, their sample size is rather small and seems to be biased to large capitalisation firms. Furthermore, they focus on only one form of inside debt that is pension benefits. Wei and Yermack (2011) investigate how investors react to the initial company disclosures of CEO inside debt following a 2006 SEC disclosure reform. They show that companies with higher CEO inside debt holdings are priced higher (lower) in secondary bond (equity) markets. They also indicate that companies providing their CEO more inside debt can enjoy a reduction in the volatility of both bond and stock prices as well as a fall in credit default swap spreads. The recent study by Colonnello et al. (2017) also documents a negative relationship between CEO inside debt and the credit default swap spreads. They show that an increase in CEO inside debt holdings is associated with a decrease in asset volatility and yield spreads.

Cassell et al. (2012) study the impact of CEO inside debt on the riskiness of firms' investment and financial policies. They find that CEO inside debt is negatively associated with future stock return volatility, research and development expenditure, and financial leverage whereas it is positively associated with firm diversification and working capital. They then conclude that CEOs holding a large amount of inside

debt tend to manage their companies with conservative investment and financial policies.

A number of studies have investigated the relationship between CEO inside debt and the company's cost of debt (Anantharaman et al., 2014; Dang and Phan, 2016; and Freund et al., 2018). Anantharaman et al. (2004) study the relationship between CEO inside debt and the design of corporate debt contracts and point out that debtholders recognise a high amount of CEO inside debt as a signal that aligns the CEO's benefits with the debtholders' benefits. Therefore, a company with a higher amount of CEO inside debt can enjoy a lower cost of debt and fewer covenants. Similarly, Dang and Phan (2016) find a negative relationship between CEO inside debt and the cost of debt. In addition, their result shows that CEO inside debt enables firms to employ more short-term debt. They explain this result by arguing that CEO inside debt leads to conservative financial policies and therefore can reduce the refinancing risk of short-term debt. Freund et al. (2018) also document that CEO inside debt holdings impact the costs of debt negatively. Moreover, they point out that firms with high CEO inside debt are more likely to issue debt and issue it more extensively when they access the external capital market.

Liu et al. (2014) demonstrate that a CEO holding more inside debt tends to hold more cash because cash is one of the most liquid assets of firms, and cash balances decrease the volatility of firms' assets. Phan (2014) finds a negative relationship between CEO inside debt holdings and a propensity to engage in merger and acquisition (M&A) activities. Given that M&As lead to an increase in the default risk of the acquiring firms (Furfine and Rosen, 2011), the result of Phan (2014) is consistent with the notion that CEO inside debt induces firms' risk-reducing investment. Furthermore, Phan (2014) argues that diversifying M&As are beneficial to debtholders and shows that if firms with high CEO inside debt do M&As, the M&A deals are more likely to be diversified M&As. Overall, the aforementioned studies suggest that CEO inside debt can reduce the CEO's risk-shifting behaviour and a higher amount of CEO inside debt can encourage the CEO to engage more in conservative corporate decisions that can reduce the firm's default risk.

Recent literature on inside debt pays special attention to the debt-like compensation functions of its components (Anantharaman et al., 2014; and Colonnello et al., 2017). Specifically, CEO pension benefits usually consist of tax-qualified plans, which need to be funded and secured under the Employee Retirement

Income Security Act (ERISA) of 1974, and supplemental executive retirement plans, which do not need to be funded and secured. In the case of bankruptcy, the former component is protected from firm insolvency to some extent whereas the latter component is exposed to the risk of loss. As a result, only SERPs more closely resemble unsecured corporate debt and therefore can help to reduce firms' risk. This also suggests that CEO pension benefits are not entirely funded or secured. In contrast, the whole amount of deferred compensation is not funded or secured. Although it is arguable that deferred compensation plans can allow withdrawal before the CEO's retirement, the withdrawal is not easy to implement since the Internal Revenue Code (Section 409A) restricts a CEO's ability to accelerate withdrawals at will. Together, this argument suggests that only the payoffs to SERPs and deferred compensation seem to be similar to the payoffs of outside unsecured debtholders.

To the best of our knowledge, there are only two studies investigating the "unsecured" characteristics of CEO inside debt (Anantharaman et al., 2014; and Colonnello et al., 2017). Anantharaman et al. (2014) show that only SERPs can decrease the costs of debt and reduce the number of restrictive covenants. Colonnello et al. (2017) define non-protected (unsecured) CEO inside debt as the sum of SERPs and deferred compensation plans and find that only the non-protected CEO inside debt leads to a reduction in credit default swap spreads, assets volatility, and yield spreads. These findings suggest that only non-protected CEO inside debt whose payoffs are similar to those of outside unsecured debtholders can affect firms' risk and firms' investment and financial behaviour.

4.2.2. CEO inside debt and the corporate hedging decisions

The previous section points out that CEO compensation incentives under the form of inside debt can induce conservative financing and investment decisions. Given that hedging by financial derivatives is one of the most important financial decisions in a company, we predict that CEO inside debt holdings can also impact firms' hedging decisions via the use of interest rate swaps. However, it is not clear how CEO inside debt can affect the way a company hedges using interest rate swaps. On one hand, CEO inside debt holdings are argued to lead to an increase in the use of interest rate swaps for hedging purposes. Hedging theory suggests that the use of financial derivatives in general and of interest rate swaps in particular can reduce

firms' risk (e.g., Smith and Stulz, 1985; Froot et al., 1993; Guay, 1999b; Hentschel and Kothari, 2001; Purnanandam, 2008; Nguyen and Faff, 2010; Bartram et al., 2011; and Bartram, 2019). As a CEO with higher inside debt has more exposure to the loss that is similarly faced by external creditors when the firm is bankrupt, she can behave more like a debtholder than a shareholder. This, in turn, suggests that she is more likely to follow a hedging strategy by employing interest rate swaps in an attempt to decrease the firm's risk. In line with this argument, Belkhir and Boubaker (2013) show that banks with larger inside debt holdings hedge more of their interest rate exposure.

On the other hand, it can be argued that CEO inside debt is negatively related to the use of interest rate swaps for hedging purposes. Nance et al. (1993) argue that firms can decrease the probability of default by holding more liquid or less risky assets because these assets help to assure debtholders that funds will be available to pay the debt claims. Bretscher et al. (2018) argue that a company can manage its interest rate risk by either employing interest rate swaps or holding cash. This suggests that using interest rate swaps for hedging purposes and holding cash can be considered as substitutes in risk management activities. Disatnik et al. (2014) find that a firm decreases its precautionary demand for cash by employing a cash flow hedging strategy such as using interest rate swaps that swap into fixed rate debt. A negative relationship between liquid assets and hedging is also documented in prior empirical studies (e.g., Tufano, 1996; Geczy et al., 1997; Graham and Rogers, 2002; Judge, 2006; Bartram et al., 2009; and Bartram, 2019). This line of reasoning implies that holding more cash reduces a firm's motivation for hedging. Given that firms with larger CEO inside debt hold more cash (Liu et al., 2014), it is argued that CEO inside debt decreases a firm's need to hedge using interest rate swaps.

Furthermore, hedging theory suggests that one of the motivations for hedging is to reduce firms' financial distress. For example, Smith and Stulz (1985) argue that hedging is effective in reducing the volatility of firm cash flows and therefore decreasing firms' bankruptcy costs. Since firms with higher CEO inside debt are associated with lower default risk (Sundaram and Yermack, 2007), which implies that these firms can have lower financial distress, it is arguable that inside debt reduces the firms' motivation for hedging.

Finally, asymmetric information between shareholders and potential bondholders makes external finance costly because bondholders can lower their offer price to

protect themselves from the opportunistic behaviours of shareholders. To avoid this problem, Mayers and Smith (1987) and Bessembinder (1991) suggest that firms should employ a hedging programme to assure the bondholders that they will not undertake the opportunistic behaviours. Since CEO inside debt holdings can align the benefits of CEOs with the benefits of bondholders, the motivation for hedging to reduce the agency costs of debt can be reduced if firms have a large amount of CEO inside debt. Overall, this stream of reasoning predicts that CEO inside debt decreases firms' motives to hedge by interest rate swaps, therefore reducing the corporate use of interest rate swaps. This leads us to develop the following hypothesis:

Hypothesis 4.1: CEO inside debt holdings have a negative relationship with the corporate hedging via the use of interest rate swaps.

As discussed in Section 2.1, only non-protected CEO inside debt has payoffs that resemble the payoffs to unsecured creditors and therefore can impact firms' financial policy. As a result, we predict that only non-protected CEO inside debt can affect the corporate hedging decisions via the use of interest rate swaps. Consequently, we develop our second hypothesis as follows:

Hypothesis 4.2: Non-protected CEO inside debt holdings have a negative relationship with the corporate hedging via the use of interest rate swaps.

4.3. Data, methodology, and variable construction

4.3.1. Data

Our data is sourced from Bretscher et al. (2018), which consists of the largest 1,600 US listed companies in Compustat.[54] Specifically, our data consists of all companies in Bretscher et al.'s (2018) sample for the period from 2006 to 2014. Our data begins from 2006 because the 2006 SEC reform required all listed companies to disclose and describe the pension benefits and deferred compensation of their top executives. And we stop our data at the year 2014 because this is the final year in Bretscher et al.'s (2018) data. Bretscher et al. (2018) collect the information on interest rate swap usage from the 10-K form of the largest 1,600 firms in Standard & Poor's Compustat (Compustat). We collect CEO compensation data from Standard & Poor's Executive Compensation (ExecuComp) database. The ExecuComp database

[54] Bretscher et al.'s (2018) sample consists of the largest 1,600 companies in Compustat. They hand-collected the data on interest rate swap usage for these companies. We thank Bretscher, Schmid, and Vedolin for providing the data on their website: https://sites.google.com/site/andreavedolin/data?authuser=0

provides data annually on a CEO's name, age, and her compensation including her pension benefits and deferred compensation. Data to calculate the equity-based compensation incentives of a CEO (her delta, vega, and equity wealth in the firm) is also collected from the ExecuComp database.

We collect financial data and stock return data from Compustat and the CRSP, respectively. As in Anantharaman et al. (2014) and Bretscher et al. (2018), we exclude financial firms from our sample. The steps to filter our data from Bretscher et al.'s (2018) original data are presented in detail in Appendix 4.1. Our final sample contains 912 firms with 5,296 firm-year observations.

4.3.2. Methodology

We start our analysis by investigating the impact of a CEO's inside debt on a firm's decision to hedge using interest rate swaps. Our probit estimation models are as follows:

$$IR_SWAP_DUMMY_{it} = \alpha_0 + \beta_1 REL_LEV_{it} + \lambda X_{it} + \varepsilon_{it} \quad (4.1)$$

$$IR_SWAP_DUMMY_{it} = \alpha_0 + \phi_1 PROTECTED_REL_LEV_{it} + \phi_2 NON_PROTECTED_REL_LEV_{it} + \lambda X_{it} + \varepsilon_{it} \quad (4.2)$$

where i and t denote the company i and time t, respectively. The dependent variable in Equations 4.1 and 4.2 is IR_SWAP_DUMMY. Our independent variables are REL_LEV in Equation 4.1 and PROTECTED_REL_LEV and NON_PROTECTED_REL_LEV in Equation 4.2.

We proceed to investigate the effects of CEO inside debt on the extent of hedging via the extent of interest rate swap usage. Specifically, we replace the dependent variables in Equation 4.1 and 4.2 by TOTAL_IR_SWAP and run the following regressions using a pooled Ordinary Least Squares model:

$$TOTAL_IR_SWAP_{it} = \alpha_0 + \beta_1 REL_LEV_{it} + \lambda X_{it} + \varepsilon_{it} \quad (4.3)$$

$$TOTAL_IR_SWAP_{it} = \alpha_0 + \phi_1 PROTECTED_REL_LEV_{it} + \phi_2 NON_PROTECTED_REL_LEV_{it} + \lambda X_{it} + \varepsilon_{it} \quad (4.4)$$

where i and t denote the company i and time t, respectively. The dependent variable in Equations 4.3 and 4.4 is TOTAL_IR_SWAP. Similar to Equations 4.1 and 4.2, our independent variables are REL_LEV in Equation 4.3 and PROTECTED_REL_LEV and NON_PROTECTED_REL_LEV in Equation 4.4.

In Equations 4.1 to 4.4, X is a vector of control variables. The definition of all the variables is presented in Section 4.3.3. We include industry and year dummy variables in all equations above to control for the industry and year fixed effects, respectively. All continuous variables are winsorised at the 1st and 99th percentiles to control for the impact of outliers. In addition, the standard errors are adjusted to heteroskedasticity and are clustered at the firm level.

4.3.3. Variable construction

4.3.3.1. Interest rate swaps variables

We use data from Bretscher et al. (2018) to construct variables to proxy for corporate hedging via the use of interest rate swaps. In essence, this data allows us to identify which firms use interest rate swaps and how much the notional amount of the interest rate swap contracts is. The first variable is a dummy variable that is set equal to 1 if a firm uses interest rate swaps and 0 otherwise (IR_SWAP_DUMMY). However, employing a dummy variable as a proxy for using interest rate swaps is not without limitations because it cannot distinguish between firms that use interest rate swaps intensively and those that use interest rate swaps marginally. In an attempt to overcome this problem, our second variable for the corporate use of interest rate swaps is a continuous measure that is computed as the ratio of the gross notional amount of interest rate swaps over the book value of total assets (TOTAL_IR_SWAP). Several studies also used the gross notional amount of derivative hedging over total assets to compute the extent of derivative usage (e.g., Goldberg et al., 1998; Belkhir and Boubaker, 2013; and Disatnik et al., 2014).

4.3.3.2. CEO inside debt holdings variables

Sundaram and Yermack (2007) and Edmans and Liu (2011) suggest that the ratio of a CEO's personal debt-to-equity ratio over the firm's debt-to-equity ratio should be able to capture the CEO's incentive alignment with debtholders vis-à-vis shareholders.[55] We refer to this ratio as a CEO relative leverage ratio in our paper (REL_LEV). This ratio is computed as the ratio of the sum of a CEO's accumulated pension benefits and deferred compensation scaled by this CEO's equity over the

[55] The value of CEO equity is computed as the value of the CEO's stock and option portfolio. The method to calculate the value of a CEO's stock and option portfolio are based on the studies of Core and Guay (2002), Coles et al. (2006), and Daniel et al. (2016).

firm's debt scaled by the firm's equity.[56] A higher CEO relative leverage ratio suggests that the CEO's incentive is more aligned with the debtholders vis-à-vis the stockholders (Sundaram and Yermack, 2007; and Edmans and Liu, 2011). In Equations 4.1 and 4.3, we expect that the coefficient on REL_LEV is significantly negative.

Furthermore, we are able to separate the parts of CEO inside debt that are funded (protected) under the ERISA from those that are unfunded (non-protected) and construct the corresponding protected CEO relative leverage ratio and non-protected CEO relative leverage ratio. Specifically, we gather the information about the name of the pension benefit plans for each CEO from ExecuComp database. Based on the name of the pension benefit plans, we can identify what plans are ERISA-qualified plans and what plans are non-qualified plans.[57] In cases where it is difficult to identify whether a pension benefit plan is ERISA-qualified or non-qualified, we will read the proxy statement of the company to identify the nature of the plan.[58]

We follow Colonnello et al. (2017) and assume that only ERISA-qualified plans are funded whereas ERISA non-qualified plans and deferred compensation are not. We then calculate the protected CEO relative leverage variable (PROTECTED_REL_LEV) and non-protected CEO relative leverage variable (NON_PROTECTED_REL_LEV) in the same manner as computing the total CEO relative leverage. Specifically, PROTECTED_REL_LEV is calculated by the ratio of a CEO's funded pension benefits scaled by this CEO's equity over the firm's debt scaled by the firm's equity. And NON_PROTECTED_REL_LEV is computed as the ratio of the sum of a CEO's non-funded pension benefits and deferred compensation scaled by this CEO's equity over the firm's debt scaled by the firm's equity. In Equations 4.2 and 4.4, we predict that the coefficient on NON_PROTECTED_REL_LEV is significantly negative.

[56] Following Colonnello et al. (2017), we replace the missing value of the accumulated pension benefits and deferred compensation by zero. Our findings do not change when we leave these values as missing values. By leaving these values as missing values, we end up with a sample consisting of 898 firms with 5,156 firm-year observations.

[57] Non-qualified plans usually have names such as Supplemental Executive Pension Plans (SERPs), Supplemental Key Employee Retirement Plans (SKERPs), Supplemental Senior Officer Retirement Plans (SSORPs), restoration plans, benefit equalisation plans, and excess plans.

[58] Appendix B provides some examples when we have difficulties in identifying whether a pension benefit plan is ERISA-qualified or non-qualified.

4.3.3.3. Control variables

We follow the literature on the determinants of corporate hedging and use a set of control variables that are documented to be associated with the hedging behaviour of a firm. Previous studies argue that equity-based compensation can impact managers' incentives to hedge (e.g., Knopf et al., 2002). Thus, we include the natural logarithm of both CEO delta (ln(DELTA)) and CEO vega (ln(VEGA)) in our regression models. Whereas CEO delta captures the change in CEO wealth for a 1 percent change in stock price, CEO vega measures the change in CEO wealth for a 1 percent change in stock return volatility. The method to calculate CEO delta and vega is based on the studies of Core and Guay (2002), Coles et al. (2006), and Daniel et al. (2016).

We also include the natural logarithm of the market value of total assets as a proxy for the firm size (ln(FIRM_SIZE)). The market value of a firm's total assets is calculated as the book value of assets minus the book value of equity plus the product of the stock price and the number of shares outstanding. Additionally, we capture the impact of firm leverage on hedging behaviour by including firm leverage in our regression models (LEVERAGE). Firm leverage is computed as the ratio of total debt over the market value of total assets.

Firms with higher profitability or more liquid assets or firms possessing a credit rating are argued to have a lower probability of distress, which suggests that these firms are less likely to hedge. Consequently, we include PROFITABILITY, which is computed as the ratio of earnings before interest and taxes over the book value of total assets, QUICK_RATIO, which is calculated as the current assets minus inventory and then divided by current liabilities, and RATED, which is a dummy variable that equals 1 if firms have a long-term credit rating and 0 otherwise, in our regression model.

We use a dummy variable that equals one if companies have a tax loss carryforward and zero otherwise (TAX_LOSS) to control for tax incentives to use derivatives. This is because, as Graham and Smith (1999) show, companies with a tax loss carryforward are more likely to hedge. Finally, we include a ratio of research and development expenditure over the book value of total assets (RND) in our regression models because high-growth firms are associated with more asymmetric information and therefore tend to hedge more (Froot et al., 1993). The definition and sources of all variables employed in our study are provided in Table 4.1.

Table 4.1: Variable definitions

This table provides the definition of all variables employed in this study. The word in the bracket indicates the name of the variable appeared in Compustat.

Variable	Definition	Sources
Interest rate swaps variables		
IR_SWAP_DUMMY	Dummy variable that is equal to 1 if the firm uses interest rate swaps and 0 otherwise.	Brescher et al. (2018)
TOTAL_IR_SWAP	The extent of using interest rate swaps. It is calculated as the total notional amount of interest rate swaps scaled by the book value of total assets (at).	Brescher et al. (2018), Compustat
CEO characteristics variables		
REL_LEV	CEO relative leverage. It is calculated by the ratio of the sum of a CEO's accumulated pension benefits (pension_value_tot) and deferred compensation (defer_balance_tot) scaled by this CEO's equity over the firm's debt (dlc + dltt) scaled by the firm's equity. The firm's equity is calculated by the stock price (prcc_f) of the company multiplied by the number of stock outstanding (csho).	Compustat, ExecuComp
PROTECTED_REL_LEV	Protected CEO relative leverage. It is calculated by the ratio of a CEO's funded pension benefits scaled by this CEO's equity over the firm's debt scaled by the firm's equity.	Compustat, ExecuComp, Company proxy statement

NON_PROTECTED_REL_LEV	Non-protected CEO relative leverage. It is computed as the ratio of a CEO's non-funded pension benefits and other deferred compensation scaled by this CEO's equity over the firm's debt scaled by the firm's equity.	Compustat, ExecuComp, Company proxy statement
VEGA	The change in CEO wealth respective to a 1% change in stock return volatility.	ExecuComp
DELTA	The change in CEO wealth given a 1% change in stock price.	ExecuComp
CEO_AGE	The age of the company's CEO (age)	ExecuComp
Firm characteristics variables		
FIRM_SIZE	The market value of firms' total assets. The market value of firms' total assets is calculated as the book value of assets (at) minus book value of equity (ceq) plus the product of the stock price (prcc_f) and the number of shares outstanding (csho).	Compustat
LEVERAGE	The ratio of firms' total debt (dlc + dltt) over the market value of firms' total assets.	Compustat
PROFITABILITY	The ratio of firms' earnings before interest and taxes (ebit) over the book value of firms' total assets (at).	Compustat
QUICK_RATIO	It is calculated by the current assets (act) minus inventory (invt) and then divided by current liabilities (lct).	Compustat
TAX_LOSS	Dummy variable that is equal to 1 if the firm has tax loss carryforward (tlcf) and 0 otherwise.	Compustat
RND	It is calculated by the ratio of research and development expenses (xrd) over the book	Compustat

	value of total assets (at)	
EXCESS_RETURN	It is computed as the difference between the stock's annual return and the CRSP value-weighted return over the same period.	CRSP
RATED	Dummy variable that is equal to 1 if firms have long-term credit rating and 0 otherwise.	Compustat
WHITED_WU_INDEX	White and Wu (2006) index. It is computed as -0.091 * Firm cash flow ((ib+dp)/at) - 0.062 * Dividend dummy + 0.021 * Long-term debt (dltt/at) - 0.044 * Size (ln(at)) + 0.102 * Industry sales growth - 0.035 * Sales growth. The dividend dummy takes the value of 1 if firms pay dividends (dvpd > 0) and 0 otherwise. Sales growth is the ratio of the difference between sales (sale) in year t and sales in year t-1 over sales in year t-1. Industry sales growth is the arithmetic average of sales growth for firms in the same three-digit SIC-code industry.	Compustat
NET_WORTH	Net worth of a firm. It is calculated as book value of assets (at) minus book value of equity (ceq) plus the product of the share price at the end of the fiscal year (prcc_f) and the number of shares outstanding (csho) minus book value of equity (ceq) minus deferred taxes (txdb).	
DD	Distance-to-default. It is measured based on Brahad and Shumway (2008).	Compustat, CRSP
EQUITY_VOLATILITY	It is measured as the standard deviation of monthly stock returns from the previous year.	CRSP

Instrumental variables		
TAXRATE_WAGE	Maximum tax rate for wages faced by the CEO in the state where the firm is headquartered.	Feenberg and Coutts (1993)
TAXRATE_GAIN	Maximum tax rate for long-term capital gains faced by the CEO in the state where the firm is headquartered.	Feenberg and Coutts (1993)
TAXRATE_MORT	Maximum tax rate for mortgage subsidy faced by the CEO in the state where the firm is headquartered.	Feenberg and Coutts (1993)

4.4. Empirical results

4.4.1. Summary statistics

Table 4.2 provides summary statistics for all variables used in our study. Table 4.2 shows that 31.5 percent of firms in our sample use interest rate swaps. On average, the gross notional amount of interest rate swap contracts is equal to 2.7 percent of total assets. Similar to previous studies (e.g., Wei and Yermack, 2011; Anantharaman et al., 2014; and Freund et al., 2018), the distribution of CEO relative leverage (REL_LEV) is right-skewed with the mean and median of 3.611 and 0.259, respectively. It should be noted that the values of CEO relative leverage in our study and other studies for non-financial companies are much higher than those in studies for financial companies. For example, Belkhir and Boubaker (2013) document a mean (median) of CEO relative leverage for their sample consisting of 150 bank holding companies is 0.048 (0.012). The corresponding figure in Srivastav et al. (2014) for 103 US banks is 0.068 (0.039). As a result, although Belkhir and Boubaker (2013) have investigated the relationship between CEO inside debt and hedging decisions using interest rate derivatives from the US banking industry, the differences in CEO relative leverage between non-financial and financial firms emphasise the importance of our study to examine the similar relationship in a setting of non-financial firms. With respect to the two components of CEO inside debt, the mean and median values of non-protected CEO relative leverage (NON_PROTECTED_REL_LEV) seem to be much higher than those of protected CEO relative leverage (PROTECTED_REL_LEV).

Table 4.2: Summary statistics

This table shows the summary statistics for the variables used in this study. Our sample consists of listed non-financial companies in the United States during the period from 2006 to 2014. IR_SWAP_DUMMY is a dummy variable that is equal to 1 if the firm uses interest rate swaps and 0 otherwise. TOTAL_IR_SWAP is the extent of using interest rate swaps, calculated as the total notional amount of interest rate swaps scaled by the book value of total assets. REL_LEV is CEO relative leverage, calculated by the ratio of the sum of a CEO's accumulated pension benefits and deferred compensation scaled by this CEO's equity over the firm's debt scaled by the firm's equity. PROTECTED_REL_LEV is protected CEO relative leverage, calculated by the ratio of a CEO's funded pension benefits scaled by this CEO's equity over the firm's debt scaled by the firm's equity. NON_PROTECTED_REL_LEV is non-protected CEO relative leverage, computed as the ratio of a CEO's non-funded pension benefits and other deferred compensation scaled by this CEO's equity over the firm's debt scaled by the firm's equity. VEGA is the change in CEO wealth respective to a 1% change in stock return volatility. DELTA is the change in CEO wealth given a 1% change in stock price. CEO_AGE is the age of the company's CEO. FIRM_SIZE is the market value of firms' total assets. LEVERAGE is the ratio of firms' total debt over the market value of firms' total assets. PROFITABILITY is the ratio of firms' earnings before interest and taxes over the book value of firms' total assets. QUICK_RATIO is calculated by the current assets minus inventory and then divided by current liabilities. TAX_LOSS is a dummy variable that is equal to 1 if the firm has tax loss carryforward and 0 otherwise. RND is calculated by the ratio of research and development expenses over the book value of total assets. EXCESS_RETURN is computed as the difference between the stock's annual return and the CRSP value-weighted return over the same period. RATED is a dummy variable that is equal to 1 if firms have long-term credit rating and 0 otherwise. DD is distance-to-default, computed based on Brahad and Shumway (2008). EQUITY_VOLATILITY is measured as the standard deviation of monthly stock return from the previous year. TAXRATE_WAGE, TAXRATE_GAIN, and TAXRATE_MORT are the maximum tax rate for wages, the maximum tax rate for long-term capital gains, and the maximum tax rate for mortgage subsidy faced by the CEO in the state where the firm is headquartered, respectively. All continuous variables are winsorised at the 1st and 99th percentile.

Variable	Obs	Mean	Std. Dev.	5th	50th	95th
Interest rate swaps variables						
IR_SWAP_DUMMY	5,296	0.315	0.465	0.000	0.000	1.000
TOTAL_IR_SWAP (%)	5,296	2.700	6.038	0.000	0.000	15.559
CEO characteristics variables						
REL_LEV	5,296	3.611	17.343	0.000	0.259	9.438
PROTECTED_REL_LEV	4,978	0.096	0.371	0.000	0.000	0.393
NON_PROTECTED_REL_LEV	5,088	3.049	13.360	0.000	0.237	8.942

VEGA ($thousands)	5,296	184.303	253.313	3.050	87.659	704.184
DELTA ($thousands)	5,296	677.475	1380.932	21.034	254.773	2562.063
CEO_AGE (years)	5,291	55.616	6.420	45.000	56.000	66.000
Firm characteristics variables						
FIRM_SIZE ($millions)	5,296	17,822.81	41,621.18	477.537	5091.755	72743.03
LEVERAGE	5,296	0.170	0.133	0.004	0.141	0.439
PROFITABILITY	5,296	0.100	0.080	-0.020	0.095	0.228
QUICK_RATIO	5,296	1.565	1.106	0.446	1.274	3.626
TAX_LOSS	5,296	0.572	0.495	0.000	1.000	1.000
RND	5,296	0.025	0.043	0.000	0.001	0.119
RATED	5,296	0.635	0.482	0.000	1.000	1.000
DD	5,214	9.433	6.815	1.609	7.928	22.612
EXCESS_RETURN (%)	5,290	0.055	0.339	-0.480	0.043	0.621
EQUITY_VOLATILITY (%)	5,278	0.356	0.197	0.136	0.310	0.732
Instrumental variables						
TAXRATE_WAGE (%)	5,256	5.581	3.734	0.000	5.770	11.180
TAXRATE_GAIN (%)	5,256	5.471	3.742	0.000	5.360	11.180
TAXRATE_MORT (%)	5,256	-3.436	4.134	-10.550	0.000	0.000

Table 4.3 presents tests for differences in means and medians of firms' characteristics in our sample between a group consisting of firms with high CEO inside debt and another group consisting of firms with low CEO inside debt. A comparison of interest rate swap usage between the former and the latter can reveal a preliminary relationship between CEO inside debt and firms' hedging behaviour. A firm will be classified in a group with high CEO inside debt if this firm's CEO relative leverage is higher than or equal to one. Otherwise, a firm will be classified in a group with low CEO inside debt. Our result shows that on average the ratio of the gross notional amount of interest rate swaps over total assets is higher for the group with high CEO inside debt than for the group with low CEO inside debt. The difference in mean between these two groups is significant at the 1 percent level.

With respect to equity-based compensation characteristics, CEOs of firms with high CEO relative leverage have a higher vega than the counterparts of firms with low CEO relative leverage. The results in Table 4.3 also show that firms with high CEO inside debt are larger, have higher profitability, have more credit ratings but have less financial leverage and less tax loss carryforward than those with low CEO inside debt. These results suggest that firms that have high CEO inside debt possess characteristics that are associated with less motivation for hedging, implying that these firms use fewer interest rate swaps for hedging purposes. For example, CEOs with higher vega prefer more volatility stock prices and thereby hedge less. Similarly, firms that are larger, have higher profitability, have credit ratings, and have less financial leverage are argued to have less financial distress, which implies that these firms have fewer incentives to hedge. Firms with a lower tax loss carryforward are also argued to use fewer derivatives for hedging. As a result, it is of particular importance to include these control variables in our regression models.

Table 4.3: Univariate results

This table provides the information about the number of observations, mean, median and standard errors of variables used in Equations 4.1, 4.2, 4.3, and 4.4 between companies with high inside debt ratio (REL_LEV ≥ 1) and those with low inside debt ratio (REL_LEV < 1). Our sample consists of listed non-financial companies in the United States during the period from 2006 to 2014. IR_SWAP_DUMMY is a dummy variable that is equal to 1 if the firm uses interest rate swaps and 0 otherwise. TOTAL_IR_SWAP is the extent of using interest rate swaps, calculated as the total notional amount of interest rate swaps scaled by the book value of total assets. REL_LEV is CEO relative leverage, calculated by the ratio of the sum of a CEO's accumulated pension benefits and deferred compensation scaled by this CEO's equity over the firm's debt scaled by the firm's equity. PROTECTED_REL_LEV is protected CEO relative leverage, calculated by the ratio of a CEO's funded pension benefits scaled by this CEO's equity over the firm's debt scaled by the firm's equity. NON_PROTECTED_REL_LEV is non-protected CEO relative leverage, computed as the ratio of a CEO's non-funded pension benefits and other deferred compensation scaled by this CEO's equity over the firm's debt scaled by the firm's equity. VEGA is the change in CEO wealth respective to a 1% change in stock return volatility. DELTA is the change in CEO wealth given a 1% change in stock price. FIRM_SIZE is the market value of firms' total assets. LEVERAGE is the ratio of firms' total debt over the market value of firms' total assets. PROFITABILITY is the ratio of firms' earnings before interest and taxes over the book value of firms' total assets. QUICK_RATIO is calculated by the current assets minus inventory and then divided by current liabilities. TAX_LOSS is a dummy variable that is equal to 1 if the firm has tax loss carryforward and 0 otherwise. RND is calculated by the ratio of research and development expenses over the book value of total assets. RATED is a dummy variable that is equal to 1 if firms have long-term credit rating and 0 otherwise. The mean and median differences between companies with a high inside debt ratio and those with a low inside debt ratio are calculated based on t-test equality of means and Wilcoxon rank sum test, respectively. ***, ** and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Companies with high inside debt ratio				Companies with low inside debt ratio					
	Obs	Mean (1)	Median (2)	Std. Dev.	Obs	Mean (3)	Median (4)	Std. Dev.	Mean difference (1)-(3)	Median difference (2)-(4)
Interest rate swaps variables										
IR_SWAP_DUMMY	1,626	0.320	0.000	0.467	3,670	0.313	0.000	0.464	0.007	0.000
TOTAL_IR_SWAP (%)	1,626	1.851	0.000	4.140	3,670	3.076	0.000	6.675	-1.224***	0.000
CEO characteristics variables										
ln(VEGA)	1,626	4.557	4.861	1.749	3,670	4.110	4.335	1.640	0.448***	0.751***
ln(DELTA)	1,626	5.549	5.647	1.369	3,670	5.479	5.465	1.506	0.070	0.182***
Firm characteristics variables										
ln(FIRM_SIZE)	1,626	9.058	9.026	1.626	3,670	8.346	8.330	1.447	0.712***	0.696***
LEVERAGE	1,626	0.121	0.106	0.095	3,670	0.192	0.165	0.141	-0.071***	-0.059***
PROFITABILITY	1,626	0.119	0.111	0.074	3,670	0.091	0.088	0.081	0.029***	0.023***

QUICK_RATIO	1,626	1.568	1.298	1.034	3,670	1.563	1.263	1.136	0.004	0.035*
TAX_LOSS	1,626	0.512	1.000	0.500	3,670	0.599	1.000	0.490	-0.087***	0.000
RND	1,626	0.023	0.008	0.034	3,670	0.026	0.000	0.046	-0.003**	0.008***
RATED	1,626	0.715	1.000	0.452	3,670	0.599	1.000	0.490	0.115***	0.000

Table 4.4 shows a pairwise correlation matrix for our variables. As can be seen from this table, all the correlation values between independent and control variables are below 0.7, implying that our estimation model is not likely to have a multicollinearity problem.

Table 4.4: Correlation matrix

This table presents the correlation matrix of variables used in Equations 4.1, 4.2, 4.3, and 4.4. Our sample consists of listed non-financial companies in the United States during the period from 2006 to 2014. IR_SWAP_DUMMY is a dummy variable that is equal to 1 if the firm uses interest rate swaps and 0 otherwise. TOTAL_IR_SWAP is the extent of using interest rate swaps, calculated as the total notional amount of interest rate swaps scaled by the book value of total assets. REL_LEV is CEO relative leverage, calculated by the ratio of the sum of a CEO's accumulated pension benefits and deferred compensation scaled by this CEO's equity over the firm's debt scaled by the firm's equity. PROTECTED_REL_LEV is protected CEO relative leverage, calculated by the ratio of a CEO's funded pension benefits scaled by this CEO's equity over the firm's debt scaled by the firm's equity. NON_PROTECTED_REL_LEV is non-protected CEO relative leverage, computed as the ratio of a CEO's non-funded pension benefits and other deferred compensation scaled by this CEO's equity over the firm's debt scaled by the firm's equity. VEGA is the change in CEO wealth respective to a 1% change in stock return volatility. DELTA is the change in CEO wealth given a 1% change in stock price. FIRM_SIZE is the market value of firms' total assets. LEVERAGE is the ratio of firms' total debt over the market value of firms' total assets. PROFITABILITY is the ratio of firms' earnings before interest and taxes over the book value of firms' total assets. QUICK_RATIO is calculated by the current assets minus inventory and then divided by current liabilities. TAX_LOSS is a dummy variable that is equal to 1 if the firm has tax loss carryforward and 0 otherwise. RND is calculated by the ratio of research and development expenses over the book value of total assets. RATED is a dummy variable that is equal to 1 if firms have long-term credit rating and 0 otherwise.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) IR_SWAP_DUMMY	1.00													
(2) TOTAL_IR_SWAP	0.66	1.00												
(3) REL_LEV	-0.08	-0.07	1.00											
(4) PROTECTED_REL_LEV	-0.04	-0.05	0.44	1.00										
(5) NON_PROTECTED_REL_LEV	-0.08	-0.07	0.99	0.46	1.00									
(6) ln(VEGA)	0.11	0.03	-0.02	-0.07	-0.00	1.00								
(7) ln(DELTA)	0.09	0.01	-0.04	-0.10	-0.03	0.67	1.00							
(8) ln(FIRM_SIZE)	0.18	-0.01	-0.04	0.01	-0.02	0.58	0.58	1.00						
(9) LEVERAGE	0.17	0.22	-0.20	-0.14	-0.21	-0.18	-0.27	-0.03	1.00					
(10) PROFITABILITY	0.05	0.05	0.04	0.03	0.06	0.24	0.36	0.28	-0.30	1.00				
(11) QUICK_RATIO	-0.17	-0.12	0.11	0.01	0.11	-0.02	-0.03	-0.20	-0.23	0.01	1.00			
(12) TAX_LOSS	-0.04	0.03	-0.02	-0.03	-0.01	-0.01	-0.06	-0.11	0.03	-0.09	0.05	1.00		
(13) RND	-0.13	-0.11	0.02	-0.04	0.02	0.10	0.01	-0.07	-0.25	-0.11	0.40	0.12	1.00	
(14) RATED	0.17	0.08	-0.10	-0.03	-0.10	0.28	0.22	0.59	0.29	0.06	-0.27	0.02	-0.23	1.00

4.4.2. Multivariate results

4.4.2.1. Impact of CEO inside debt on the corporate hedging decisions

Table 4.5 presents our probit estimation results of the impact of CEO inside debt on firms' decision to hedge using interest rate swaps. Column 1, which reports results estimated from Equation 4.1, shows that the estimated coefficient on REL_LEV is significantly negative at the 1 percent level. In column 2, we estimate Equation 4.2 and find that whereas the coefficient estimated on protected CEO relative leverage is insignificant, the coefficient on non-protected CEO relative leverage is negative and significant at the 1 percent level. This suggests that our result in column 1 is driven by non-protected CEO inside debt. Since there may be cycles in firms' behaviours in using interest rate swaps within industries, we interact year dummy variables with industry dummy variables and include these new variables in our regression models to capture for industry-year fixed effects. The results that are reported in columns 3 and 4 of Table 4.5 are similar to those in columns 1 and 2, respectively.

Table 4.5: The impact of inside debt on the decision to use interest rate swap

This table provides results of probit regressions investigating the relationship between CEO inside debt and the use of interest rate swaps. Our sample consists of listed non-financial companies in the United States during the period from 2006 to 2014. The dependent variable is IR_SWAP_DUMMY, which is a dummy variable that is equal to 1 if the firm uses interest rate swaps and 0 otherwise. REL_LEV is CEO relative leverage, calculated by the ratio of the sum of a CEO's accumulated pension benefits and deferred compensation scaled by this CEO's equity over the firm's debt scaled by the firm's equity. PROTECTED_REL_LEV is protected CEO relative leverage, calculated by the ratio of a CEO's funded pension benefits scaled by this CEO's equity over the firm's debt scaled by the firm's equity. NON_PROTECTED_REL_LEV is non-protected CEO relative leverage, computed as the ratio of a CEO's non-funded pension benefits and other deferred compensation scaled by this CEO's equity over the firm's debt scaled by the firm's equity. VEGA is the change in CEO wealth respective to a 1% change in stock return volatility. DELTA is the change in CEO wealth given a 1% change in stock price. FIRM_SIZE is the market value of firms' total assets. LEVERAGE is the ratio of firms' total debt over the market value of firms' total assets. PROFITABILITY is the ratio of firms' earnings before interest and taxes over the book value of firms' total assets. QUICK_RATIO is calculated by the current assets minus inventory and then divided by current liabilities. TAX_LOSS is a dummy variable that is equal to 1 if the firm has tax loss carryforward and 0 otherwise. RND is calculated by the ratio of research and development expenses over the book value of total assets. RATED is a dummy variable that is equal to 1 if firms have long-term credit rating and 0 otherwise. In columns 1 and 2, industry dummy variables and year dummy variables are included in the regressions but not reported. In columns 3 and 4, the interaction variables between industry dummies and year dummies are included in the regression but not reported. The standard errors are adjusted for heteroskedasticity and clustered at the firm level. ***, ** and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Dependent variable: IR_SWAP_DUMMY			
VARIABLES	(1)	(2)	(3)	(4)
REL_LEV	-0.008***		-0.008***	
	(0.003)		(0.003)	
PROTECTED_REL_LEV		0.105		0.102
		(0.121)		(0.120)
NON_PROTECTED_REL_LEV		-0.013***		-0.012***
		(0.005)		(0.004)
ln(VEGA)	0.040	0.049*	0.040	0.049*
	(0.027)	(0.028)	(0.027)	(0.028)
ln(DELTA)	0.013	-0.006	0.016	-0.004
	(0.035)	(0.036)	(0.035)	(0.036)
ln(FIRM_SIZE)	0.127***	0.131***	0.124***	0.129***
	(0.040)	(0.042)	(0.040)	(0.043)
LEVERAGE	1.751***	1.615***	1.773***	1.640***
	(0.330)	(0.356)	(0.331)	(0.357)
PROFITABILITY	0.845*	0.780	0.865*	0.825
	(0.487)	(0.506)	(0.495)	(0.515)
QUICK_RATIO	-0.155***	-0.147***	-0.155***	-0.148***
	(0.040)	(0.039)	(0.040)	(0.039)
TAX_LOSS	-0.017	-0.030	-0.016	-0.027
	(0.071)	(0.075)	(0.071)	(0.075)
RND	-3.081***	-3.185***	-3.056***	-3.156***
	(1.021)	(1.030)	(1.023)	(1.032)
RATED	-0.027	0.002	-0.023	0.006
	(0.105)	(0.108)	(0.106)	(0.109)
Constant	-2.368***	-2.324***	-2.233***	-2.221***
	(0.381)	(0.401)	(0.393)	(0.416)
Observations	5,296	4,779	5,296	4,762
Industry FE	YES	YES		
Year FE	YES	YES		
Industry FE * Year FE			YES	YES
Pseudo R-squared	0.087	0.088	0.092	0.093
Log pseudolikelihood	-3013.95	-2703.89	-2998.29	-2687.89

Focusing on the extent of hedging proxied by interest rate swap usage, Table 4.6 provides results estimated from a pooled OLS regression of the level of interest rate swap usage on CEO inside debt. The structure of Table 4.6 is similar to the structure of Table 4.5. In columns 1 and 3, the coefficient estimated on REL_LEV is negative and significant at the 5 percent level, suggesting a negative relationship between CEO inside debt and the extent of interest rate swap usage. In columns 2 and 4, while the coefficient on PROTECTED_REL_LEV is insignificant, the coefficients on NONPROTECTED_REL_LEV are negative and significant at the 1 percent level, suggesting that only non-protected CEO inside debt can reduce the extent of interest rate swap usage. In economic terms, column 2 shows that a one standard deviation increase in non-protected CEO relative leverage can reduce the extent of interest rate swap usage by around 5.94% percent.[59] This economic impact is not different from any of the other studies. For example, Liu et al. (2014) and Dang and Phan (2016) find that a one standard deviation increase in CEO relative leverage increases cash holdings and short-term debt over total debt by around 5.1% and 10.6%, respectively.[60] Overall, our results suggest that firms with higher non-protected CEO inside debt holdings are less likely to hedge using interest rate swaps and if they hedge, they will hedge using interest rate swaps less intensively. Therefore, this finding supports our hypotheses 4.1 and 4.2.

[59] 5.94% = 0.012 * 13.360 / 2.7 * 100%, where 0.012 is the absolute value of the coefficient on NONPROTECTED_REL_LEV in column 2 of Table 4.6, 13.360 is the standard deviation of NONPROTECTED_REL_LEV, and 2.7 is the mean of TOTAL_IR_SWAP.

[60] Liu et al. (2014) define cash holdings as the ratio of cash and marketable securities over net assets, where net assets are computed as total assets minus cash and marketable securities. Dang and Phan (2016) measure short-term debt as the sum of debt in current liabilities plus debt maturing in two or three years.

Table 4.6: The impact of inside debt on the extent of using interest rate swaps

This table provides results of pooled OLS regressions investigating the relationship between CEO inside debt and the extent of using interest rate swaps. Our sample consists of listed non-financial companies in the United States during the period from 2006 to 2014. The dependent variable is TOTAL_IR_SWAP, which is the extent of using interest rate swaps. REL_LEV is CEO relative leverage, calculated by the ratio of the sum of a CEO's accumulated pension benefits and deferred compensation scaled by this CEO's equity over the firm's debt scaled by the firm's equity. PROTECTED_REL_LEV is protected CEO relative leverage, calculated by the ratio of a CEO's funded pension benefits scaled by this CEO's equity over the firm's debt scaled by the firm's equity. NON_PROTECTED_REL_LEV is non-protected CEO relative leverage, computed as the ratio of a CEO's non-funded pension benefits and other deferred compensation scaled by this CEO's equity over the firm's debt scaled by the firm's equity. VEGA is the change in CEO wealth respective to a 1% change in stock return volatility. DELTA is the change in CEO wealth given a 1% change in stock price. FIRM_SIZE is the market value of firms' total assets. LEVERAGE is the ratio of firms' total debt over the market value of firms' total assets. PROFITABILITY is the ratio of firms' earnings before interest and taxes over the book value of firms' total assets. QUICK_RATIO is calculated by the current assets minus inventory and then divided by current liabilities. TAX_LOSS is a dummy variable that is equal to 1 if the firm has tax loss carryforward and 0 otherwise. RND is calculated by the ratio of research and development expenses over the book value of total assets. RATED is a dummy variable that is equal to 1 if firms have long-term credit rating and 0 otherwise. In columns 1 and 2, industry dummy variables and year dummy variables are included in the regressions but not reported. In columns 3 and 4, the interaction variables between industry dummies and year dummies are included in the regression but not reported. The standard errors are adjusted for heteroskedasticity and clustered at the firm level. ***, ** and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Dependent variable: TOTAL_IR_SWAP			
VARIABLES	(1)	(2)	(3)	(4)
REL_LEV	-0.007**		-0.006**	
	(0.003)		(0.003)	
PROTECTED_REL_LEV		0.063		0.087
		(0.189)		(0.192)
NON_PROTECTED_REL_LEV		-0.012***		-0.011***
		(0.004)		(0.004)
ln(VEGA)	0.245***	0.271***	0.241**	0.266***
	(0.092)	(0.097)	(0.094)	(0.099)
ln(DELTA)	0.206	0.163	0.211	0.165
	(0.133)	(0.138)	(0.134)	(0.140)
ln(FIRM_SIZE)	-0.367**	-0.444**	-0.370**	-0.447**
	(0.170)	(0.182)	(0.171)	(0.183)
LEVERAGE	12.166***	10.309***	12.276***	10.429***
	(1.898)	(1.804)	(1.913)	(1.818)
PROFITABILITY	8.221***	8.031***	8.152***	8.009***
	(2.143)	(2.238)	(2.189)	(2.292)
QUICK_RATIO	-0.346***	-0.377***	-0.350***	-0.380***
	(0.100)	(0.097)	(0.101)	(0.098)
TAX_LOSS	0.349	0.364	0.348	0.365
	(0.291)	(0.304)	(0.292)	(0.304)
RND	-6.601**	-6.494**	-6.517**	-6.340**
	(2.683)	(2.798)	(2.708)	(2.830)
RATED	0.107	0.276	0.114	0.289
	(0.438)	(0.462)	(0.440)	(0.464)
Constant	-0.812	0.646	-1.509	8.680
	(1.556)	(1.487)	(1.361)	(8.051)
Observations	5,296	4,779	5,296	4,779
Industry FE	YES	YES		
Year FE	YES	YES		
Industry FE * Year FE			YES	YES
R-squared	0.092	0.079	0.098	0.084

With a couple of exceptions, the sign of some control variables is in line with our prediction. We find that large firms that have benefits from scale economies to start a hedging programme are more likely to use interest rate swaps. However, firms hedge less intensively when their size increases, which is consistent with the finding that the direct costs of financial distress are less than proportional to firm size (Warner, 1977). Our results show that the coefficient estimated on firm leverage is significantly positive, which can be explained by Graham and Roger's (2002) argument that hedging by financial derivatives increases debt capacity. Our quick ratio variable has a significantly negative coefficient, suggesting that firms possessing more liquid assets have less financial distress and therefore hedge less. However, some of our control variables have signs that are not consistent with theoretical predictions. For example, we find that the coefficients estimated on CEO vega and firm profitability variables are significantly positive in all four columns of Table 4.6. By contrast, the coefficient on RND variable is negative and significant at the 1 percent level in all specifications. Nevertheless, prior studies also provide mixed evidence on the relationship between these control variables and the corporate use of derivatives (e.g., Graham and Rogers, 2002; Bartram et al., 2009; and Bartram, 2019).

The value of the R-squared in columns 1-4 of Table 4.6 ranges from 0.079 to 0.098, which is not much different from the corresponding figure of approximately 0.13 in Goldberg et al. (1998). The R-squared comparison between our study and their study is potentially meaningful because Goldberg et al. (1998) investigate the determinants of US corporate hedging behaviour, which include some firms' characteristics as in our model. In their regression analysis, the dependent variable is the notional value of derivative use scaled by the firm's total assets. Some other US studies investigate the determinants of corporate hedging behaviour proxied by the corporate use of commodity derivatives and find the R-squared of around 0.05 (e.g., Kumar and Rabinovitch, 2013) or 0.13 (e.g., Haushalter, 2000).

4.4.2.2. Robustness check

So far this paper has focused on the relationship between CEO inside debt and the corporate hedging via the use of interest rate swaps. Our results show that there is a negative relationship between CEO inside debt and the corporate hedging. Additionally, we find that this relationship exists only when the CEO inside debt is

non-protected. In this section, we perform a battery of robustness tests for these results using alternative econometric models. The results are reported in Table 4.7. Firstly, in columns 1 and 2, we use the lag one year of the right-hand side variables in our model specifications to mitigate the reverse causality of corporate use of interest rate swaps to CEO inside debt. The results from the lag model confirm our previous findings.

Table 4.7: Robustness check

This table provides robustness results investigating the impact of CEO inside debt on the extent of using interest rate swaps by using a range of alternative econometric methods. Our sample consists of listed non-financial companies in the United States during the period from 2006 to 2014. The dependent variable is TOTAL_IR_SWAP, which is the extent of using interest rate swaps. REL_LEV is CEO relative leverage, calculated by the ratio of the sum of a CEO's accumulated pension benefits and deferred compensation scaled by this CEO's equity over the firm's debt scaled by the firm's equity. PROTECTED_REL_LEV is protected CEO relative leverage, calculated by the ratio of a CEO's funded pension benefits scaled by this CEO's equity over the firm's debt scaled by the firm's equity. NON_PROTECTED_REL_LEV is non-protected CEO relative leverage, computed as the ratio of a CEO's non-funded pension benefits and other deferred compensation scaled by this CEO's equity over the firm's debt scaled by the firm's equity. VEGA is the change in CEO wealth respective to a 1% change in stock return volatility. DELTA is the change in CEO wealth given a 1% change in stock price. FIRM_SIZE is the market value of firms' total assets. LEVERAGE is the ratio of firms' total debt over the market value of firms' total assets. PROFITABILITY is the ratio of firms' earnings before interest and taxes over the book value of firms' total assets. QUICK_RATIO is calculated by the current assets minus inventory and then divided by current liabilities. TAX_LOSS is a dummy variable that is equal to 1 if the firm has tax loss carryforward and 0 otherwise. RND is calculated by the ratio of research and development expenses over the book value of total assets. RATED is a dummy variable that is equal to 1 if firms have long-term credit rating and 0 otherwise. In columns 1 and 2, we use lag one-year of the right-hand side variables. In columns 3 and 4, we employ a Tobit regression model. And in columns 4, 5, and 6, we employ an instrumental variables technique. Industry dummy variables and year dummy variables are included in the regressions but not reported. The standard errors are adjusted for heteroskedasticity and clustered at the firm level. ***, ** and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Dependent variable: TOTAL_IR_SWAP						
	LAG	LAG	TOBIT	TOBIT	IV	IV	IV
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
REL_LEV	-0.007**		-0.103***		-0.237*		
	(0.003)		(0.038)		(0.127)		
PROTECTED_REL_LEV		0.351		1.189		-13.558*	
		(0.269)		(1.446)		(6.940)	
NON_PROTECTED_REL_LEV		-0.015***		-0.163***			-0.266*
		(0.005)		(0.058)			(0.158)
ln(VEGA)	0.190	0.156	0.342	0.148	-0.132	-0.506	-0.086
	(0.162)	(0.171)	(0.395)	(0.416)	(0.223)	(0.355)	(0.222)
ln(DELTA)	0.054	0.230	0.115	0.556	-0.125	-0.063	-0.039
	(0.497)	(0.528)	(1.324)	(1.401)	(0.527)	(0.601)	(0.515)
ln(FIRM_SIZE)	-0.435**	-0.540**	0.343	0.272	-0.258	0.011	-0.230
	(0.199)	(0.214)	(0.471)	(0.503)	(0.201)	(0.301)	(0.207)

LEVERAGE	12.046***	10.045***	29.424***	26.510***	4.976	1.811	5.663
	(2.134)	(2.041)	(4.418)	(4.647)	(4.216)	(4.681)	(4.343)
PROFITABILITY	7.849***	7.509***	21.503***	21.041***	7.845***	7.280***	8.055***
	(2.282)	(2.379)	(6.587)	(6.926)	(2.384)	(2.756)	(2.365)
QUICK_RATIO	-0.344***	-0.381***	-1.900***	-1.923***	-0.068	-0.463***	-0.081
	(0.111)	(0.111)	(0.497)	(0.489)	(0.185)	(0.132)	(0.188)
TAX_LOSS	0.079	0.074	0.415	0.327	0.245	0.196	0.299
	(0.326)	(0.339)	(0.853)	(0.906)	(0.351)	(0.412)	(0.338)
RND	-8.548***	-8.251***	-36.992***	-38.941***	-13.523***	-19.459**	-12.564**
	(2.965)	(3.106)	(12.335)	(12.951)	(4.941)	(8.260)	(4.883)
RATED	0.290**	0.324***	0.659**	0.776**	0.284***	0.126	0.272**
	(0.114)	(0.120)	(0.304)	(0.324)	(0.107)	(0.129)	(0.106)
Constant	0.285	1.934	-24.319***	-22.326***	1.883	4.372	1.213
	(1.779)	(1.720)	(4.556)	(4.694)	(2.395)	(2.742)	(2.231)
Observations	4,202	3,785	5,296	4,779	5,251	4,933	5,047
Industry FE	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES
R-squared	0.085	0.071			0.019	0.010	0.026
Pseudo R-squared			0.035	0.033			
Log pseudolikelihood			-8288.97	-7419.09			
Kleibergen-Paap rk LM statistics (p-value)					0.042	0.003	0.049
Cragg-Donald Wald F statistic					16.632	10.490	16.371
Hasen statistic (p-value)					0.777	0.710	0.448

Secondly, we estimate Equations 4.3 and 4.4 using a Tobit regression model with a left-censoring limit of 0. Verbeek (2017) shows that Tobit regression is suitable for a model where the dependent variable is zero for a nontrivial part of the population but positive for the remaining part of the population. The estimated results are presented in columns 3 and 4 of Table 4.7. The results show that the coefficients estimated on the total CEO relative leverage and non-protected CEO relative leverage are negative and significant at the 1 percent level, which is consistent with our previous finding.

Finally, we use a two-stage instrumental variable (IV) technique to cope with endogeneity problems. Specifically, in the first stage, we estimate our CEO inside debt variables as a function of a set of selected instrumental variables and control variables in the second equation. In the second stage, we estimate the interest rate swap usage on the predicted value of our CEO inside debt variables and control variables mentioned above. We follow prior studies to select our instruments (e.g., Cassell et al., 2012; Phan, 2014; and Anantharaman et al., 2014). Our first instrumental variable is the natural logarithm of CEO age. CEO pension values are argued to increase more rapidly than the value of CEO equity when the CEO gets older, suggesting a positive relationship between our CEO inside debt variables and CEO age. Our second and third instruments are the maximum tax rate for wages and the maximum tax rate for long-term capital gains faced by the CEO in the state where the firm is headquartered.[61] Scholes et al. (2002) and Kim and Lu (2011) show that deferring tax payment can generate benefits that increase with the CEO's marginal tax rate. Therefore, we predict that if the CEO's marginal tax rate increases, the CEO's willingness to accept deferred compensation can increase and so can the CEO inside debt.

The results estimated from an IV regression model are reported in columns 5, 6, and 7 of Table 4.7 for the total CEO relative leverage, protected CEO relative leverage, and non-protected CEO relative leverage, respectively. The results in columns 5 and 7 indicate that the coefficients on total CEO relative leverage and non-protected CEO relative leverage are significantly negative, which is similar to our previous finding. The post-estimation tests confirm the relevance of the instruments in these specifications. The Kleibergen-Paap rk LM statistics are

[61] The data for the maximum tax rate for wages and the maximum tax rate for long-term capital gains are sourced from Feenberg and Coutts (1993).

significant at the 5 percent level in both columns 5 and 7, which indicates that our instruments are relevant to the endogenous variables. Additionally, the Cragg-Donald Wald F statistics are higher than the Stock and Yogo (2005) critical value of 13.91 for a maximal relative bias in the IV estimation of 5 percent in both columns 5 and 7, which suggests that our instruments are not weak. The p-values of Hansen's J statistic for the test of over-identification are 0.777 and 0.448 in columns 5 and 7, respectively, suggesting that our instruments are valid. In column 6, surprisingly, we find a significantly abnormal large negative coefficient on the protected CEO relative leverage variable. However, this result can be explained because of the weak correlation between this variable and our instruments. Although the Kleibergen-Paap rk LM statistic is significant at the 1 percent level in column 6, the Cragg-Donald Wald F statistic is smaller than the Stock and Yogo (2005) critical value of 13.91 for a maximal relative bias in the IV estimation of 5 percent. Overall, our results in this analysis provide further corroboration for our previous findings.[62]

4.4.2.3. Impact of financial constraint

In this section, we attempt to go a step further by incorporating the condition of financial constraints in our analysis. There is some evidence to suggest that the impact of CEO inside debt on firms' financing and investment policies is weakened if companies face financial constraints. For example, Liu et al. (2014) indicate that although inside debt can induce CEOs to hold excess cash, the CEOs of financially constrained firms may find it difficult to do this. Dang and Phan (2016) show that the positive relationship between CEO inside debt and a short-term debt ratio only appears for unconstrained firms, not for constrained firms. In addition, it is arguable that financial constraints do matter in determining the companies' hedging behaviours. For instance, some studies document that companies hedge more in the presence of financial constraints (Geczy et al., 1997) and that hedging can be more valuable if companies face financial constraints (Froot et al., 1993; and Kuersten and Linde, 2011). Given that financial constraints can dampen the effect of CEO inside debt on firms' financial policy but increase firms' motivation to hedge, we predict

[62] In unreported analysis, we add another instrument in our IV analysis, which is the maximum tax rate for mortgage subsidy faced by the CEO in the state where the firm is headquartered. The results do not change, except that the Cragg-Donald Wald F statistics are lower in this analysis.

that the negative impact of CEO inside debt on hedging will be weakened if firms are financially constrained.

To investigate this, we estimate Equation 4.4 for financially constrained and unconstrained groups separately. We use the two following proxies to measure the degree of financial constraints: a Whited and Wu (2006) index and the net worth of a firm.[63] Firms whose Whited and Wu index is in the 60th percentile and above or firms whose net worth is in the 40th percentile and below are classified as financially constrained firms. By contrast, firms with their Whited and Wu index in the 40th percentile and below or firms with their net worth in the 60th percentile and above are considered as financially unconstrained firms. The results are reported in Table 4.8.

[63] The definition of Whited and Wu (2006) index and the net worth of a firm is presented in Table 4.1.

Table 4.8: The impact of financial constraint

This table provides results from pooled OLS regressions investigating the impact of protected and non-protected CEO inside debt on the extent of using interest rate swap, conditional on the degree of firms' financial constraints. Our sample consists of listed non-financial companies in the United States during the period from 2006 to 2014. The dependent variable is TOTAL_IR_SWAP, which is the extent of using interest rate swaps. REL_LEV is CEO relative leverage, calculated by the ratio of the sum of a CEO's accumulated pension benefits and deferred compensation scaled by this CEO's equity over the firm's debt scaled by the firm's equity. PROTECTED_REL_LEV is protected CEO relative leverage, calculated by the ratio of a CEO's funded pension benefits scaled by this CEO's equity over the firm's debt scaled by the firm's equity. NON_PROTECTED_REL_LEV is non-protected CEO relative leverage, computed as the ratio of a CEO's non-funded pension benefits and other deferred compensation scaled by this CEO's equity over the firm's debt scaled by the firm's equity. VEGA is the change in CEO wealth respective to a 1% change in stock return volatility. DELTA is the change in CEO wealth given a 1% change in stock price. FIRM_SIZE is the market value of firms' total assets. LEVERAGE is the ratio of firms' total debt over the market value of firms' total assets. PROFITABILITY is the ratio of firms' earnings before interest and taxes over the book value of firms' total assets. QUICK_RATIO is calculated by the current assets minus inventory and then divided by current liabilities. TAX_LOSS is a dummy variable that is equal to 1 if the firm has tax loss carryforward and 0 otherwise. RND is calculated by the ratio of research and development expenses over the book value of total assets. RATED is a dummy variable that is equal to 1 if firms have long-term credit rating and 0 otherwise. Columns 1 and 2 report the results using the Whited and Wu (2006) index as the proxy for financial constraints while columns 3 and 4 report the results using the firm's net worth as the proxy for financial constraints. Industry dummy variables and year dummy variables are included in the regressions but not reported. The standard errors are adjusted for heteroskedasticity and clustered at the firm level. ***, ** and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Dependent variable: TOTAL_IR_SWAP			
	WHITED_WU_INDEX		NET_WORTH	
	Constrained	Unconstrained	Constrained	Unconstrained
VARIABLES	(1)	(2)	(3)	(4)
PROTECTED_REL_LEV	-0.019	0.176	0.013	-0.027
	(0.290)	(0.415)	(0.293)	(0.338)
NON_PROTECTED_REL_LEV	-0.009	-0.021*	-0.010*	-0.021**
	(0.006)	(0.012)	(0.005)	(0.008)
ln(VEGA)	0.316*	0.096	0.414**	0.137
	(0.185)	(0.118)	(0.188)	(0.105)
ln(DELTA)	0.097	0.123	0.136	-0.108
	(0.181)	(0.195)	(0.199)	(0.162)
ln(FIRM_SIZE)	-0.128	-0.008	-0.391	0.060
	(0.356)	(0.216)	(0.529)	(0.231)
LEVERAGE	8.226***	10.199***	8.055***	8.927***
	(2.414)	(2.774)	(2.384)	(2.717)
PROFITABILITY	6.013*	10.238**	8.433***	7.408*
	(3.070)	(4.656)	(2.964)	(3.798)
QUICK_RATIO	-0.488***	-0.017	-0.568***	0.009
	(0.116)	(0.193)	(0.128)	(0.162)
TAX_LOSS	0.753	-0.220	0.605	-0.093
	(0.472)	(0.432)	(0.497)	(0.444)
RND	-12.339***	10.089	-12.226***	-0.455
	(3.728)	(6.604)	(3.778)	(4.516)
RATED	-0.279	1.945***	-0.315	1.035*
	(0.696)	(0.402)	(0.760)	(0.582)
Constant	1.313	-5.085**	1.683	-2.580
	(2.700)	(2.419)	(4.123)	(2.745)
Observations	1,961	1,882	1,715	1,809
Industry FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
R-squared	0.096	0.065	0.097	0.064

Columns 1–2 and 3–4 present the results using the Whited and Wu index and the net worth as the proxies for financial constraints, respectively. The results show that the impact of non-protected CEO inside debt on the extent of interest rate swaps disappears or is weakened for a financially constrained group. Specifically, in column 1 for a constrained group, the coefficient estimated on non-protected CEO relative leverage is insignificant, while it is significantly negative in column 2 for an unconstrained group. Although this coefficient is negative in column 3 for a constrained group, it is only statistically significant at the 10 percent level, whereas it is significantly negative at the 5 percent level in column 4 for an unconstrained group. Furthermore, the results in columns 3 and 4 suggest that the economic impact of non-protected CEO relative leverage on interest rate swap usage for an unconstrained group is nearly double than that for a constrained group. We find that a one standard deviation increase in CEO relative leverage can reduce the interest rate swap usage by around 5.14% and 10.19% for financially constrained and unconstrained groups, respectively.[64] Overall, these results support our prediction of the weakened impact of non-protected CEO inside debt on the corporate hedging when firms are financially constrained.

4.4.2.4. Impact of interest rate uncertainty

Our paper thus far has found that CEO inside debt exerts a negative impact on the corporate hedging via the use of interest rate swaps and that this impact of CEO inside debt is dampened when firms are in financial constraints. In this section, we investigate this effect of CEO inside debt conditional on interest rate uncertainty. Bretscher et al. (2018) show that during the period of heightened interest rate uncertainty, hedging by interest rate swaps is valuable to firms because it reduces the adverse impact of interest rate uncertainty on firm investment. As a result, we predict that the negative effect of CEO inside debt on hedging using interest rate swaps is

[64] 5.14% = (0.010*14.558/2.832)*100%, where 0.010 is the absolute value of the coefficient estimated on non-protected CEO relative leverage in column 3 of Table 4.8, 14.558 and 2.832 are the standard deviation of non-protected CEO relative leverage and the mean of interest rate swap usage for the financially constrained group, respectively.

10.19% = (0.021*11.325/2.333)*100%, where 0.021 is the absolute value of the coefficient estimated on non-protected CEO relative leverage in column 4 of Table 4.8, 11.325 and 2.333 are the standard deviation of non-protected CEO relative leverage and the mean of interest rate swap usage for the financially unconstrained group, respectively.

weakened during the period of heightened interest rate uncertainty since motivations for hedging using interest rate swaps are strong during this period.

To test this prediction, we estimate Equation 4.4 for the two sub-sample periods, one being associated with periods of low interest rate uncertainty and one being associated with periods of high interest rate uncertainty. We source the data for interest rate uncertainty from Choi et al. (2017). Choi et al. (2017) calculate a monthly interest rate uncertainty index based on an implied volatility index extracted from 1-month options written on 10-year treasury note futures. This implied volatility index is argued to reflect uncertainties about future economic activities as well as future actions of monetary authorities (Bretscher et al., 2018). In our paper, we calculate the annual interest rate uncertainty index by averaging the monthly interest rate uncertainty index. Periods of low interest rate uncertainty are defined as periods whose interest rate uncertainty index is lower than the median of this index. The remaining periods are defined as high interest rate uncertainty periods.

We report estimated results for periods of low and high interest rate uncertainty in columns 1 and 2 of Table 4.9, respectively. We find that the coefficient estimated on non-protected CEO relative leverage is negative and significant at the 1 percent level in column 1 and at the 5 percent level in column 2, suggesting that non-protected CEO inside debt reduces interest rate swap usage in both periods of low and high interest rate uncertainty. However, it seems that the economic impact of non-protected CEO inside debt on interest rate swap usage is much stronger during the periods of low interest rate uncertainty. Specifically, our results suggest that during periods of low interest rate uncertainty, a one standard deviation increase in non-protected CEO relative leverage can reduce the interest rate swap usage by an amount of around 8.39%, which is nearly double the corresponding amount of approximately 4.24% during periods of high interest rate volatility.[65]

[65] 8.39% = (0.016*11.559/2.210)*100%, where 0.016 is the absolute value of the coefficient estimated on non-protected CEO relative leverage in column 1 of Table 4.9, 11.559 and 2.210 are the standard deviation of non-protected CEO relative leverage and the mean of interest rate swap usage for the sub-sample period of low interest rate volatility, respectively.

4.24% = (0.009*13.998/2.970)*100%, where 0.009 is the absolute value of the coefficient estimated on non-protected CEO relative leverage in column 2 of Table 4.9, 11.325 and 2.333 are the standard deviation of non-protected CEO relative leverage and the mean of interest rate swap usage for the sub-sample group of high interest rate volatility, respectively.

Table 4.9: The impact of interest rate uncertainty

This table provides results from pooled OLS regressions investigating the impact of protected and non-protected CEO inside debt on the extent of using interest rate swap, conditional on the level of market interest rate uncertainty. Our sample consists of listed non-financial companies in the United States during the period from 2006 to 2014. The dependent variable is TOTAL_IR_SWAP, which is the extent of using interest rate swaps. REL_LEV is CEO relative leverage, calculated by the ratio of the sum of a CEO's accumulated pension benefits and deferred compensation scaled by this CEO's equity over the firm's debt scaled by the firm's equity. PROTECTED_REL_LEV is protected CEO relative leverage, calculated by the ratio of a CEO's funded pension benefits scaled by this CEO's equity over the firm's debt scaled by the firm's equity. NON_PROTECTED_REL_LEV is non-protected CEO relative leverage, computed as the ratio of a CEO's non-funded pension benefits and other deferred compensation scaled by this CEO's equity over the firm's debt scaled by the firm's equity. VEGA is the change in CEO wealth respective to a 1% change in stock return volatility. DELTA is the change in CEO wealth given a 1% change in stock price. FIRM_SIZE is the market value of firms' total assets. LEVERAGE is the ratio of firms' total debt over the market value of firms' total assets. PROFITABILITY is the ratio of firms' earnings before interest and taxes over the book value of firms' total assets. QUICK_RATIO is calculated by the current assets minus inventory and then divided by current liabilities. TAX_LOSS is a dummy variable that is equal to 1 if the firm has tax loss carryforward and 0 otherwise. RND is calculated by the ratio of research and development expenses over the book value of total assets. RATED is a dummy variable that is equal to 1 if firms have long-term credit rating and 0 otherwise. Column 1 reports the results during the period of low market interest rate uncertainty and column 2 reports the results during the period of high market interest rate uncertainty. Industry dummy variables and year dummy variables are included in the regressions but not reported. The standard errors are adjusted for heteroskedasticity and clustered at the firm level. ***, ** and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Dependent variable: TOTAL_IR_SWAP	
	LOW TIV	HIGH TIV
VARIABLES	(1)	(2)
PROTECTED_REL_LEV	-0.066	0.105
	(0.217)	(0.222)
NON_PROTECTED_REL_LEV	-0.016***	-0.009**
	(0.005)	(0.004)
ln(VEGA)	0.283***	0.270**
	(0.104)	(0.127)
ln(DELTA)	0.084	0.209
	(0.132)	(0.177)
ln(FIRM_SIZE)	-0.280	-0.556***
	(0.194)	(0.209)
LEVERAGE	8.551***	11.184***
	(1.763)	(2.165)
PROFITABILITY	6.280**	8.998***
	(2.736)	(2.489)
QUICK_RATIO	-0.222*	-0.466***
	(0.114)	(0.111)
TAX_LOSS	0.351	0.351
	(0.353)	(0.363)
RND	-6.084*	-6.709**
	(3.481)	(3.355)
RATED	-0.089	0.527
	(0.515)	(0.566)
Constant	0.507	1.182
	(1.703)	(1.660)
Observations	1,859	2,920
Year FE	YES	YES
Industry FE	YES	YES
R-squared	0.050	0.094

4.4.2.5. Impact of CEO inside debt and corporate hedging on default risk

The theoretical model of Edmans and Liu (2011) suggests the effects of CEO inside debt on alleviating the agency costs of debt are weakened when companies' probability of default is low. Hedging theory suggests that the use of financial derivatives can reduce the probability of bankruptcy (Smith and Stulz, 1985; Froot et al., 1993; and Purnanandam, 2008). Some empirical studies support the hedging theory and find a negative relationship between the use of financial derivatives and firms' risk (e.g., Guay, 1999b, Hentschel and Kothari, 2001; Bartram et al., 2011; and Bartram, 2019). This result suggests that hedging by interest rate swaps can reduce the likelihood of bankruptcy. Based on the prediction of Edmans and Liu's (2011) model, we predict that the negative impact of CEO inside debt on firms' default risk will be dampened if the firms undertake a hedging programme.

To investigate this, we estimate a model where firms' default risk is regressed on CEO inside debt variables and their interaction terms with interest rate swap usage. We use the distance to default as a proxy for firms' default risk. We calculate the distance to default of a company for a given year based on the method of Bharath and Shumway (2008):

$$DD_{it} = \frac{\log\left(\frac{Equity_{it}+Debt_{it}}{Debt_{it}}\right)+\left(r_{i,t-1}-\frac{\sigma_{V,it}^2}{2}\right)\times T_{it}}{\sigma_{V,it}\times\sqrt{T_{it}}} \quad (5)$$

$$\sigma_{V,it} = \frac{Equity_{it}}{Equity_{it}+Debt_{it}}\times\sigma_{E,it} + \frac{Debt_{it}}{Equity_{it}+Debt_{it}}\times\left(0.05+0.25\times\sigma_{E,it}\right) \quad (6)$$

where $Equity_{it}$ is the market value of equity, which is measured as the product of the stock price at the end of the year and the number of shares outstanding; $Debt_{it}$ is calculated as the sum of debt in current liabilities and one-half of long-term debt at the end of the year; $r_{i,t-1}$ is the past annual return of firm i, which is computed based on the monthly stock return during the previous year; $\sigma_{E,it}$ is the volatility of the stock return for company i during year t, which is calculated using the monthly stock return from the previous year; $\sigma_{V,it}$ measures the volatility of assets; and T_{it} is set to one year. A higher value of the distance to default suggests lower default risk.

Besides CEO inside debt variables and an interest rate swap variable, we also follow previous studies (e.g., Shumway, 2001; Chava and Jarrow, 2004; Campbell et al., 2008; and Borgaard et al., 2017) and include in the model a set of control variables, including a CEO's characteristics such as her vega and delta as well as a firm's characteristics such as its firm size, leverage, profitability, quick ratio, stock

excess return, and stock volatility. The definition and sources of these control variables are provided in Table 4.1. Industry and year dummy variables are included in the regression to control for the industry and year fixed effects, respectively. Additionally, the standard errors are adjusted to heteroskedasticity and are clustered at the firm level.

Table 4.10 reports the results of this analysis. In Panel A, the CEO inside debt variable is total CEO relative leverage. In columns 1 and 3, we use a pooled OLS model. In columns 2 and 4, we employ a fixed-effects model to mitigate the endogeneity caused by time-invariant omitted variables in our regression. In columns 1 and 2, the estimated coefficient on CEO relative leverage is significantly positive at the 1 percent level, suggesting that an increase in CEO inside debt is associated with an increase in firms' distance to default, which implies a negative relationship between CEO inside debt and firms' default risk. In columns 3 and 4, the coefficient on CEO relative leverage is still significantly positive. However, the coefficient on the interaction term between CEO relative leverage and interest rate swap usage is negative and significant at the 1 percent level, suggesting that the negative impact of CEO inside debt on a company's default risk is weakened if firms increase hedging by interest rate swaps.

Table 4.10: The impact of inside debt and interest rate swaps on firms' default risk

This table provides results of pooled OLS regressions and fixed-effects regressions investigating the relationship between CEO inside debt and firms' default risk and how the use of interest rate swaps affects this relationship. Our sample consists of listed non-financial companies in the United States during the period from 2006 to 2014. The dependent variable is firms' distance-to-default (DD). REL_LEV is CEO relative leverage, calculated by the ratio of the sum of a CEO's accumulated pension benefits and deferred compensation scaled by this CEO's equity over the firm's debt scaled by the firm's equity. PROTECTED_REL_LEV is protected CEO relative leverage, calculated by the ratio of a CEO's funded pension benefits scaled by this CEO's equity over the firm's debt scaled by the firm's equity. NON_PROTECTED_REL_LEV is non-protected CEO relative leverage, computed as the ratio of a CEO's non-funded pension benefits and other deferred compensation scaled by this CEO's equity over the firm's debt scaled by the firm's equity. TOTAL_IR_SWAP is the extent of using interest rate swaps. VEGA is the change in CEO wealth respective to a 1% change in stock return volatility. DELTA is the change in CEO wealth given a 1% change in stock price. FIRM_SIZE is the market value of firms' total assets. LEVERAGE is the ratio of firms' total debt over the market value of firms' total assets. PROFITABILITY is the ratio of firms' earnings before interest and taxes over the book value of firms' total assets. QUICK_RATIO is calculated by the current assets minus inventory and then divided by current liabilities. EXCESS_RETURN is computed as the difference between the stock's annual return and the CRSP value-weighted return over the same period. EQUITY_VOLATILITY is measured as the standard deviation of monthly stock return from the previous year. In Panel A, we use REL_LEV as a measure of CEO inside debt. In Panel B, we use PROTECTED_REL_LEV and NONPROTECTED_REL_LEV as measures of CEO inside debt. Panel A presents the estimation results when the CEO inside debt variable is REL_LEV. Panel B presents the estimation results when the CEO inside variables are PROTECTED_REL_LEV and NON_PROTECTED_REL_LEV. In Panels A and B, columns 1 and 3 report the results from a pooled OLS regression model and columns 2 and 4 report the results from a firm fixed-effects model. The standard errors are adjusted for heteroskedasticity and clustered at the firm level. ***, ** and * indicate significance at the 1%, 5%, and 10% level, respectively.

PANEL A: TOTAL INSIDE DEBT

	Dependent variable: DD			
	OLS	FE	OLS	FE
VARIABLES	(1)	(2)	(3)	(4)
REL_LEV	0.081***	0.064***	0.082***	0.066***
	-0.009	-0.008	-0.009	-0.008
REL_LEV * TOTAL_IR_SWAP			-0.014***	-0.014***
			-0.004	-0.004
TOTAL_IR_SWAP			-0.008	-0.015
			-0.012	-0.016
ln(VEGA)	-0.132*	-0.379***	-0.13	-0.378***
	-0.079	-0.079	-0.079	-0.079
ln(DELTA)	0.236**	0.377***	0.228**	0.365***
	-0.112	-0.118	-0.112	-0.118
ln(FIRM_SIZE)	0.224**	0.332	0.231**	0.319
	-0.108	-0.267	-0.109	-0.263
LEVERAGE	-20.436***	-21.087***	-20.344***	-21.109***
	-0.889	-1.331	-0.914	-1.316
PROFITABILITY	8.595***	2.968**	8.835***	2.968**
	-1.305	-1.309	-1.307	-1.309
QUICK_RATIO	0.470***	0.505***	0.461***	0.498***
	-0.098	-0.119	-0.098	-0.118
EXCESS_RETURN	0.790***	0.762***	0.782***	0.751***
	-0.151	-0.143	-0.151	-0.143
EQUITY_VOLATILITY	-14.931***	-12.615***	-14.934***	-12.580***
	-0.664	-0.647	-0.664	-0.646
Constant	14.795***	14.192***	14.761***	14.421***
	-1.025	-2.277	-1.023	-2.251
Observations	5,210	5,210	5,210	5,210
Industry FE	YES	NO	YES	NO
Year FE	YES	YES	YES	YES
R-squared	0.648	0.497	0.648	0.499

PANEL B: PROTECTED AND NON-PROTECTED INSIDE DEBT				
	Dependent variable: DD			
	OLS	FE	OLS	FE
VARIABLES	(1)	(2)	(3)	(4)
PROTECTED_REL_LEV	-0.178	0.322	-0.133	0.383
	-0.463	-0.541	-0.482	-0.555
NON_PROTECTED_REL_LEV	0.107***	0.081***	0.108***	0.083***
	-0.014	-0.013	-0.014	-0.013
PROTECTED_REL_LEV*TOTAL_IR_SWAP			0.116	0.143
			-0.103	-0.115
NON-PROTECTED_REL_LEV*TOTAL_IR_SWAP			-0.020***	-0.024***
			-0.006	-0.005
TOTAL_IR_SWAP			-0.016	-0.022
			-0.014	-0.018
ln(VEGA)	-0.12	-0.370***	-0.112	-0.368***
	-0.085	-0.082	-0.085	-0.082
ln(DELTA)	0.229*	0.381***	0.225*	0.383***
	-0.119	-0.126	-0.119	-0.126
ln(FIRM_SIZE)	0.187	0.349	0.191	0.331
	-0.116	-0.275	-0.117	-0.271
LEVERAGE	-20.862***	-21.020***	-20.665***	-20.931***
	-0.973	-1.467	-0.988	-1.448
PROFITABILITY	8.247***	3.189**	8.516***	3.148**
	-1.362	-1.426	-1.353	-1.424
QUICK_RATIO	0.431***	0.475***	0.420***	0.471***
	-0.099	-0.122	-0.099	-0.121
EXCESS_RETURN	0.807***	0.784***	0.798***	0.766***
	-0.161	-0.153	-0.161	-0.153
EQUITY_VOLATILITY	-15.223***	-12.795***	-15.230***	-12.772***
	-0.731	-0.712	-0.733	-0.71
Constant	14.967***	13.949***	15.185***	14.142***
	-1.131	-2.333	-1.122	-2.305
Observations	4,702	4,702	4,702	4,702
Industry FE	YES	NO	YES	NO
Year FE	YES	YES	YES	YES
R-squared	0.642	0.493	0.643	0.495

Panel B of Table 4.10 reports results of how protected and non-protected CEO inside debt exerts an impact on the firm's default risk and whether interest rate swap usage affects this relationship. The structure of Panel B is similar to the structure of Panel A. The results in columns 1 and 2 show that the coefficient estimated on non-protected CEO relative leverage is positive and significant at the 1 percent level. However, the coefficient estimated on protected CEO relative leverage is insignificant in both columns. These results indicate that only non-protected CEO inside debt can lead to a reduction in firms' default risk, which is consistent with the results of Anantharaman et al. (2014) and Colonnello et al. (2017). In economic terms, column 1 shows that a one standard deviation increase in the non-protected CEO inside debt can lead to an approximately 15.15% increase in firms' distance to default.[66] These results are in line with the notion that only the payoffs to non-protected CEO inside debt are truly similar to the payoffs to unsecured corporate debt (Anantharaman et al., 2014; and Colonnello et al., 2017).

In columns 3 and 4 of Panel B, the results show that the sign and significance of the coefficients estimated on protected CEO relative leverage and non-protected CEO relative leverage do not change. Regarding the interaction terms between them and interest rate swap usage, we find that whereas the coefficient on the interaction term between protected CEO relative leverage and interest rate swap is insignificant, the interaction term between non-protected CEO relative leverage and interest rate swap usage is significantly negative. In economic terms, column 3 shows that a 1 percentage point increase in interest rate swap usage reduces the negative impact of non-protected CEO relative leverage by 18.52%.[67] This result implies that hedging by interest rate swaps can dampen the negative effects of non-protected CEO inside debt on firms' default risk, which supports our aforementioned prediction. This finding also suggests that firms with high non-protected CEO inside debt decrease the use of interest rate swaps for hedging purposes to avoid the unintended adverse impact of the hedging on the role of non-protected CEO inside debt in reducing firms' default risk.

[66] 15.15% = (0.107*13.360/9.433)*100%, where 0.107 is the coefficient on NONPROTECTED_REL_LEV in column 1, 13.360 is the standard deviation of NONPROTECTED_REL_LEV, and 9.433 is the mean of DD.

[67] 18.52% = (0.020/0.108)*100%, where 0.108 is the coefficient on NONPROTECTED_REL_LEV and 0.020 is the absolute value of the coefficient on its interaction term with TOTAL_IR_SWAP in column 3.

The value of the R-squared in Panels A and B of Table 4.10 varies from 0.493 to 0.648, which is not different from the corresponding figure of around 0.582 in Magee (2013). The R-squared comparison between our study and his study is potentially meaningful since Magee (2013) also investigates the impact of corporate hedging on the firms' risk, measured by distance-to-default.

4.5. Conclusion

The main purpose of this paper is to examine the relationship between CEO inside debt and the corporate hedging by interest rate swaps. On one hand, if CEO inside debt can induce managers to follow risk-reducing activities, it will increase the use of interest rate swaps for hedging purposes. On the other hand, if CEO inside debt can reduce the motivations for hedging by financial derivatives, it will decrease the use of interest rate swaps. Our result supports the latter. The result shows that a high amount of CEO inside debt holdings leads to a reduction in hedging via interest rate swaps. Moreover, we find that this reduction is entirely driven by non-protected CEO inside debt. Additionally, we show that this decrease is weakened when firms are financially constrained or during periods of heightened interest rate volatility.

In our paper, we also investigate the relationship between CEO inside debt and firms' default risk. We find that an increase in CEO inside debt holdings is associated with a decrease in firms' default risk. Similar to the relationship between CEO inside debt and hedging, the negative impact of CEO inside debt on firms' default risk is completely driven by non-protected CEO inside debt, suggesting that only non-protected CEO inside debt can align the benefits of companies' managers and their debt holders by curbing managerial risk-increasing behaviours. However, our further analysis shows that the negative impact of non-protected CEO inside debt on firms' default risk is dampened when firms hedge using interest rate swaps. This finding suggests an explanation of why firms with high non-protected CEO inside debt reduce the use of interest rate swaps for hedging purposes. In effect, these firms decrease the level of interest rate swap usage to avoid the unintended adverse impact of hedging by interest rate swaps on the role of non-protected CEO inside debt in reducing firms' default risk.

Our paper suggests some policy implications. We expect that our findings will be of interest to regulators who are interested in the impact of managerial compensation incentives on corporate hedging by financial derivatives. Although prior studies

suggest that inside debt holdings can increase conservative investment and financial policies (e.g., Cassell et al., 2012), the results in our paper imply that an increase in inside debt holdings can have unwanted negative effects on corporate hedging by financial derivatives. Our paper is also of interest to regulators who are concerned about the impact of managerial compensation on firms' default risk. The regulators should be aware that only non-protected CEO inside debt reduces firms' default risk. However, they should be aware of the unintended adverse impact of hedging by financial derivatives on the risk-reducing effects of non-protected CEO inside debt on firms' default risk. Finally, our paper is also of interest to researchers who examine the effects of inside debt on firms' investment and financial policies. Given that hedging by financial derivatives such as interest rate swaps can affect the impact of inside debt on firms' default risk, could hedging by financial derivatives also affect the relationship between inside debt and firms' investment and financial policies, such as the debt structure, cash holdings, or mergers and acquisitions? We leave this question for future research.

Appendix to "Chapter 4: Inside Debt and Interest Rate Swap"

This Appendix provides additional information on the data used in our study. Appendix 1 presents steps to collect our data. Appendix 2 present some examples of CEO pension benefits and other deferred compensation disclosure.

Appendix 4.1: Steps to select our sample

Step	Content	Number of firms	Number of firm year observations
1	Bretscher et al. (2018)'s original data from 1994 to 2014	1,612	23,252
2	Bretscher et al. (2018) data from 2006 to 2014	1,349	9,607
3	Matching with Compustat	1,298	9,158
4	Matching with ExecuComp	1,176	8,041
5	Matching with CRSP	1,109	7,588
6	Matching with Cole et al. (2007)'s data	1,060	7,191
7	Drop financial firms	1,052	7,124
8	Drop firm-year observation with missing value	912	5,295

Appendix 4.2: Examples of CEO pension benefits and other deferred compensation disclosure

In cases where a company acquires another company, it may be difficult to know the nature of the pension plans if we only based on the name of the pension plans that are provided by ExecuComp database. Therefore we need to read the company's related proxy statements to find out whether the pension plans are protected or not. For example, The Walt Disney Company has a pension plan with the name "ABC Inc. Retirement Plan" that appears in ExecuComp database. In page 43-44 of its Notice of 2013 Annual Meeting and Proxy Statement, The Walt Disney Company described its pension benefit plans as follows:[68]

"Company employees (including two of the named executive officers) who transferred to the Company from ABC, Inc. after the Company's acquisition of ABC are also eligible to receive benefits under the **Disney Salaried Pension Plan A** (formerly known as the **ABC, Inc. Retirement Plan**) and a Benefits Equalisation Plan which, like the Amended and Restated Key Plan, provides eligible participants retirement benefits in excess of the compensation limits and maximum benefit accruals that apply to tax-qualified plans."

This indicates that ABC Inc. Retirement Plan is Disney Salaried Pension Plan A, which is a tax-qualified plan. Therefore, this plan is classified as protected inside debt.

It may also be difficult to identify the nature of pension plans since ExecuComp database may provide a vague name for the pension plan. For instance, Unisys Corporation has a pension plan named "Unisys Corporation Elected Officer Pension Plan" In page 37 of its Notice of Annual Meeting of Stockholders 2007, Unisys Corporation described its pension plans as follow:[69]

"Each Named Officer participates in three pension plans sponsored by Unisys in the United States:

- Unisys Pension Plan (UPP) - a qualified denied benefit pension plan avaialble to all US employees who met eligibility requirements by December 31, 2006.

- Unisys Corporation Supplemental Executive Retirement Income Plan (SERIP) - a nonqualified excess defined benefit plan avaiable to all US employees who met

[68] https://www.sec.gov/Archives/edgar/data/1001039/000120677413000240/waltdisney_def14a.htm
[69] https://www.app5.unisys.com/investors/proxy/2007_unisys_proxy.pdf

eligibility requirements by December 31, 2006 and whose qualified plan benefits are limited by the Internal Revenue Code or limited because they have deferred compensation under non-qualified plans. The plan is designed to make up for the benefit shortfall created by the Internal Revenue Code limits and the non-qualified deferrals of compensation.

- Unisys Corporation Elected Officer Pension Plan (EOPP) - a nonqualified defined benefit plan available to all elected officers who met eligibility requirements by December 31, 2006. The plan is designed to provide a minimum target of retirement income for executives."

This indicates that Unisys Corporation Elected Officer Pension Plan is a nonqualified defined benefit plan that is classified as non-protected inside debt.

Chapter 5: Conclusion

5.1. Summary of findings

This thesis presents three essays that examine three different but related topics in the corporate use of derivatives.

In Chapter 2, we explore the impact of the use and the direction of interest rate swaps on firms' default risk. Our findings show that a higher level of interest rate swap usage, irrespective of swap direction, leads to a larger reduction in firms' probability of default. In economic terms, our results show that a one standard deviation increase in the absolute amount of the extent of interest rate swap usage on average reduces firms' probability of default by approximately 12 percent. Additionally, our results suggest that swapping into either fixed or floating rate debt generates a statistically significant reduction in the probability of default.

We proceed to examine the relationship between interest rate swaps and firms' default risk conditional on firms' size. Our results indicate that the use of interest rate swaps by small- and medium-sized firms reduces their default risk whether they are swapping into fixed or floating rate debt. In contrast, very large firms that swap into floating rate debt increase their probability of default, and when these firms swap into fixed rate debt the impact on the probability of default is insignificant. In addition, this essay demonstrates that whereas economic policy uncertainty does not affect the negative effect of swapping into fixed rate debt on firms' probability of default, it dampens the effectiveness of swapping into floating rate debt in reducing firms' default risk. Moreover, this essay finds that during the zero lower bound period, whereas swapping into fixed rate debt reduces firms' default risk, swapping into floating rate debt does not.

In Chapter 3, we examine how creditor rights affect hedging behaviour of airlines across the world. Using a variety of econometric models, we find that airlines hedge more of their jet fuel exposures in strong creditor rights countries. In economic terms, our results suggest that a unit increase in creditor rights index leads to an increase in the extent of jet fuel hedging by around 31.5 percent. In addition, we identify six creditor rights reforms during our sample period and perform a model that is akin to a difference-in-differences model. The results of this analysis provide further corroboration for our findings.

Moreover, our results suggest that the positive impact of creditor rights on the extent of jet fuel hedging is dampened during the financial crisis period but strengthened during times of high jet fuel prices. Furthermore, this essay provides new evidence on the role of hedging in mitigating the adverse effects of strong creditor rights on firms' financing and investing activities. In essence, our results imply that a hedging strategy enables a firm to boost its leverage, to take greater risk, and to increase investment in strong creditor rights countries.

In Chapter 4, we investigate the relationship between CEO inside debt and corporate hedging by interest rate swaps. Our results suggest that large CEO inside debt holdings lead to a reduction in the use of interest rate swaps for hedging purposes. In addition, our results indicate that this reduction effect only exists if the CEO inside debt is non-protected. In economic terms, we show that a one standard deviation increase in the proxy of non-protected CEO inside debt can reduce the extent of interest rate swap usage by around 5.94% percent. Moreover, we find that the negative effect of non-protected CEO inside debt on the use of interest rate swaps is dampened when firms experience financial constraint or when there is a high level of volatility in interest rate.

Furthermore, we show that an increase in non-protected CEO inside debt is associated with a reduction in firms' default risk, which suggests that only non-protected CEO inside debt can reduce the agency costs of debt. However, our further analysis shows that this risk-reducing effect of non-protected CEO inside debt is weakened when firms hedge using interest rate swaps. This result suggests that firms with high non-protected CEO inside debt holdings reduce the level of interest rate swap usage to avoid the unintended adverse impact of hedging by interest rate swap on the role of non-protected CEO inside debt in reducing firms' default risk.

5.2. Research implications

The findings of this thesis provide some implications for policymakers.

Chapter 2 suggests that small- and medium-size firms use interest rate swaps, irrespective of the direction, for risk-reducing purposes. By contrast, the use of interest rate swaps by very large firms can increase the firms' default risk if the interest rate swaps are to swap into floating rate debt. This suggests one important policy implication. Since the overwhelming majority of firms in the sample of this chapter seem to be using interest rate swaps to reduce their default risk, financial

market regulators should look at exempting non-financials from the financial transaction tax.

Chapter 3 suggests that the protection of creditor rights is an important determinant of corporate hedging and hedging by financial derivatives ameliorates the adverse effects of strong creditor rights. The findings of this essay provide one important implication for policymakers. Specifically, our results suggest that derivatives market regulators should be aware that policies like the financial transactions tax that could potentially discourage the use of derivatives for hedging purposes might have adverse unintended consequences for firms in countries with strong creditor rights.

Chapter 4 suggests that CEOs with larger inside debt tend to hedge less. This finding suggests that regulators should keep in mind the unwanted negative effects of inside debt on corporate hedging. Additionally, the results of this chapter show that the negative effects of CEO inside debt on firms' default risk are dampened by the corporate use of interest rate swaps. As a result, policymakers should be aware of the unintended adverse effects of corporate hedging by financial derivatives on the curbing effect of CEO inside debt on firms' default risk.

5.3. Research limitations

This section acknowledges some limitations of this thesis. In essence, this thesis has two limitations. The first limitation of this thesis is that although this thesis has attempted to deal with endogeneity problems by using traditional econometric approaches such as a fixed effects model, an instrumental variables technique, a Heckman regression model, or a SGMM model, these methods may not be adequate. Angrist and Pischke (2008) suggest that employing a difference-in-differences model or a regression discontinuity design can estimate a causal relationship in empirical research. These two methods exploit a natural experiment to identify treatment and control groups. Then they will compare the effects of this experiment on the treatment and control groups. Based on this comparison, they will estimate the causal effects of the experiment on the treatment group. However, finding a suitable natural experiment is extremely difficult in the context of corporate hedging.

The second limitation of this thesis is related to the sample periods of each chapter. For Chapter 2, the sample period is from 2001 to 2015. The sample period of Chapter 3 is from 2002 to 2016. And for Chapter 4, the sample period is from

2006 to 2014. Although this thesis has justified the reasons to select these sample periods in each chapter, it may be better if this thesis can expand the sample periods to 2019.

5.4. Avenues for future studies

The results of this thesis provide some suggestions for future research.

One of the results in Chapter 2 shows that the impact of interest rate swaps on firms' default risk varies according to firm size. This suggests a non-linear impact of interest rate swaps on firms' default risk. Therefore, further studies can investigate the non-linear impact of using financial derivatives on firm value or firm investment.

Chapter 3 also has a suggestion for future research. This chapter shows that the impact of hedging on firms' financial and investment policies might be dependent on creditor rights. As a result, scholars that are interested in examining the real effects of hedging should pay attention to an international country setting since differences in legal frameworks such as creditor rights can affect these real effects.

The findings of Chapter 4 indicate that corporate hedging by interest rate swaps can reduce the negative impact of CEO inside debt on firms' default risk. This suggests that scholars who are interested in investigating the relationship between inside debt and firms' investment and financial policies should consider the impact of corporate hedging by financial derivatives on this relationship.

References

ACEMOGLU, D., ROBINSON, J. and JOHNSON, S., 2011. The colonial origins of comparative developments: an empirical investigation. *American Economic Review*, 91(5), pp.1369-1401.

ACHARYA, V.V., AMIHUD, Y. and LITOV, L., 2011. Creditor rights and corporate risk-taking. *Journal of Financial Economics*, 102(1), pp.150-166.

ADAM, T.R., 2002. Do firms use derivatives to reduce their dependence on external capital markets?. *Review of Finance*, 6(2), pp.163-187.

AGHION, P., DELTA, P. and HART, O., 1992. The economics of bankruptcy reform. Journal of Law, *Economics, and Organization*, 8(3), pp.523-546.

AHMED, S., JUDGE, A. and MAHMUD, S.E., 2018. Does derivatives use reduce the cost of equity?. *International Review of Financial Analysis*, 60, pp.1-16.

ALESINA, A., DEVLEESCHAUWER, A., EASTERLY, W., KURLAT, A. and WACZIARG, R., 2003. Fractionalization. *Journal of Economic Growth*, 8(2), pp.155-194.

ALTMAN, E.I., 1968. Financial ratios, discriminant analysis and the prediction of corporate bankruptcy. *The Journal of Finance*, 23(4), pp.589-609.

ANANTHARAMAN, D., FANG, V.W. and GONG, G., 2014. Inside debt and the design of corporate debt contracts. *Management Science*, 60(5), pp.1260-1280.

ANBIL, S., SARETTO, A. and TOOKES, H., 2019. How does hedge designation impact the market's perception of credit risk?. *Journal of Financial Stability*, 41, pp.25-42.

ANGRIST, J.D. and PISCHKE, J.S., 2008. *Mostly harmless econometrics: An empiricist's companion*. Princeton university press.

ARELLANO, M. and BOVER, O., 1995. Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics*, 68(1), pp.29-51.

BAE, K.H. and GOYAL, V.K., 2009. Creditor rights, enforcement, and bank loans. *The Journal of Finance*, 64(2), pp.823-860.

BAKER, S.R., BLOOM, N. and DAVIS, S.J., 2016. Measuring economic policy uncertainty. *The Quarterly Journal of Economics*, *131*(4), pp.1593-1636.

BAKKE, T.E., MAHMUDI, H., FERNANDO, C.S. and SALAS, J.M., 2016. The causal effect of option pay on corporate risk management. *Journal of Financial Economics*, 120(3), pp.623-643.

BALDASSARRI, G. and CHEN, A., 2016. PD Model market signals: An enhanced structural probability of default model. S&P Global Market Intelligence.

BARTRAM, S.M., BROWN, G.W. and FEHLE, F., 2009. International evidence on financial derivatives usage. *Financial Management*, 38(1), pp.185-206.

BARTRAM, S.M., BROWN, G.W. and CONRAD, J., 2011. The effects of derivatives on firm risk and value. *Journal of Financial Quantitative Analysis*, 46(4), pp.967-999.

BARTRAM, S.M., 2019. Corporate hedging and speculation with derivatives. *Journal of Corporate Finance*, 57, pp.9-34.

BECK, T., DEMIRGUC-KUNT, A. and LEVINE, R., 2003. Law, endowments and finance. *Journal of Financial Economics*, 70(2), pp.137-181.

BECK, T., DEMIRGUC-KUNT, A. and LEVINE, R., 2006. Bank concentration, competition, and crises: first results. *Journal of Banking and Finance*, 30(5), pp.1581-1603.

BELKHIR, M. and BOUBAKER, S., 2013. CEO inside debt and hedging decisions: Lessons from the US banking industry. *Journal of International Financial Markets, Institutions and Money*, 24, pp.223-246.

BERNANKE, B.S., 1983. Irreversibility, uncertainty, and cyclical investment. *Quarterly Journal of Economics*, 98(1), pp.85-106.

BERGHOFER, B. and LUCEY, B., 2014. Fuel hedging, operational hedging and risk exposure - Evidence from the global airline industry. *International Review of Financial Analysis*, 34, pp.124-139.

BERNDT, A., DOUGLAS, R., DUFFIE, D. and FERGUSON, M., 2018. Corporate credit risk premia. *Review of Finance*, 22(2), pp. 419-454.

BERTRAND, M. and MULLAINATHAN, S., 2003. Enjoying the quiet life? Corporate governance and managerial preferences. *Journal of Political Economy*, 111(5), pp.1043-1075.

BESSEMBINDER, H., 1991. Forward contracts and firm value: Investment incentive and contracting effects. *Journal of Financial and Quantitative Analysis*, 26(4), pp.519-532.

BHARATH, S. and SHUMWAY, T., 2008. Forecasting default with the Merton distance-to-default model. *The Review of Financial Stud*ies, 21(3), pp.1339-1369.

BLACK, F. and SCHOLES, M., 1973. The pricing of options and corporate liabilities. *Journal of Political Economy*, 81(3), pp.637-654.

BLOCK, S.B. and GALLAGHER, T.J., 1986. The use of interest rate futures and options by corporate financial managers. *Financial Management*, 15, pp.73-78.

BLUNDELL, R. and BOND, S., 1998. Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, 87(1), pp.115-143.

BODNAR, G.M., HAYT, G.S. and MARSTON, R.C., 1998. 1998 Wharton survey of financial risk management by US non-financial firms. *Financial Management,* 27(4), pp.70-91.

BOHN, J.R. and CROSSBIE, P.J., 2003. Modeling default risk. *KMV Corporation*.

BOROKHOVICH, K.A., BRUNARSKI, K.R., CRUTCHLEY, C.E. and SIMKINS, B.J., 2004. Board composition and corporate use of interest rate derivatives. *Journal of Financial Research*, 27(2), pp.199-216.

BRETSCHER, L., SCHMID, L. and VEDOLIN, A., 2018. Interest rate risk management in uncertain times. *The Review of Financial Studies,* 31(8), pp.3019-3060.

BROGAARD, J., LI, D. and XIA, Y., 2017. Stock liquidity and default risk. *Journal of Financial Economics,* 124(3), pp.486-502.

CAMPBELL, J.Y., HILSCHER, J. and SZILAGYI, J., 2008. In search of distress risk. *The Journal of Finance,* 63(6), pp.2899-2939.

CAMPELLO, M., LIN, C., MA, Y. and ZOU, H., 2011. The real and financial Implications of corporate hedging. *The Journal of Finance*, 66(5), pp.1615-1647.

CANIPEK, A., KIND, A.H. and WENDE, S., 2018. The effect of creditor rights on capital structure, investment, and risk: Evidence from a natural experiment. SSRN: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3121980

CARTER, D.A., ROGERS, D.A. and SIMKINS, B.J., 2006. Does hedging affect firm value? Evidence from the US airline industry. *Financial Management*, 35(1), pp.53-86.

CHAVA, S. and JARROW, R.A., 2004. Bankruptcy prediction with industry effects. *Review of Finance*, 8(4), pp.537-569.

CASSEL, C.A., HUANG, S.X., SANCHEZ, J.M. and STUART, M.D., 2012. Seeking safety: The relation between CEO inside debt holdings and the riskiness of firm investment and financial policies. *Journal of Financial Economics*, 103(3), pp.588-610.

CHAVA, S. and PURNANANDAM, A., 2007. Determinants of the floating-to-fixed rate debt structure of firms. *Journal of Financial Economics*, 85(3), pp.755-786.

CHAVA, S. and JARROW, R.A., 2004. Bankruptcy prediction with industry effects. *Review of Finance*, 8(4), pp.537-569.

CHEN, J. and KING, T.H.D., 2014. Corporate hedging and the cost of debt. *Journal of Corporate Finance*, 29, pp.221-245.

CHERNENKO, S. and FAULKENDER, M., 2011. The two sides of derivatives usage: Hedging and speculating with interest rate swaps. *Journal of Financial Quantitative Analysis*, 46(6), pp.1727-1754.

CHO, S.S., GHOUL, S.E., GUEDHAMI, O. and SUH, J., 2014. Creditor rights and capital structure: Evidence from international data. *Journal of Corporate Finance*, 25, pp.40-60.

CHOI, H., MUELLER, P. and VENDOLIN, A., 2017. Bond variance risk premiums. *Review of Finance*, 21(3), pp.987-1022.

COLES, J.L., DANIEL, N.D. and NAVEEN, L., 2006. Managerial incentives and risk taking. *Journal of Financial Economics*, 79(2), pp.431-468.

COLONNELLO, S., CURATOLA, G. and HOANG, N.G., 2017. Direct and indirect risk-taking incentives of inside debt. *Journal of Corporate Finance*, 45, pp.428-466.

CORE, J. and GUAY, W., 2002. Estimating the value of employee stock option portfolios and their sensitivities to price and volatility. *Journal of Accounting Research*, 40(3), pp.613-630.

CORNAGGIA, J., MAO, Y., TIAN, X. and WOLFE, B., 2015. Does banking competition affect innovation?. *Journal of Financial Economics*, 115(1), pp.189-209.

CROSSEN, C., QU, S. and ZHANG, X., 2011. Validating the public EDF model for North American corporate firms. *Moody's Analytics report*.

CROUHY, M., GALAI, D. and MARK, R., 2000. A comparative analysis of current credit risk models. *Journal of Banking and Finance,* 24(1-2), pp.59-117.

DANG, V.A. and PHAN, H.V., 2016. CEO inside debt and corporate debt maturity structure. *Journal of Banking and Finance*, 70, pp.38-54.

DANIEL, N., LI, Y. and NAVEEN, L., 2016. Asymmetry in pay for luck: A size effect?. *Available at SSRN 2160015.*

DISATNIK, D., DUCHIN, R. and SCHMIDT, B., 2014. Cash flow hedging and liquidity choices. *Review of Finance,* 18(2), pp.715-748.

DJANKOV, S., MCLIESH, C. and SHLEIFER, A., 2007. Private credit in 129 countries. *Journal of Financial Economics,* 84(2), pp.299-329.

DJANKOV, S., LA PORTA, R., LOPEZ-DE-SILANES, F. and SHLEIFER, A., 2008. The law and economics of self-dealing. *Journal of Financial Economics*, 88(3), pp.430-465.

DJANKOV, S., HART, O., MCLIESH, C. and SHLEIFER, A., 2008. Debt enforcement around the world. *Journal of Political Economy*, 116(6), pp.1105-1149.

EDMANS, A. and LIU, Q., 2011. Inside debt. *Review of Finance*, 15(1), pp.75-102.

ERKAN, A. and NGUYEN, T., 2020. Does inside debt help mitigate agency problems? The case with investment inefficiency and payout policies. *Financial Research Letters*, https://doi.org/10.1016/j.frl.2020.101560

EUROPEAN COMMISSION, 2015. A second chance for entrepreneurs: prevention of bankruptcy, simplification of bankruptcy procedures and support for a fresh start, http://ec.europa.eu/DocsRoom/documents/10451/attachments/1/translations

FAULKENDER, M., 2005. Hedging or market timing? Selecting the interest rate exposure of corporate debt. *The Journal of Finance*, 60(2), pp.931-962.

FAVARA, G., MORELLEC, E., SCHROTH, E. and VALTA, P., 2017. Debt enforcement, investment, and risk taking across countries. *Journal of Financial Economics*, 123(1), pp.22-41.

FAZARRI, S.M., HUBBARD, R.G., PETERSEN, B.C., BLINDER, A.S., and PORTERBA, J.M., 1998. Financing constrains and corporate investment. *Brookings papers on economic activity*, 1988(1), pp.141-206.

FEENBERG, D.R. and COUTTS, E., 1993. An introduction to the TAXSIM model. *Journal of Policy Analysis and Management*, 12(1), pp.189-194.

FREUND, S., LATIF, S. and PHAN, H.V., 2018. Executive compensation and corporate financing policies: Evidence from CEO inside debt. *Journal of Corproate Finance*, 50, pp.484-504.

FROOT K.A., SCHARFSTEIN, D.S. and STEIN, J.C., 1993. Risk management: Coordinating corporate investment and financing policies. *The Journal of Finance*, 48(5), pp.1629-1658.

FURFINE, C.H. and ROSEN, R.J., 2011. Mergers increase default risk. *Journal of Corporate Finance*, 17(4), pp.832-849.

GAY, G.D., LIN, C.M. and SMITH, S.D., 2011. Corporate derivatives use and the cost of equity. *Journal of Banking and Finance*, 35(6), pp.1491-1506.

GECZY, C., MINTON, B.A. and SCHRAND, C., 1997. Why firms use currency derivatives. *The Journal of Finance*, 52(4), pp.1323-1354.

GECZY, C.C., MINTON, B.A. and SCHRAND, C.M., 2007. Taking a view: Corporate speculation, governance, and compensation. *The Journal of Finance*, 62(5), pp.2405-2443.

GOLDBERG, S.R., GODWIN, J.H., KIM, M.S. and TRITSCHLER, C.A., 1998. On the determinants of corporate usage of financial derivatives. *Journal of International Financial Management and Accounting*, 9(2), pp.132-166.

GORMLEY, T.A., MATSA, D.A. and MILBOURN, T., 2013. CEO compensation and corporate risk: Evidence from a natural experiment. *Journal of Accounting and Economics*, 56(2-3), pp.79-101.

GRAHAM, J.R. and ROGERS, D.A., 2002. Do firms hedge in response to tax incentives?. *The Journal of Finance*, 57(2), pp.815-840.

GRAHAM, J.R. and SMITH, C.W., 1999. Tax incentives to hedge. *The Journal of Finance*, 54, pp.2241-2202.

GREGORY, R.P., 2020. Political risk and financial flexibility in BRICS countries. *The Quarterly Review of Economics and Finance*, https://doi.org/10.1016/j.qref.2020.01.011

GUAY, W.R., 1999a. The sensitivity of CEO wealth to equity risk: An analysis of the magnitude and determinants. *Journal of Financial Economics*, 53(1), pp.43-71.

GUAY, W.R., 1999b. The impact of derivatives on firm risk: An empirical examination of new derivative users. *Journal of Accounting and Economics*, 26(1-3), pp.319-351.

HAUSHALTER, G.D., 2000. Financing policy, basis risk, and corporate hedging: Evidence from oil and gas producers. *The Journal of Finance*, 55(1), pp.107-152.

HAYES, R.M., LEMMON, M. and QIU, M., 2012. Stock options and managerial incentives for risk taking: Evidence from FAS 123R. *Journal of Financial Economics*, 105(1), pp.174-190.

HENTSCHEL, L. and KOTHARI, S.P., 2001. Are corporations reducing or taking risks with derivatives?. *Journal of Financial Quantitative Analysis*, 36(01), pp.93-118.

HOFSTEDE, G., 2001. *Culture's consequences: Comparing values, behaviours, institutions, and organizations across nations*. Sage Publications, Thousand Oak.

HOLMSTROM, B. and TIROLE, J., 2000. Liquidity and risk management. *Journal of Money, Credit and Banking*, pp.295-319.

HOUSTON, J.F., LIN, C., LIN, P. and MA, Y., 2010. Creditor rights, information sharing, an bank risk taking. *Journal of Financial Economics*, 96(3), pp.485-512.

HUANG, P., HUANG, H.Y. and ZHANG, Y., 2019. Do firms hedge with foreign currency derivatives for employees?. *Journal of Financial Economics*, 133(2), pp.418-440.

IPPOLITO, F., OZDAGLI, A.K. and PEREZ-ORIVE, A., 2018. The transmission of monetary policy through bank lending: The floating rate channel. *Journal of Monetary Economics*, 95, pp.49-71.

ISTREFI, K. and MOUABBI, S., 2018. Subjective interest rate uncertainty and the macroeconomy: A cross-country anlaysis. *Journal of International Money and Finance*, 88, pp.296-313.

JENSEN, M.C. and MECKLING, W.H., 1976. Theory of the firm: Managerial behaviour, agency costs and ownership structure. *Journal of Financial Economics*, 3(4), pp.305-360.

JUDGE, A., 2006. Why and how UK firms hedge. *European Financial Management*, 12(3), pp.407-441.

KANG, W., LEE, K. and RATTI, R.A., 2014. Economic policy uncertainty and firm-level investment. *Journal of Macroeconomics*, *39*, pp.42-53.

KIM, E.H. and LU, Y., 2011. CEO ownership, external governance, and risk-taking. *Journal of Financial Economics*, 102(2), pp.272-292.

KIM, K., PATRO, S. and PEREIRA, R., 2017. Option incentives, leverage, and risk-taking. *Journal of Corporate Finance*, 43, pp.1-18.

KNOPF, J.D., NAM, J. and THORNTON JR, J.H., 2002. The volatility and price sensitivies of managerial stock option portfolios and corporate hedging. *The Journal of Finance*, 57(2), pp.801-813.

KORABLEV, I. and DWYER, D., 2007. Power and level validation of the Moody's KMV EDF credit measures in North America, Europe, and Asia. *Moody's KMV report.*

KUERSTEN, W. and LINDE, R., 2011. Corporate hedging versus risk-shifting in financially constrained firms: The time-horizon matters!. *Journal of Corporate Finance*, 17, pp.502-525.

KUMAR, P. and RABINOVITCH, R., 2013. CEO entrenchment and corporate hedging: Evidence from the oil and gas industry. *Journal of Financial and Quantitative Analysis*, 48(3), pp.887-917.

LA PORTA, R., LOPEZ-DE-SILANES, F., SHLEIFER, A. and VISHNY, R.W., 1997. Legal determinants of external finance. *The Journal of Finance*, 52, pp.1131-1150.

LA PORTA, R., LOPEZ-DE-SILANES, F., SHLEIFER, A. and VISHNY, R.W., 1998. Law and finance. *Journal of Political Economics*, 106(6), pp.1113-1155.

LA PORTA, R., LOPEZ-DE-SILANES, F., SHLEIFER, A. and VISHNY, R.W., 1999. The quality of government. *Journal of Law, Economics, and Organization*, 15(1), pp.222-279.

LEL, U., 2012. Currency hedging and corporate governance: A cross-country analysis. *Journal of Corpofate Finance*, 18(2), pp.221-237.

LELAND, H., 1998. Agency costs, risk management, and capital structure. *The Journal of Finance*, 53(4), pp.1213-1243.

LEWELLEN, K., 2006. Financing decisions when managers are risk averse. *Journal of Financial Economics*, 82, pp.551-589.

LIEVENBRUCK, M. and SCHMID, T., 2014. Why do firms (not) hedge? Novel evidence on cultural influence. *Journal of Corporate Finance*, 25, pp.92-106.

LIU, H.H., CHANG, A. and SHIU, Y.M., 2020. Interest rate derivatives and risk exposure: Evidence from the life insurance industry. *The North American Journal of Economics and Finance*, 51, p.100978.

LIU, Y., MAUER, D.C and ZHANG, Y., 2014. Firm cash holdings and CEO inside debt. *Journal of Banking and Finance*, 48, pp.83-100.

LOW, A., 2009. Managerial risk-taking behavior and equity-based compensation. *Journal of Financial Economics*, 82, pp.551-589.

MAGEE, S., 2013. The effect of foreign currency hedging on the probability of financial distress. *Accounting and Finance, 53*(4), pp.1107-1127.

MAYERS, D. and SMITH JR, C.W., 1987. Corporate insurance and the underinvestment problem. *Journal of Risk and Insurance*, pp.45-54.

MERTON, R.C., 1974. On the pricing of corporate debt: The risk structure of interest rates. *The Journal of Finance*, 29, pp.449-470.

MIHET, R., 2013. Effects of culture on firm risk-taking: A cross-country and cross-industry analysis. *Journal of Cultural Economics*, 37(1), pp.109-151.

MILIDONIS, A. and STATHOPOULOS, K., 2014. Managerial incentives, risk aversion, and debt. *Journal of Financial and Quantitative Analysis*, 49(2), pp.453-481.

MILLER, T. and KIM, A.B., 2016. *Index of economic freedom: Promoting economic opportunity and prosperity*. The Heritage Foundation and Dow Jones & Company, Inc.

MODIGLIANI, F. and MILLER, M.H., 1958. The cost of capital, corporation finance and the theory of investment. *The American Economic Review*, 48(3), pp.261-297.

MOHANTY, M. and SUNDARESAN, S., 2018. FX hedging and creditor rights: Evidence from an exogenous change in bankruptcy law. *BIS working papers*. Available at: https://www.bis.org/publ/bppdf/bispap96.pdf#page=33

NANCE, D.R., SMITH Jr., C.W. and SMITHSON, C.W., 1993. On the determinants of corporate hedging. *The Journal of Finance*, 48(1), pp.267-284.

NEWEY, W.K. and WEST, K.D., 1994. Automatic lag selection in covariance matrix estimation. *The Review of Economic Studies*, 61(4), pp.631-653.

NGUYEN, H. and FAFF, R., 2010. Are firms hedging or speculating? The relationship between financial derivatives and firm risk. *Applied Financial Economics*, 20(10), pp.827-843.

OBEROI, J., 2018. Interest rate risk management and the mix of fixed and floating rate debt. *Journal of Banking and Finance*, 86, pp.70-86.

PAKE, L.E. and WOOLDRIDGE, J.M., 1996. Econometric methods for fractional response variables with an application to 401(k) plan participation rates, *Journal of Applied Econometrics*, 11(6), pp.619-632.

PHAN, H.V., 2014. Inside debt and mergers and acquisitions. *Journal of Financial and Quantitative Analysis*, 49(5-6), pp.1365-1401.

PONTICELLI, J. and ALENCAR, L.S., 2016. Court enforcement, bank loans, and firm investment: Evidence from a bankruptcy reform in Brazil. *Quarterly Journal of Economics*, 131(3), pp.1365-1413.

PURNANANDAM, A., 2008. Financial distress and corporate risk management: Theory and evidence. *Journal of Financial Economics*, 87(3), pp.706-739.

QI, Y., ROTH, L. and WALD, J., 2016. Creditor protection laws, debt financing, and corporate investment over the business cycle. *Journal of International Business Studies*, 48(4), pp.1-21.

RAJAN, R.G. and ZINGALES, L., 1995. What do we know about capital structure? Some evidence from international data. *The Journal of Finance*, 50(5), pp.1421-1460.

RAJGOPAL, S. and SHEVLIN, T., 2002. Empirical evidence on the relation between stock option compensation and risk taking. *Journal of Accounting and Economics*, 33. 145-171.

RAMPINI, A.A., SUFI, A. and VISWANATHAN, S., 2014. Dynamic risk management. *Journal of Financial Economics*, 111(2), pp.271-296.

RODANO, G., SERRANO-VELRDE, N. and TARANTINO, E., 2016. Bankruptcy law and bank financing. *Journal of Financial Economics*, 120(2), pp.363-382.

ROSS, M.P., 1997. Corporate hedging: What, why and how?. Working paper, University of California, Berkeley.

SCHOLES, M.S., WOLFSON, M.A., ERICKSON, M., MAYDEW, E.L. and SHEVLIN, T. *Taxes and Business Strategy*. Prentice Hall.

SCHULTZ, E.L., TAN, D.T. and WALSH, K.D., 2017. Corporate governance and the probability of default. *Acconting and Finance*, 57, pp.235.253.

SEIFERT, B. and GONENC, H., 2012. Creditor rights and R&D expenditures. *Corporate Governance: An International Review*, 20(1), pp.3-20.

SERVAES, H., TAMAYO, A. and TUFANO, P., 2009. The theory and practice of corporate risk management. *Journal of Applied Corporate Finance,* 21(4), pp.60-78.

SHUMWAY, T., 2001. Forecasting bankruptcy more accurately: A simple hazard model. *Journal of Business,* 74(1), pp.101-124.

SMITH, C.W. and STULZ, R.M., 1985. The determinants of firms' hedging policies. *Journal of Financial Quantitative Analaysls,* 20(4), pp.391-405.

SRIVASTAV, A., ARMITAGE, S. and HAGENDORFF, J., 2014. CEO inside debt holdings and risk-shifting: Evidence from bank payout policies. *Journal of Banking and Finance*, 47, pp.41-53.

STOCK, J.H. and YOGO, M., 2005. Testing for weak instruments in linear IV regression. In D.W.K. Andrews and J.H. Stock, eds. *Identification and Inference for Econometric Models: Essays in Honor of Thomas J. Rothenberg.* Cambridge:

Cambridge University Press, pp.80-108. Working paper version: NBER Technical Working Paper 284: http://www.nber.org/papers/T0284.

STULZ, R.M., 1984. Optimal hedging policies. *Journal of Financial and Quantitative Analysis*, 19(2), pp.127-140.

STULZ, R.M., 1996. Rethinking risk management. *Journal of Applied Corporate Finance*, 9(3), pp.8-25.

SUNDARAM, R. and YERMACK, D.L., 2007. Pay me later: Inside debt and its role in managerial compensation. *The Journal of Finance*, 51(2), pp.359-385.

TIROLE, J., 2010. The theory of corporate finance. Princeton University Press.

TOKIC, D., 2012. When hedging fails: What every CEO should know about speculation. Journal of Management Development, 31(8), pp.801-807.

TREANOR, S.D., ROGERS, D.A., CARTER, D.A. and SIMKINS B.J., 2014a. Exposure, hedging, and value: New evidence from the U.S. airline industry. *International Review of Financial Analysis*, 34, pp.200-211.

TREANOR, S.D., SIMKINS, B.J., ROGERS, D.A. and CARTER, D.A., 2014b. Does operational and financial hedging reduce exposure? Evidence from the U.S. Airline Industry. *Financial Review*, 49(1), pp.149-172.

TUFANO, P., 1996. Who manages risk? An empirical examination of risk management practices in the gold mining industry. *The Journal of Finance*, 51(4), pp.1097-1137.

VERBEEK, M., 2017. *A guide to modern econometrics.* John Wiley & Sons.

VIG, V., 2013. Access to collateral and corporate debt structure: Evidence from a natural experiment. *The Journal of Finance*, 68(3), pp.881-928.

WARNER, J.B., 1977. Bankruptcy costs: Some evidence. *The Journal of Finance*, 32(2), pp.337-347.

WEI, C. and YERMACK, D., 2011. Investor reactions to CEOs' inside debt incentives. *The Review of Financial Studies*, 24(11), pp.3831-3840.

WHITED, T. and WU, G., 2006. Financial constraints risk. *The Review of Financial Studies*, 19(2), pp.531-559.

WOOLDRIDGE, J.M., 2010. *Econometric analysis of cross section and panel data.* MIT Press.

WYMAN, O., WAGNER, M., BENJAMIN, S. and CHRISTOPHER, R., 2012. Proposed EU Commission Financial Transaction Tax Impact Analysis on Foreign Exchange Markets, *New York: Oliver Wyman.*

ZHOU, X., 2001. Understanding the determinants of managerial ownership and the link between ownership and performance: comment. *Journal of Financial Economics*, 62, pp.559-571.

ZHOU, V.Y. and WANG, P., 2013. Managing foreign exchange risk with derivatives in UK non-financial firms. *International Review of Financial Analysis*, 29, pp.294-302.