

Essays on Corporate Debt Structure

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Abstract

This thesis discusses two aspects of debt structure and is divided into three essays. The first essay examines the decision of whether to use fixed- or floating-rate debt. The liquid and deep swap markets in most countries enable firms to issue any type of debt that is cheaper and then swap it into their preferred structure. If firms are hedging, then their choices of interest rate exposures should be driven by the sensitivity of their cash flows to interest rates. Alternatively, if firms are timing the market to reduce their cost of capital, then the selection of those exposures should be driven by the interest rate movements. The second essay attempts to determine what factors they consider to be important when firms use foreign currency debt. The currency debt mix is important for many firms and in particular multinationals, which generate some of their revenues in foreign currency and are therefore exposed to movements of currencies in which these revenues are denominated. Funding in currencies where the firm operates to hedge exposure is an alternative to the use of foreign currency derivatives. The third essay examines the relationship between the corporate use of interest rate swaps and the probability of default. This study attempts to answer the question of whether firms are hedging or speculating when using interest rate swaps. This thesis uses a large hand-collected dataset of UK non-financial firms during the period from 1999 to 2015, which covers two distinct periods of contrasting economic fortune. The global 2007 financial crisis is an event that could affect the selection of interest rate and foreign exchange exposure of corporate debt. Previous studies have to manually make the adjustment to a firm's pre-derivative debt structure to arrive at the net of derivative debt profile. In the UK, data is reported after the effect of derivatives. The data, therefore, is potentially more accurate than that employed by previous US studies. Additional data on the direction of interest rate and foreign currency swaps were also collected, which provides additional insight into debt structure and firm risk management.

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Chapter 1: Introduction

This thesis is not about the optimal level of debt. Instead, it deals with two elements of debt structure: fixed versus floating mix of debt, i.e. how much of debt should be at fixed interest rates and how much at floating interest rates, and currency mix of debt, i.e. in which currency should the debt be denominated. Floating-rate debt is generally cheaper than fixed-rate debt but may increase cash flow volatility. However, if cash flows are positively correlated with interest rates, floating-rate debt may act as a natural hedge, thereby reducing volatility. The use of foreign currency denominated debt is driven by the need to reduce risk associated with foreign sales/assets as well as market factors such as market depth or relative taxes.

Firms are sophisticated when it comes to debt structure decisions. Most of them have specific targets for fixed/floating debt mix and the fraction of borrowing in foreign currency. Survey results show that pricing is an important element when firms structure their debts (see, for example, Servaes and Tufano (2006) and Hakkarainen et al. (1997)). They often take a view on price movements when considering debt structure. Firms often consider their debts by themselves without considering how these decisions may interact with their assets and cash flows. In that case, investment perspective, which focuses on pricing and movements in interest rates, will dominate risk management perspective, which focuses on the relation between debts and assets. If firms are actually following this approach, we should urge them to be cautious.

Debt characteristics such as interest rate and currency mix of debt have been of interest to corporate treasurers for many years, but until recently, the lack of reliable data has limited research on these issues. Also, the empirical literature on corporate debt structure has not yet reached a consensus regarding the determinants of fixed/floating rate and foreign currency debt use. This thesis adds to the empirical evidence by employing an unique dataset of UK non-financial firms over the 1999-2015 period. Given that the UK has a large and sophisticated corporate sector, it remains as a particular focus for empirical investigation. UK data is also well suited for studying the role of foreign currency debt as the UK has a more open economy than most industrial countries.

Our sample period covers two distinct periods of contrasting economic fortune. It begins with several years of a relatively benign macroeconomic environment before the

onset of the global financial crisis in 2007, which resulted in several years of economic recession followed by slow recovery. This provides a natural experiment to observe the effects of the crisis on the selection of firms' interest rate and currency exposures. Data on derivatives use and debt structure (net of derivatives) are hand-collected from annual reports. We also get access to data on debt structure (pre-derivative) from S&P Capital IQ. Previous US studies have had to manually make the adjustment to a firm's pre-derivative debt structure to arrive at the net of derivative debt profile. In the UK, the interest rate and currency mix adjustment resulting from derivatives use is carried out by firms, and therefore firms report the net of derivative fixed/floating and currency structure of debt. Our data, therefore, are potentially more accurate than those employed by previous US studies. Not only do we have the interest rate mix of all borrowings, but we also have the interest mix by currency of borrowings. If a firm enters into any interest rate or foreign currency swap during the fiscal year, we attempt to obtain data on the direction of swaps, i.e. whether the firm pays floating or fixed rate in its swap transaction and whether the firm swaps into local or foreign currency. These types of data provide additional insight into the effects of swap usage on the firm's interest rate and foreign exchange exposures. Compared with previous studies, our summary statistics show that UK firms tend to have more floating-rate debt and the level of foreign debt use is markedly higher in the UK. The statistics also suggest that there are more swap activities in the UK and the magnitude of swap usage by UK firms is larger.

This thesis consists of three essays:

Chapter 2: The interest rate structure of UK firms' debt: Hedging or market timing?

Chapter 3: The determinants of corporate foreign currency debt use by UK firms

Chapter 4: The effects of interest rate swap usage on the probability of default

The first essay (Chapter 2) looks at potential factors that may determine a firm's interest rate structure of debt. It is clear from the language contained in the notes to accounting statements as well as the investor expectation that firms select the interest rate exposure of their debts to manage risk. However, it appears that firms may also have alternative objectives, such as to time the market and hence reduce the cost of financing. If firms are hedging, then their choices of interest rate exposures should be driven by the sensitivity of their cash flows to interest rates. Alternatively, if firms are timing the market in an attempt to reduce their cost of capital, then the selection of those exposures should be driven by the interest rate movements. This essay attempts

to determine which of these objectives, to hedge their cash flows or to reduce their cost of capital, is the primary determinant of the choices of firms' interest rate exposures.

The second essay (Chapter 3) examines the determinants of foreign currency debt use. The topic of foreign exchange risk management has commanded a great deal of attention from researchers. Most of this attention focuses on the use of foreign currency derivatives and its potential impact on firm value. However, this is just one aspect of an integrated hedging policy. Funding in currencies where the firm operates to hedge exposure is an alternative. Examining the role of foreign currency debt as a hedging instrument provides a comprehensive understanding of firm risk management activities and hence complements the existing literature.

The third essay (Chapter 4) assesses the effects of interest rate swap usage on the probability of default. The question of whether the use of derivatives increases or reduces firm default risk is important for several reasons. According to the Bank of England Systemic Risk Survey (October 2009), corporate default is ranked second in a list of five risks that market participants believed would have the strongest effects on the UK financial system. Since the 2007 financial crisis, regulators have attempted to curb the use of over-the-counter derivatives. The derivative market is also predicted to bear a huge burden of the financial transaction tax if it is introduced. The significant variation in macroeconomic conditions and more importantly credit risk during our sample period provides an unique opportunity to estimate the effects of swap usage on default probability as such activity is expected to be most beneficial in times of economic downturn.

Taken as a whole, our results from three essays show that firms are hedging when selecting the interest rate and currency exposure of their debts. There are, however, changes in firm risk preferences before and after the 2007 financial crisis. Firms became more cautious after the crisis. Interest rate swap users have lower probabilities of default, controlling for other firm characteristics that may affect default risk. The impact of interest rate swaps on default probability is stronger during periods of heightened macroeconomic uncertainty.

Chapter 2: The Interest Rate Structure of UK Firms' Debt: Hedging or Market Timing?

Abstract

This essay examines whether UK firms are hedging or timing the market when selecting the interest rate structure of their debt. We measure the chosen interest rate exposure by downloading data on the initial interest rate exposure from S&P Capital IQ and hand-collecting data on the final interest rate exposure after incorporating the use of interest rate swaps from annual reports. Overall, the results show that interest rate risk management practices in the UK are primarily driven by hedging considerations. However, there are changes in risk preferences before and after the 2007 financial crisis. Our results suggest that firms became more cautious after the crisis. We also find that there might be some attempt to match the interest rate profile of debt across currencies, potentially because a firm's fixed/floating debt mix target is similar across currencies. Firms are getting closer to their desired interest rate exposure. Regardless of the direction of interest rate swaps that firms undertake, there is a convergence in the interest rate profiles of firms' debt.

Keywords: Derivatives, interest rate swaps, debt structure, hedging, market timing

JEL CODES: G3, G32.

I. Introduction

Debt comes in many forms. The mix of debt that each firm issues reflects the following elements: maturity structure of debt (i.e. should the firm borrow short-term or long-term?); fixed versus floating mix of debt (i.e. should the debt be fixed- or floating-rate?); currency mix of debt (i.e. what currency should the firm borrow?); source of debt (i.e. should the debt be obtained through capital markets or bank loans?); and hybrid securities (i.e. how do hybrid securities fit into a firm's debt structure?). When capital markets are perfect, the structure of debt does not matter to the firm. However, relaxing one or more of the perfect capital markets assumptions can translate into debt structure decisions. This study attempts to examine the decision of whether to use fixed- or floating-rate debt. Most long-term bonds offer a fixed rate at the time of issue while the interest payment on bank loans is commonly floating. The liquid and deep swap markets in most countries enable firms to issue any type of debt that is cheaper and then swap into their preferred structure. This study will look at how firms decide on the mix of fixed- and floating-rate debt and potential factors that may determine a firm's interest rate structure of debt. If firms are hedging, then their choices of interest rate exposures should be driven by the sensitivity of their cash flows to interest rates. By matching the interest rate sensitivity of their liabilities to that of their assets, they can reduce their cash flow variability. Alternatively, if firms are timing the market to reduce their cost of capital, then the selection of those exposures should be driven by the interest rate movements. Our study attempts to determine which of these objectives, to hedge their cash flows or to reduce their cost of capital, is the primary determinant of the choices of firms' interest rate exposures.

The importance of understanding the determinants of the fixed versus floating mix of debt stems from the fact that it plays an increasingly significant role in the debt financing policy of many non-financial firms. It is clear from the language contained in the notes to accounting statements as well as the investor expectation that firms select the interest rate exposure of their debts to manage risk. However, it appears that firms may also have alternative objectives, such as to time the market and hence reduce the cost of financing. A number of survey results show that when firms make decisions on the fixed/floating debt mix, they often consider their debts by themselves without considering how these decisions may interact with their assets and cash flows (see, for example, Servaes and Tufano (2006) and Hakkarainen et al. (1997)). If firms are

actually following this approach, we should urge them to be cautious as debt structure may impact firm value.

The limited research in the UK as well as the lack of a consensus on this issue provides the motivation for our study. While the use of fixed- or floating-rate debt by US firms is well documented in the literature, to the best of our knowledge, there is only one study on this issue in the UK.[1] This UK study, however, ignores the impact of derivatives and only focuses on new debt issues, ignoring debt that is already on the balance sheet. As discussed later, this could reduce the test's statistical power. Our study attempts to fill this gap by providing evidence for UK firms and looking at the final interest rate exposure of total debt. Given that the UK has a large and sophisticated corporate sector, it remains as a particular focus for empirical investigation. Our study aims to provide a valuable additional case study, thereby facilitating comparisons with the extant empirical literature.

This study covers two distinct periods of contrasting economic fortune. Our sample period begins with several years of a relatively benign macroeconomic environment before the onset of the global financial crisis in 2007, which resulted in several years of economic recession followed by slow recovery. The 2007 financial crisis is an event that could affect the selection of interest rate exposure of corporate debt. For this reason, our study provides a natural experiment to determine whether the choices of these exposures are solely for the purpose of hedging or not.

Previous studies have had to manually make the adjustment to a firm's pre-derivative debt structure to arrive at the net of derivative debt profile. In the UK, data is reported after the effect of derivatives. The interest rate mix adjustment resulting from derivatives use is carried out by firms, and therefore firms report the net of derivative (net of interest rate swap) fixed/floating structure of debt. Our data, therefore, are potentially more accurate than those employed by previous US studies. As well as having the interest rate mix of all borrowings we also have the interest mix by currency of borrowings. We also collect data on the direction of interest rate swaps such as whether the firm swaps into fixed or swaps into floating. To the best of our knowledge, we are the first to collect these types of data which provide additional insight into the interest rate structure of corporate debt. Compared with other studies, our study shows that UK firms tend to have more floating-rate debt, regardless of whether the effect of

[1] A list of empirical studies relating to the interest rate structure of corporate debt are provided in Table 1.

swaps are incorporated or not.[2] The statistics also suggest that there are more swap activities in the UK and the magnitude of swap usage by UK firms is larger.

We begin by benchmarking our study against Faulkender (2005) and Chernenko and Faulkender (2011). We begin with multivariate regression analysis and find that the key drives of initial debt structure are the sources of debt. Firms may then use interest rate swaps to alter the initial interest sensitivity of their debt. The final interest rate exposure, incorporating the effect of swaps, best reflects their interest rate risk management activities. Contrary to the results of most previous studies, we do not find that firms are timing the market. Overall, our results suggest that firms are hedging when selecting the interest rate exposure of their debt. However, the choices of those exposures differ between before and after the crisis. We repeat the OLS analysis conducted previously using two separate sample periods, i.e. 1999-2006 and 2007-2015, to explain the effect of the 2007 financial crisis on the firms' interest rate exposure. In contrast to the earlier results, prior to the crisis, firms are both hedging and timing the market. This is the first study to specifically look at the impact of the financial crisis on firm debt financing decisions and risk management decisions.

Next, we follow the approach adopted by Chernenko and Faulkender (2011), who argue that testing theories of hedging requires separating the hedging and speculative components of risk management policies. We assume that the optimal hedge ratio remains constant over time and deviations from this ratio driven by speculation are zero on average. We then use the Fama and MacBeth (1973) specifications and "between" specifications to examine the firms' hedging activities. To explain time-series variation in floating-rate debt share, which captures firms' speculative activities, we use the firm-level "within" specification. The results from both specifications are qualitatively similar to the earlier OLS results.

We then examine the determinants of floating-rate debt at the currency level and find that the level of floating-rate debt by currency is quite similar and the currency mix of debt does have an impact on the fixed versus floating debt mix. Finally, we explain the effects of swap usage on the final interest rate exposure of firms. We look at firms that use interest rate swaps at least once over the sample period and find that firms that initially use more floating-rate debt are less likely to swap toward floating. Also, firms

[2] Summary information on floating-rate debt usage in previous empirical studies is provided in Table 6.

are getting closer to their desired interest rate exposure, regardless of the direction of interest rate swaps.

The remainder of the paper is organized as follows. Section II reviews the literature on the fixed versus floating mix of debt that relates to this topic. Section III discusses the hypotheses and empirical strategy of distinguishing the cross-sectional and time-series factors that explain the variation in floating-rate debt percentages. Section IV provides a description of the data as well as summary statistics. The multivariate analysis is presented in Section V, followed by an analysis of the cross-sectional and time-series effects. The determinants of floating-rate debt by currency as well as the size and directions of swap usage are also examined in this section. Section VI concludes.

II. Literature Review

In this section, we examine the literature on the fixed versus floating mix of debt. We begin by providing an overview of debt structure theory together with an analysis of the results of recent empirical studies. We then look at some issues concerning the measurement of the fixed/floating debt mix. Table 1 provides a list of empirical studies on this subject. As can be seen from this table, most of the studies involve firms in the US and only one involves firms in the UK. Data on the interest rate structure of corporate debt can be sourced from annual reports, surveys or widely-used databases. The studies focus mainly on non-financial firms. Table 2 presents a summary of dependent variables and econometric methodology in these studies. The fixed/floating debt mix can be measured by a dummy variable for whether the debt issue has a fixed/floating exposure, or the amount of fixed/floating-rate debt as a percentage of total debt. Accordingly, probit/logit and OLS models are used. A summary of variables and hypotheses in previous studies is provided in Table A3 in the appendices. Table A4-Table A8 present summaries of empirical evidence in these studies.

A. Theoretical Considerations

1. Hedging

There are two sources of firms' interest rate risk: the interest rate sensitivity of their debts and the sensitivity of their assets. Hence, if volatile cash flows prove to be costly for firms, their risk management policy is to match the interest rate sensitivity of their cash flows to the exposure of their debts. This indicates that if firms are hedging interest rate risk, then firms with cash flows that are either negatively correlated or uncorrelated with interest rates should prefer interest payments on their debts to be fixed, while firms

with cash flows that are positively correlated with interest rates would prefer floating interest payments (Faulkender, 2005, Chava and Purnanandam, 2007, Chernenko and Faulkender, 2011).

Servaes and Tufano (2006) assume that fixed- and floating-rate debt has the same expected cost and consider the interaction between the volatility of the business and the volatility of interest payments. They argue that if earnings are positively related to interest rates, then floating-rate debt serves as a natural hedge. Debt service is low when funds are short and high when funds are available. The natural hedge hypothesis is also proposed by Vickery (2008). He suggests that in industries in which cash flows or output covaries positively with interest rates, the effects of rising interest rates on the credit supply will be partially offset by higher internal cash flows. Fixed-rate debt is, therefore, less likely to be optimal.

Considering the correlation between cash flows and interest rates is not sufficient. Servaes and Tufano (2006) argue that it is also essential to consider the correlation between investment opportunities and interest rates. If this correlation is negative, floating-rate debt should dominate. Under this circumstance, high interest payments would not prevent firms from investing since investment needs are weak. Consistent with Servaes and Tufano (2006), Chava and Purnanandam (2007) indicate that firms with investment needs that are negatively correlated with interest rates can smooth their cash requirements by employing floating-rate debt.

Apart from the interest rate sensitivity of cash flows, a firm's incentive to reduce their cash flow variability can stem from considerations such as financial distress and growth options. As shown by Mayers and Smith (1982) and Smith and Stulz (1985), in the presence of financial distress costs firms prefer smooth cash flows. Bankruptcy costs induce firms to hedge by reducing the probability of suffering distress and thus incurring such costs. Also, with costly external finance, firms are less likely to forgo positive net present value (NPV) projects if their cash flows are more stable and less outside capital is required (Myers and Majluf, 1984, Froot et al., 1993). Accordingly, Chava and Purnanandam (2007) suggest that controlling for the interest rate sensitivity of cash flows, firms with higher likelihood of financial distress or more growth opportunities optimally prefer a lower amount of floating-rate debt as a fraction of their total debts.

2. Market Timing

As indicated earlier, the choices of firms' interest rate exposures may be for the purpose of hedging. However, if the benefits from hedging interest rate risk are not significant enough, then firms may have an alternative objective in the selection of these exposures. Specifically, they may be timing the market in an attempt to reduce their cost of capital.

Market timing can be considered as responses to issue-specific mispricing due to information asymmetry. It can also refer to responses to changes in macroeconomic conditions correlated with the cost of capital. Most studies use market timing in the latter context. Baker and Wurgler (2000) find the effects of market timing in equity markets. Firms increase the equity share in total new equity and debt issues before periods of low equity market returns. Others find evidence that firms time the debt market as well. Baker et al. (2003) find that the maturity of new debt issues is negatively related to future excess bond returns, consistent with firms using market conditions in an attempt to determine the lowest-cost maturity choice. Allayannis et al. (2003) find that direct costs of debt are an important determinant of foreign currency debt. Firms tend to borrow in foreign currency when the difference between local and foreign interest rates increase.

If firms believe that they can reduce their cost of capital through market timing, then the selection of their interest rate exposures should be driven by interest rate movements. Faulkender (2005) suggests that firms may believe, as interest rate changes, their interest costs can be reduced by "actively managing" their interest rate exposure. When the yield curve is steep, firms with a floating exposure may have lower interest costs than firms that select a fixed interest rate exposure, at least in the short term. Similarly, Servaes and Tufano (2006) indicate that some firms may choose to issue floating-rate debt since it is cheaper. In that case, investment perspective, which focuses on pricing and movements in interest rates, will dominate risk management perspective, which focuses on the relation between debts and assets.

3. Managerial Incentive

Agency problem between managers and shareholders has been considered as a key determinant of important corporate decisions including risk management. Early studies in the corporate risk management literature suggest that if risk-averse and under-diversified managers hold large quantities of stocks in the firm, they would find it optimal to pursue risk-reducing strategies. Meanwhile, managers with significant stock option ownership could prefer risk-increasing strategies since the option value

increases with the firm risk (see, for example, Servaes and Tufano (2006), Smith and Stulz (1985) and Stulz (1984)). Following these theories, Chava and Purnanandam (2007) argue that due to conflicts of interest between managers and shareholders, managerial incentives can play an important role in the choice of fixed versus floating debt structure. Controlling for the sensitivity of the firm's cash flows to interest rates, higher floating-rate debt ratio increases cash flow's volatility, which in turn benefits managers with risk-increasing incentives. Such an action, however, decreases the utility of managers with incentives to reduce risk.

4. Source of Debt

Source of debt may account for the joint determination of fixed versus floating mix of debt. Chava and Purnanandam (2007) argue that banks have an advantage in providing floating-rate loans and hence, bank-dependent firms generally have a higher percentage of floating-rate debt. Although a firm can modify its initial interest rate exposure via interest rate swaps, empirical studies show that many bank-dependent firms do not frequently engage in derivative transactions (see, for example, Purnanandam (2008) and Dolde (1993)). Accordingly, they suggest that whether a firm is bank-dependent or not, or whether it has access to the public debt market or not, could impact its debt structure since banks typically offer floating-rate shorter-term loans while the bond market is normally fixed in nature and of longer maturity.

Similarly, Vickery (2008) argues that both borrowers and lenders may suffer from interest rate exposure, and the allocation of risk in the loan agreement, therefore, depends partly on the interest rate risk profile of the lender. Lenders that are highly exposed to rising interest rates tend to provide a lower fraction of fixed-rate loans to reduce their interest rate sensitivity. Vickery (2008) compares bank loans to loans from non-bank financial institutions and discusses two mechanisms through which banks receive interest rate exposure. First, rising interest rates lead to deposit outflows from the banking system which cannot be replaced by other sources of finance without cost. Second, because long-term assets are funded by short-term deposits, banks face maturity mismatch. Thus, he concludes that a floating interest rate is more likely to apply to bank loans than loans from non-bank financial institutions.

5. Maturity of Debt

Titman (1992) suggests that if firms are trying to signal their quality by issuing interest rate-sensitive debt, then high-quality firms are expected to issue more floating-rate debts. Flannery (1986) also points out that high-quality firms use shorter-maturity

debt to signal their quality. Rokkanen (2007) bridges together these two arguments of signalling and predicts that shorter-maturity debt is more likely to match with floating interest payments. In addition, as discussed above, floating-rate debt is beneficial if the correlation between the firm's cash flows and interest rates is positive. However, Guedes and Thompson (1995) argue that as the maturity of debt increases, this correlation may become less obvious in the long run and firms prefer fixed-rate debt. Debt maturity, therefore, is a possible determinant of the fixed/floating mix of debt.

B. Overview of Empirical Studies

1. Hedging

To examine the correlation between cash flows and interest rates, Faulkender (2005) estimates the interest rate exposure of the firm's cash flow, which is referred to as the cash flow beta. Cash flow is regressed on the average interest rate. This approach is similar to that broadly adopted in the literature (see, for example, Graham and Rogers (2002), Visvanathan (1998) and Fenn et al. (1996)). In the spirit of measures used by Faulkender (2005), Chava and Purnanandam (2007) and Chernenko and Faulkender (2011) also construct beta to capture firms' desire to smooth their cash flows across low and high interest rate environments in the future. Chava and Purnanandam (2007), however, claim that firm-level estimations are unstable (across time periods) and have huge outlier problems. Therefore, they run an industry-level regression.

Among these above studies, only one suggests that firms do select the interest rate exposure of their debt in a manner consistent with hedging. Both Faulkender (2005) and Chava and Purnanandam (2007) do not find a positive and statistically significant coefficient on cash flow beta. Chernenko and Faulkender (2011) show a hedging effect but its economic magnitude is relatively modest. A 1-standard deviation increase in the sensitivity of cash flows to interest rates increases floating-rate debt by just about 2%.

Using industry data, Vickery (2008) examines the correlation between output and interest rates. He regresses industry output on interest rate together with a time trend. Industry interest rate exposure has a negative coefficient as predicted by hedging theories. However, the estimated coefficient is between 1.2 and 1.5, and because most industries have beta around -0.02 and 0.02, the natural hedge effect is fairly weak.

As argued by Antoniou et al. (2009), the use of cash flows may be problematic due to their discontinuous nature and the fact that firms tend to manipulate financial statements. To avoid these problems, they estimate the interest rate exposure based on

stock returns. The results indicate that a firm's initial interest rate sensitivity does not affect its choice of yield types as the beta coefficient is statistically insignificant.

We estimate the sensitivity of the firm's free cash flow to interest rates to determine whether the firm would better match the interest rate exposure of its operations via a fixed or floating interest rate exposure on its debt. If firms are hedging their interest rate exposure, we would expect those with cash flows that are positively exposed to interest rates to be more likely to select a floating interest rate exposure, compared to those with cash flows that are negatively exposed to interest rates.

The primary measure of interest rate exposure of the firm's cash flow is similar to that broadly used in the literature (see, for example, Graham and Rogers (2002), Visvanathan (1998) and Fenn et al. (1996)). We define free cash flow as operating income before depreciation minus capital expenditures and scale this difference by book assets. Chernenko and Faulkender (2011) emphasize the importance of including investment in the measurement of free cash flow. They give an example of a firm whose investment opportunities are negatively correlated with interest rates, but operating cash flow is positively correlated with interest rates. For this firm, free cash flow, as defined, is positively correlated with interest rates and the firm, therefore, prefers floating-rate debt. By contrast, a firm with operating cash flow and investment opportunities that are both positively correlated with interest rates would be less concerned about managing the interest rate risk of its debt because free cash flow is uncorrelated with interest rates. In these examples, the difference lies in the way investment varies with operating cash flow across interest rate regimes. Also, we use a pre-interest expense measure of cash flow. This allows for an estimate of interest rate sensitivity prior to the incorporation of interest rate management activities that would alter the underlying exposure the firm is trying to match.

To estimate each firm's cash flow interest rate sensitivity, which we refer to as the cash flow beta, we regress free cash flow for a given year on the average 3-month LIBOR during that year. If commercial debt is floating, it is primarily tied to LIBOR. Therefore, to have fixed-rate debt or floating-rate debt tied to LIBOR is the appropriate choice for firms in our sample. Specifically, we run the following regression for each firm-year observation:

$$Cash\ flow_{it}/Book\ assets_{it} = \alpha + \beta_{CF,i}(LIBOR_t) + \varepsilon_{it}\ (1).$$

The use of cash flows may be problematic. Antoniou et al. (2009) argue that firms tend to manipulate financial statements to smooth out cash flows. Furthermore, since cash flows are often reported annually or semi-annually, interest rate volatility in the period between the two dates when cash flows are reported is ignored. Therefore, we use stock prices instead of cash flows to examine the firm's interest rate exposure as a robustness check. Following Antoniou et al. (2009), stock returns is regressed on interest rates and market returns as follows.

$$R_{i,t} = \alpha + \gamma R_{m,t} + \beta_{s,i} I_{s,t} + \beta_{l,i} I_{l,t} + \varepsilon_{i,t} \ (2),$$

where $R_{i,t}$ is the weekly stock return of stock i at week t; $R_{m,t}$ is the weekly return on UK FTSE-All index; and $I_{s,t}$ and $I_{l,t}$ are the weekly changes of 3-month Treasury bill rates and 10-year Treasury bond rates, respectively. Market return is introduced to exclude the influence of the stock market when measuring the firm-specific interest rate sensitivity.

To control for a firm's desire to smooth earnings independent of cash flow beta, Chava and Purnanandam (2007) use several proxies. As proved in Altman (1977), a Z-score of below 1.81 shows that a firm is closer to financial distress. Hence, they construct a dummy equal to 1 if Altman Z-score is less than 1.81 and 0 otherwise. They use market-to-book and research and development (R&D) expenses to measure growth opportunities. The findings show insignificant coefficients on Z-dummy and positive and significant coefficients on the market-to-book variable. The positive coefficient on market-to-book ratio is inconsistent with hedging motivations, in which firms with more growth options should borrow lower levels of floating-rate debt to avoid the costs involved in raising external funds when financing new projects. This result, however, is consistent with the underinvestment hypothesis of Myers (1977), who suggests that shareholders of a high-growth firm may forgo some positive NPV projects if debtholders gain enough benefits from these projects. To avoid this problem, high-growth firms should maintain more short-term debt, thus leading to higher floating-rate debt.

In terms of financial distress, Faulkender (2005) also considers R&D expenditures, advertising expenditures and capital expenditures as potential costs. He argues that if these measures increase, firms should be more concerned about the volatility of their interest payments that may cause such expenditures to be cut in times of distress. The results show that as a firm spends more on advertising, it is less likely to float.

Motivated by the work of Froot et al. (1993), Chernenko and Faulkender (2011) also include in their study various measures of firm investment such as capital and acquisition expenditures, along with R&D expenditures. All of these capture the benefit of generating internal cash so that firms can make investments without relying on capital markets. The findings indicate that more investment- and R&D-intensive firms find floating-rate obligations more risky than fixed-rate debt.

Faulkender (2005) argues that firms with less debt may be less concerned about suffering financial distress and thus should be less concerned about interest rate volatility. Similarly, Chernenko and Faulkender (2011) include leverage defined as the proportion of debt maturing in more than 5 years. The results indicate that firms with high leverage ratios have less floating-rate debt. In a report examining the debt mixes of Fortune 100 companies, Brobst and Huang (2002) also find that increased financial leverage is associated with increased fixed-rate debt proportion. This suggests that firms with greater debt burdens have less tolerance for interest rate exposure. Inconsistent with these findings, Vickery (2008) and Oberoi (2018), however, identify a negative correlation between firm leverage and the probability of using fixed-rate debt. An alternative explanation, as pointed out by Oberoi (2018), is an increase in short-term borrowing when firms borrow short-term funds to make large investments.

Barry et al. (2009) find that firms with greater interest coverage are more likely to issue fixed-rate debt instead of floating-rate debt. This finding, however, is opposite to the evidence presented by Brobst and Huang (2002) that as interest coverage increases, the proportion of fixed-rate to total debt tends to decline. This report suggests that firms with higher interest coverage are willing to face more interest rate risks in exchange for lower interest expense.

We use several variables to capture hedging motivations independent of cash flow beta. Motivated by the work of Froot et al. (1993) and Chernenko and Faulkender (2011), we include two measures of firm investment, i.e. capital expenditures and R&D expenditures, both scaled by book assets. We calculate firm leverage as total debt divided by total assets. Controlling for their interest rate sensitivity, more investment-intensive firms or firms with higher leverage ratios could find fixed rate obligations less risky and choose a lower amount of floating-rate debt as a fraction of their total debts. We also control for the use of interest rate swaps to examine their impact on the interest rate structure of firms' debt. We define a dummy variable for whether a firm uses any interest rate swaps during the fiscal year. If, for example, firms that engage in

more swap contracts have less floating-rate debt, this could be consistent with firms hedging by swapping toward fixed.

2. Market Conditions

2.1. Yield spread

The primary measure of macroeconomic conditions widely used in the literature is the term spread. Faulkender (2005) argues that if a firm is responding to changes in market prices in an attempt to reduce its short-term cost of capital, then its interest rate exposure is likely to vary with changes in the term structure. Later studies all follow Faulkender (2005) in constructing term spread (see, for example, Chernenko and Faulkender (2011), Vickery (2008) and Chava and Purnanandam (2007)). Most of these find evidence in support of the relation between yield type and the slope of yield curve at the time when the debt funds are raised.

Faulkender (2005), for example, shows that when there is a steep yield curve, firms are more likely to have a floating-rate exposure than when the yield curve is nearly flat. Statistically, a 1-standard deviation increase in the term structure increases the probability of maintaining floating-rate debt from 30% to 41%, which implies a large economic significance. In contrast to Faulkender (2005) and the other studies, Rokkanen (2007) shows that firms do time the market, but the historically low interest rate environment has induced firms to primarily use fixed-rate debt. This finding follows predictions by Longstaff and Schwartz (1995), who suggest higher levels of fixed-rate debt when interest rates fall below their long-term averages.

Apart from term spread, credit spread is used as another measure of market conditions. As indicated by Rokkanen (2007), changes in the investor's credit risk appetite over time may cause fluctuations in funding costs for firms. This variable, however, is not a significant predictor of interest rate exposure in most studies, except one by Barry et al. (2009), which shows that for firms issuing fixed-rate debt, credit spread is an important consideration. In addition to credit spread, Chernenko and Faulkender (2011) also use a measure of swap spread to control for changes in credit market conditions. This variable is significant in explaining time-series variation in floating-rate debt.

Our primary measure of macroeconomic conditions is the term spread. As argued by Chava and Purnanandam (2007), an ideal proxy for market timing motivations requires the knowledge of managerial expectations about term structure. If the prevailing yield curve is too steep relative to the manager's expectation, then the debt

structure may be skewed toward floating-rate debt because long-term debt is found too expensive. However, since a precise measure of managerial expectations is not readily available, the difference between long-term and short-term rates can be used as a plausible proxy for market timing motivations if the manager's expectation approximately equals the long-run average of the term structure. We measure term spread as the difference during the fiscal year between the 10-year Treasury bond and 3-month Treasury bill rates. If firms are timing the market, we would expect them to maintain higher floating-rate debt at times when the term spread is greater. Following Faulkender (2005) and Chernenko and Faulkender (2011), we also use credit spread as a measure of credit market conditions. Credit spread is defined as the average difference between the yields on BBB and AAA corporate bonds during the fiscal year.

2.2. Level of interest rates

Firms may actually be responding to the level instead of the spread of interest rates. Specifically, firms may float when interest rates are relatively high and go fixed when interest rates are at low levels. Therefore, several studies consider both the nominal and real level of interest rates. Additionally, Barry et al. (2009) include changes in current rates relative to past and future rates. Most studies find that these variables are significantly correlated with the choices of yield types. Rokkanen (2007), however, obtains the reversed sign for the coefficient on short-end level of interest rates. The explanation for this result has been discussed above.

Besides these above empirical studies, a survey of Finnish firms by Hakkarainen et al. (1997) reports that managers believe trends in interest rate development are predictable and rely on the forecasts in the selection of debt and hedging instruments. When they were asked how to decide between fixed- and floating-rate funding, the most frequent answer was that decisions are based on interest rate view. In another survey by Servaes and Tufano (2006), with responses distributed globally and widely by industry, a similar result is obtained. Among potential factors determining the fixed/floating mix of debt, two factors receiving the most support are the current level of long-term interest rates relative to manager's expectations and to historical norms. If long-term rates are low compared to what they are expected to be or have been, firms will lock in fixed-rate debt. This suggests that when decisions on fixed/floating mix are made, firms often consider the debts by themselves without interacting these decisions with assets and cash flows. As argued by Servaes and Tufano (2006), it is possible that risk management is taken into consideration to set the target range, whereas investment

considerations allow firms to decide on where they want to be within this range. However, given the broad target range, the survey still confirms that investment perspective dominates risk management perspective.

2.3. State of the economy

If changes in the economy results in changes in a firm's likelihood of financial distress, then the firm's choice of interest rate exposure should change with the state of the economy. Faulkender (2005) uses the Index of Leading Indicators to examine expectations about future macroeconomic activities at the time of the debt issue, while Rokkanen (2007) includes inflation as well as the volatility of short-term interest rate and swap rate to quantify potential sources of uncertainty about the future economy. The findings suggest that when the economy is expected to perform strongly, firms are more adverse to locking in the interest rate. Vickery (2008) and Antoniou et al. (2009) use inflation rate, whereas Barry et al. (2009) control for market return. The results show that firms are more likely to issue a fixed-rate debt when inflation rate is low. Chernenko and Faulkender (2011) estimate the economy-wide proportion of floating-rate debt to measure changes in lending sources that may affect a firm's initial interest rate exposure. They find that firms have more floating-rate debt when floating-rate debt accounts for a greater proportion of outstanding debt in the economy.

2.4. Conditions of the industry

In addition to the state of the economy, conditions of the industry may also impact a firm's willingness to bear interest rate volatility. Faulkender (2005) uses the Industrial Production Index as a measure of current industry strength. The results show that firms are better able to take on interest rate risk when industrial conditions are strong. The extent of industry competitiveness can drive firms to reduce cash flow variance to avoid its strategic costs. Chava and Purnanandam (2007) include the Herfindahl index based on SIC codes but do not find supporting evidence. To account for industrial effects, several studies also introduce industry dummies or divide the sample into industry super-categories (see, for example, Antoniou et al. (2009), Vickery (2008) and Rokkanen (2007)).

3. Managerial Incentive and Owner Characteristics

To capture managerial incentives, Chava and Purnanandam (2007) construct delta and vega of top managers (CEO and CFO) of the firm. Delta and vega measure the sensitivities of a manager's wealth to changes in the firm's stock price and stock return volatility, respectively. Delta provides incentives to reduce risk while vega induces

risk-increasing incentives. Firms maintain higher floating-rate debt percentage if managers have higher vega and lower percentage of floating-rate debt if they have higher delta. Using a similar approach, Chernenko and Faulkender (2011) also estimate delta and vega of each manager's stock and option portfolios.

Chava and Purnanandam (2007) find that although the CEO's incentives do not affect a firm's debt structure, the CFO's delta and vega are significant determinants of these decisions. A firm borrows higher floating-rate debt when the CFO's wealth increases with the volatility of stock returns. The reverse applies when the CFO's wealth increases with stock price. Opposite to this finding, Chernenko and Faulkender (2011) indicate that higher stock price sensitivity is associated with greater floating-rate debt usage. When they interact measures of compensation with term structure, the results suggest that higher delta and vega increase the use of floating-rate debt when the yield curve is steep. The evidence implies that firms with performance-sensitive compensation contracts engage in more interest rate speculation, consistent with the survey results reported in Géczy et al. (2007).

A firm's owner characteristics can also influence loan agreement outcomes. Vickery (2008) takes an example of firms with wealthier owners, who are less likely to face financial constraints or less risk-averse, and claims that floating-rate debts are more common among these firms. To investigate this possibility, he includes five personal characteristics of the firm's owner: the primary owner's age, years of business experience and ownership share, and two dummies respectively equal to 1 if the owner is also the primary manager or the firm is majority-owned by a single family. These variables, however, have little explanatory power. Therefore, he then measures owner wealth by summing the primary owner's stake in the firm and their non-firm wealth. He finds some weak evidence that firms matching with floating-rate debt reflect the fact that their wealthier owners are less concerned about interest rate fluctuations.

4. Firm Controls

4.1. Size

Firm size may impact the interest rate choice due to the difference in firms' ability to achieve a particular exposure. Larger firms are said to be better at managing risk (Faulkender, 2005). Chava and Purnanandam (2007) include firm size to control for the economies of scale in derivative usage. They point out that large firms have better access to both derivative and public debt market, and hence have a wider set of tools to alter their interest rate exposure, while small firms rely heavily on bank financing. The

size finding is consistent with this clientele effect. Larger firms are more likely to have a fixed interest rate exposure as these firms borrow in the bond market, whereas smaller firms borrow from banks at floating rates.

We use the natural log of assets to measure firm size. Empirical studies have found conflicting results on the effect of size. On one hand, following the clientele effect, smaller firms access banks for funds at floating interest rates, while larger firms tend to raise funds in the bond market at fixed interest rates. On the other hand, small firms are often financially constrained and therefore match with fixed-rate debt.

4.2. Financial constraint

As shown by Froot et al. (1993), the objective of risk management policy is to maximize cash flows in states of nature which internal funds is most valuable. Also, evidence on the credit channel of monetary policy suggests that during periods of rising interest rates, finance to bank-dependent firms becomes less available compared to investment opportunities, resulting in lower output. Accordingly, Vickery (2008) argues that credit-constrained firms are more likely to match with fixed-rate debt. He measures firm financial constraints by size, age, banking relationships and cash flows relative to investment opportunities.

Large firms are believed to face less severe financial constraints than small firms due to economies of scale in administration and information acquisition. Financial constraints may also decrease with firm age because over time, a firm can build a reputation and relationships with financial institutions as well as accumulate capital. In terms of banking relationships, switching lenders involves some costs, and firms with concentrated or long relationships are likely to have greater access to finance. To capture the strength of banking relationships, Vickery (2008) includes three proxies, namely the number of financial institutions with which the firm has a relationship, the length of relationship with its primary lender and a dummy variable that equals 1 if the most recent loan is not from its primary lender. In addition, if cash flows are low or investment opportunities are high, financial constraints are tighter. Vickery (2008) calculates return on assets as a proxy for cash flows and sales growth as a measure of investment opportunities. The results provide consistent support for the notion that credit-constrained firms reduce their exposure to interest rates by employing fixed-rate debt. Smaller and younger firms, those switching from their primary lender and those with lower cash flows or more growth opportunities are more likely to match with a fixed-rate loan.

4.3. Other firm controls

Faulkender (2005) measures profit margin to examine whether profitability affects a firm's decision to manage interest rate risk. He finds that less profitable firms are more likely to float. One interpretation of this result is that these firms prefer the cheaper debt and are willing to take on interest rate exposure associated with lower-cost financing. Oberoi (2018), by contrast, sees that firms with higher cash flow margins have a lower fixed-rate debt share, consistent with these firms facing a reduced financial constraint. The notion of constraint in his study is the firm's future borrowing capacity. He also argues that a firm with more fixed-rate debt would hold more liquid reserves such as cash and short-term assets as a hedge against the risk of increased leverage and reduced borrowing capacity. Therefore, higher liquidity, measured by the quick ratio, is associated with higher fixed-rate debt share. Barry et al. (2009) measure 3-year standard deviation of EBITDA and the ratio of EBITDA to total asset and fixed to total asset. The results indicate that higher cash flow leads to increased probability of floating-rate debt. Also, firms with higher levels of fixed assets relative to total assets are more likely to issue fixed-rate debt instead of floating-rate debt.

We use the return on assets to test whether profitability affects a firm's choice of interest rate exposure. Less profitable firms may be more willing to endure interest rate risk, and hence more likely to float (Faulkender, 2005). It is also possible that firms with lower profitability face more severe financial constraints and tend to have a lower floating-rate debt share (Oberoi, 2018). Cash in the bank typically earns interest linked to a floating-rate index. Firms with higher short-term liquidity, therefore, would have more floating-rate debt as a natural hedge. Also, it may be the case that a firm with more fixed-rate debt is at the risk of increased leverage and reduced borrowing capacity. Such a firm would hold more liquid reserves as a hedge (Oberoi, 2018). In that case, higher liquidity is associated with a lower floating-rate debt share. We use current ratio, defined as current assets to current liabilities, as a measure of firm liquidity.

Information asymmetry between a firm and its lenders provides implications for its risk management strategies. Chava and Purnanandam (2007) suggest that if a firm expects an improvement in its credit quality, it may have an incentive to issue short-term debt so that when its true credit quality is disclosed to the market, it can borrow at more favourable terms. Since they consider short-term debt as a part of floating-rate

debt, they conclude that such firms should have higher floating-rate debt.[3] To control for the firm' private information concerning its credit quality, they compute the changes in Z-scores of every firm over the next year. If this change is positive, which means a firm's credit risk decreases, they set a dummy variable named Z-change to 1 and 0 otherwise. The sign of the coefficient on this variable is positive. However, the statistical significance is weak.

Apart from these above variables, Vickery (2008) constructs various dummies to control for firm characteristics: a dummy for whether the local bank's Herfindahl index is higher than 1800 (i.e. the firm is located in a concentrated local banking market), a dummy that equals 1 if the firm has recently been solicited by financial institutions, two dummies equal to 1 if the firm is an C-corp or S-corp, respectively, and three dummies for the firm's geographic region. The results for these variables, however, are not reported.

5. Loan Controls

5.1. Source of debt/Lender type

To control for the firm's source of debt, Chava and Purnanandam (2007) and Chernenko and Faulkender (2011) construct a dummy variable equal to 1 if a firm has rated debt, and 0 otherwise, while Vickery (2008) includes two dummy variables that respectively equal 1 if the lender is a bank or a non-financial institution. The results strongly support the notion that bank loans are more likely to involve a floating interest rate, or bank-dependent firms borrow more floating-rate debts than others. In one study, however, Rokkanen (2007) includes a dummy that takes the value of 1 if an issuer has a credit rating and shows that rated issuers prefer floating-rate debt. He suggests that unrated, and thus less transparent, firms occasionally access the public market to borrow fixed-rate debt as an alternative to floating-rate bank funding.

We use several variables to control for the source of debt. In addition to the percentage of bank debt and bond debt to total debt, we construct a dummy variable equal to 1 if a firm has credit rating, and 0 otherwise. Empirical evidence suggests that bank loans are more likely to involve a floating interest rate and bank-dependent firms have higher floating-rate debt ratio, whereas most corporate bonds are fixed in nature (Faulkender, 2005, Chava and Purnanandam, 2007, Vickery, 2008, Chernenko and

[3] Chava and Purnanandam (2007) consider short-term debt as floating-rate debt since it has the same economic effect with respect to interest rate exposure as long-term debt with floating rate.

Faulkender, 2011). Firms with credit rating have better access to the public debt market and, therefore, are less likely to float.

5.2. Lender controls

Lender controls include other controls relating to the loan provider. Vickery (2008) estimates the distance between the lender and the borrower and uses two dummy variables indicating the primary form of interaction between them (i.e. face to face, telephone or others). He argues that distance and the type of interaction are broadly used in the literature to evaluate the importance of non-verifiable information about the firm for lending decisions. The results for these variables, however, are not reported. In another model, he also controls for bank characteristics and examines bank size as well as liquidity. Given the lack of firm controls in this model, the negative and significant coefficient on the bank size variable suggests that small banks tend to lend to small firms, which, in turn, are more likely to use floating-rate debt.

5.3. Loan size

Issue size is often assumed to highly correlate with firm size, and thus may be related to the choice of interest rate exposure. Rokkanen (2007) and Vickery (2008) both control for loan size but find conflicting results on this effect. Rokkanen (2007) observes a negative and significant coefficient on the issue size variable, which implies that larger debt issues are more likely to involve a fixed interest rate. This result is in line with the firm size effect documented in Faulkender (2005) and Chava and Purnanandam (2007) as indicated earlier. By contrast, Vickery (2008) shows that smaller loans are more likely to match with fixed interest payments. He interprets loan size as a proxy for firm size and finds this result consistent with his previous findings that smaller firms take out more fixed-rate debts.

5.4. Loan maturity

Debt maturity may be a determinant for the yield type of debt. Rokkanen (2007) and Vickery (2008) both include loan maturity and report consistent results. Rokkanen (2007) indicates that increased maturity reduces the likelihood of floating-rate debt, following his prediction and a parallel explanation by Guedes and Thompson (1995). Vickery (2008) also identifies a positive relationship between loan maturity and the probability of using fixed-rate debt. We include the percentage of long-term debt to total debt to determine whether firms decide on the fixed/floating mix and maturity structure together. Signalling theory suggests that longer-term debt is more likely issued with fixed interest payments (Rokkanen, 2007).

5.5. Loan default risk

Two measures of loan default risk widely adopted in empirical studies are collateral and credit rating. To control for collateral, Vickery (2008) constructs a dummy variable reflecting whether the loan is collateralized and seven dummies for types of pledged collateral. Loan risk rating consists of dummy variables for each rating value, a dummy equal to 1 if the bank branch applies risk ratings, and a dummy variable for whether it applies ratings to some loans but not the most recent loan. Antoniou et al. (2009) introduce a dummy equal to 1 for high-rating debt. The results are somewhat inconsistent.

On one hand, Vickery (2008) finds that collateralized loans are more likely to match with a fixed interest rate. As shown by Berger and Udell (1990), loan collateral is associated with high-risk firms. Therefore, this positive coefficient proves that firms with high default risk match with fixed-rate debt. A report by Brobst and Huang (2002) confirms this finding and concludes that the higher a firm's credit rating, the lower the portion of fixed-rate debt it carries. This probably implies highly rated firms' ability to suffer higher interest rate exposure so as to obtain the benefits of lower floating-rate interest payment.

However, the risk rating estimates by Vickery (2008) indicate an opposite result. Loans with the lowest risk are more likely to involve a fixed interest rate, while those with the highest risk are found less likely to be fixed rate. One interpretation of these conflicting results, as given by Vickery (2008), is that loans in the lowest and highest risk bucket only account for a small proportion of loans. Also, the risk rating data neither reflect an ex ante assessment of the firm's creditworthiness nor correlate with ex post performance measures.

C. Measurement of the Fixed/Floating Mix of Debt

There are two main issues concerning the measurement of the fixed/floating mix of debt: whether to include the impact of derivatives and whether to focus on incremental debt or total outstanding debt. Table 2 provides a summary of dependent variables in previous empirical studies. As can be seen from this table, only three studies control for both interest rate derivatives and total outstanding debt.

1. The Impact of Interest Rate Derivatives

A critique of the existing risk management literature relates to the assumption that firms that do not engage in derivative transactions are not hedging. A firm that issues floating-rate debt and then swaps it for a fixed rate has the same interest rate exposure,

and hence receives the same benefits of smooth cash flows, as one that issues fixed-rate debt. However, when the empirical literature examines interest rate hedging, it has often equated the former with being a hedger, whereas the latter is considered a non-hedger (Mian, 1996, Nance et al., 1993). The above example illustrates that firms can manage their interest rate risk by means other than derivatives. By entering into a debt contract that is aligned with their target interest rate exposure, there is no need to issue an accompanying derivative contract.

For this reason, Faulkender (2005) argues that an examination of whether firms are hedging should focus on "the final interest rate exposure of the debt, not the intermediate step of how many derivatives the firm uses" (p. 932). He points out that the theoretical literature does not explore how a firm achieves a specific exposure but mostly examines what final exposure it should have. Following this argument, Faulkender (2005) examines the final interest rate exposure of newly issued debt funds, which is defined as the combination of the initial exposure and use of swaps to modify that exposure. He then constructs a dummy variable that equals 1 if the final exposure of the debt instrument is floating, and 0 otherwise. Servaes and Tufano (2006) consider debt structure after the effect of derivatives. They find the only factor that makes the floating-rate bond structure different from the fixed-rate bond plus swap structure is credit risk associated with the swap user. However, this risk is normally low.

Chava and Purnanandam (2007) also account for the impact of swaps. They start with the sum of short-term debt and long-term floating-rate debt as a measure of floating-rate debt before derivative transactions. They add the amount of pay-floating swap and subtract the pay-fixed swap, then scale this by the total debt to obtain the net floating-rate debt percentage. Using a similar approach to calculate the floating-rate debt amount, Chernenko and Faulkender (2011) indicate that firms can hedge or speculate in the interest rate market by using interest rate swaps or via the choice of their interest rate exposures. They expand upon the above example and suggest that a firm that issues floating-rate debt but enters into an interest rate swap would have the same interest rate exposure as one that issues fixed-rate debt if the swap matches (1) the face value of the debt, (2) the maturity of the debt, (3) the frequency of interest payments and (4) the index of floating rate. They conclude that it is the combination of the firm' interest rate swap activities and the initial interest rate exposure of the debt that determines the firm's overall interest rate exposure.

There are, however, some studies that look at the initial interest rate exposure of the debt only. Rokkanen (2007) argues that focusing on the original debt type gives a greater insight into the debt market's willingness and ability to fund corporate borrowers in different interest rate regimes. Rokkanen (2007) and Antoniou et al. (2009) both employ a dummy variable equal to 1 if the debt is issued as floating rate, and 0 otherwise. Similarly, Vickery (2008) uses a dummy that takes the value of 1 if the most recent loan of the firm is fixed. Barry et al. (2009) estimate the probability of issuing fixed-rate debt versus issuing floating-rate debt.

2. Incremental Debt or Total Outstanding Debt

The second issue concerning how to measure the fixed/floating mix of debt relates to incremental debt. As mentioned previously, Faulkender (2005) examines the final interest rate exposure of incremental issuances. This allows one to specifically determine which debt fund the firm is altering via the swap. In addition, since firms often modify the interest rate exposure of debt instruments at the time of the debt issue, the final interest rate exposure of newly issued debt securities closely reflects the firm's interest rate risk management strategy. By looking at incremental issuances over a period of time, Faulkender (2005) can analyse not only cross-sectional variation but also time-series variation at monthly intervals, thus constructing a panel series and improving upon the more traditional study of derivative usage. On examination of whether firms are timing the market, another benefit of looking at individual debt issues is that the month that the exposure was chosen together with the structure of interest rates during that month are observable. This would improve the test's statistical power. Following Faulkender (2005), Rokkanen (2007), Vickery (2008), Antoniou et al. (2009) and Barry et al. (2009) all focus on newly issued debt rather the total outstanding debt. Vickery (2008) includes the existing percentage of fixed-rate loan in only one econometric specification.

In contrast to these above studies, Chava and Purnanandam (2007) and Chernenko and Faulkender (2011) both measure the firm's floating-rate debt as a fraction of total debt. The advantage of this method is, as stated by Chava and Purnanandam (2007), to "capture the entire gamut of borrowings" (p. 759). They take credit lines, an important method of corporate borrowing, as an example and quote a survey by the US Federal Reserve, which reports that lines of credit account for more than 82% of commercial and industrial loans offered by US banks in terms of volume. These borrowings, however, are not captured in studies of incremental debt issuances because they do not

have a specific maturity date. The issue of credit lines is also discussed further by Vickery (2008). He points out that the distinction between lines of credit and other types of loan is important for the fixed versus floating component of the loan agreement. A fixed-rate line of credit may provide an arbitrage opportunity as any change in the market interest rate would affect the spread between it and the rate in the agreement. He gives an example that if the market rate increases dramatically, the firm could draw down the line and invest the proceeds at the higher rate. Also, a credit line's interest rate risk is contingent since only to the extent that the firm actually draws down the line does it face risk.

Faulkender (2005), in alternative analyses, also points out that if firms are hedging, then the selection of the exposure of new debt issuances depends on the current mix of fixed- and floating-rate debt, including any modification made via swaps to the existing issues. A firm that manages the interest rate exposure of its aggregate liability toward a long-term average may issue fixed-rate debt when its percentage of fixed-rate debt is low and vice versa. Therefore, Faulkender (2005) measures the percentage of floating-rate debt in the firm's capital structure before the new issue as robustness checks.

III. Empirical Strategy

We first construct our explanatory variables, which come from recent papers in the literature (Faulkender, 2005, Chava and Purnanandam, 2007, Vickery, 2008, Chernenko and Faulkender, 2011) and include controls for hedging and market timing motivations, as well as variables related to the characteristics of the firm and the loan itself. We estimate each firm's cash flow interest rate sensitivity, which we refer to as the cash flow beta, using Equation 1, and stock price interest rate sensitivity, which we refer to as the stock return beta, using Equation 2. Table 3 summarizes the definitions of all explanatory variables and the predicted signs on the estimated coefficients of each variable. Except market condition variables which are collected from Datastream, all other variables are downloaded from S&P Capital IQ. We then begin with OLS regression analysis and investigate the key drives of initial and final debt structure, i.e. before and after incorporating the effect of swaps. We also break down the sample period into two subperiods, i.e. 1999-2006 and 2007-2015, to test the effect of the 2007 financial crisis on the firms' interest rate exposure.

When firms select the interest rate exposure of their debts and use derivatives to alter that exposure, are they hedging or timing the market? To answer this question, we follow the approach adopted by Chernenko and Faulkender (2011), who argue that

testing theories of hedging requires separating the hedging and speculative components of risk management policies. Assuming that non-financial firms' exposure to interest rates is stable over time, a firm's optimal hedge ratio should stay constant. Also, as a firm's beliefs on the direction of interest rates are likely to vary with market conditions, their interest rate exposure will move with changes in these beliefs. Therefore, if firms are both hedging and speculating on interest rate movements, Chernenko and Faulkender (2011) suggest that firms' interest rate risk management practices can be empirically modelled as "having a target hedge ratio driven by the interest rate sensitivity of their operations, with deviations from that target driven by firms' interest rate views" (p.1732). Over time, average hedge ratios should reach the optimal hedge ratio. The difference between the observed ratio and its average captures market timing activities. We use the Fama and MacBeth (1973) specifications and "between" specifications to explain the cross-sectional variation in floating-rate debt share, which capture firms' hedging activities, and the firm-level "within" specification to explain the time-series variation in floating-rate debt share, which capture firms' speculative activities. These specifications are described in detail below.

A. Benchmark Multivariate Analysis

We begin with multivariate regression analysis of the determinants of floating-rate debt usage without distinguishing between time-series and cross-sectional variation. These specifications are reported to provide a benchmark that can be compared with those estimated in previous studies and our various panel specifications as indicated later. We run an ordinary least squares (OLS) regression in the general form as follows:

$$\frac{Float}{Total}(\%)_{it} = \gamma_0 + \gamma_1 \times Interest\ rate\ swaps_{it} + \gamma_2 \times Cash\ flow\ beta_{it} + \gamma_3 \times \frac{CAPEX}{Assets}(\%)_{it} + \gamma_4 \times \frac{R\&D}{Assets}(\%)_{it} + \gamma_5 \times Book\ leverage_{it} + \gamma_6 \times Term\ spread\ (\%)_t + \gamma_7 \times Credit\ spread\ (\%)_t + \gamma_8 \times Size_{it} + \gamma_9 \times ROA_{it} + \gamma_{10} \times Current\ ratio_{it} + \gamma_{11} \times Credit\ rating_{it} + \gamma_{12} \times Long-term\ debt\ (\%)_{it} + \varepsilon_{it} \qquad (3).$$

We use the initial and final floating-rate debt share as the dependent variables. Explanatory variables are described in Section II. As robustness checks, we replace cash flow beta with short-term and long-term stock return beta, and credit rating dummy with the percentage of bank debt and bond debt. As argued by Chernenko and Faulkender (2011), if a result is entirely driven by time-series variation, then a panel

specification may obscure its effect. Therefore, in the next sections, we decompose the time-series and cross-sectional variations in floating-rate debt usage.

B. Cross-sectional Variation

To estimate a firm's interest rate hedging activities, we use the Fama and MacBeth (1973) and "between" specifications. A Fama and MacBeth (1973) specification estimates cross-sectional variations each year and then averages the estimated coefficients over the sample period, whereas the between specification regresses the mean of the dependent variable on the means of the explanatory variables. While speculative activities may move firms away from their optimal hedge ratio at some points, a panel covering a long period of time should generate an estimate of risk management activity that is an unbiased estimate of the optimal hedge ratio (Chernenko and Faulkender, 2011). Therefore, estimated coefficients from a between specification could explain cross-sectional variations in that optimal hedge ratio. Similarly, a Fama and MacBeth (1973) specification could capture the cross-sectional relationships over time.

C. Time-series Variation

To explain time-series variation in floating-rate debt share, which captures firms' speculative activities, we use the firm-level "within" specification. A within specification regresses the deviations from the mean of the dependent variable on those from the means of the explanatory variables. This specification focuses on movements away from the firm's constant optimal hedge ratio. The coefficients estimated by a within specification explain which variables are correlated with deviations from the firm's averaged position, and thus its speculative activities.

IV. Data and Summary Statistics

Our sample consists of large UK non-financial firms over the 1999-2015 period. We hand-collect data on derivative usage and floating-rate debt by each firm in our sample. Using annual reports, we search the entire footnotes to financial statements for any mention of the following keywords: "risk management", "hedg", or "derivative". If a reference is found, we read the surrounding text and record whether a firm used any derivative instruments during a fiscal year and, if any, the notional amounts of derivatives outstanding at the fiscal year end. Table 4 provides the frequency distribution of derivative usage by UK firms over the sample period. Of the observations, 82.4% are derivative users, and of these, 81.0% used interest rate derivatives. We note that firms use other contracts such as collars and caps to manage

their interest rate risk. However, swaps are considered the predominant tool. In our sample, of 94.7% interest rate derivative users that disclose types of derivatives, 95.5% use interest rate swaps, whereas only 15.4% use interest rate options. In previous studies, Chava and Purnanandam (2007), for example, find that only 10% of derivative users enter into option contracts. Therefore, these non-linear derivative contracts are expected to have a minor effect for our analysis, and our measure of firm's final floating-rate debt, which accounts for the effect of swaps, serves as a good approximation of the firm's final interest rate exposure. In addition, we attempt to determine the directions of swaps, i.e. whether the firm pays floating or fixed rate in its swap transactions. Most firms explicitly disclose if swaps were used to manage interest rate risk. However, only 56.1% of swap users report swap positions. Of these, more than half (58.5%) swapped to fixed, while 23.1% swapped to floating and the rest swapped to both. To the best of our knowledge, we are the first to collect these data which provide additional insight into the effects of swap usage on the firm's interest rate exposure.

In addition to derivative usage, we record the amount of floating-rate debt after incorporating the effects of interest rate swaps from annual reports. We divide this variable by the firm's total debt to construct our dependent variable. Overall, after keeping observations that have positive book value of debt and dropping those with missing data on floating-rate debt, we are left with 5,190 firm-year observations. We also collect data on the share of firms' debt that is floating before interest rate swap effects from S&P Capital IQ (CIQ). The CIQ database provides detailed information on debt and capital structure from the notes to financial statements in annual reports. Using these data on the initial and final debt mix of the firm, we calculate the net floating swap percentage as the final floating-rate debt percentage minus the initial floating-rate debt percentage. It is the net share of the firm's total debt that is swapped to floating, the absolute value of which represents the amount of interest rate swaps outstanding at the fiscal year end as a percentage of the firm's debt.

If firms do not use interest rate swaps, then their initial floating-rate debt percentage (pre-swap) should be equal to their final floating-rate debt percentage (net of swap). In untabulated statistics, we test the difference in means between these two variables for a subsample of swap non-users and find that they are not significantly different. We also repeat the test for firms that do not use interest rate derivatives as a robustness check. Given that we use data from two sources, the floating-rate debt variables prove

to be measured with precision and serve as good approximations of the firm's interest rate exposure. Contrary to our findings, Ippolito et al. (2018) also obtain data on the interest rate profile of firms' debt from CIQ and show that the initial floating-rate debt variable is measured with some error as the sum of fixed- plus floating-rate debt does not add up to total debt. Therefore, in their study, it is only used as an approximation.

Panel A of Table 5 provides summary statistics for initial and final floating-rate debt for the full sample. On average, the percentages of outstanding debt that have a floating rate exposure before and after accounting for the effect of swaps are 56.6% and 55.9%, respectively. Given that some firm-years are included in our database but not the CIQ database and vice versa, we also report summary statistics for the subsample of firms that has data on both initial and final debt mix in Panel B of Table 5. Prior to the effect of swaps, the mean (median) percentage of floating-rate debt is 57.7% (70.6%). After some firms swap to floating and others swap to fixed, 57.1% (56.7%) of the outstanding debt is floating. The average amount of interest rate swaps is equivalent to 24.2% of the firm's total debt, and a net share of 0.7% is swapped to fixed. Although the mean floating swap percentage is relatively small, the standard deviation is 39.3%, indicating considerable variation in swap usage across firms and over time. Again, the data shows that considering swaps in the analysis is important as the use of swaps can 'redistribute' firms across different levels of debt mix. The summary statistics for the swap users subsample are reported in Panel C of Table 5. This sample includes those firms that at least once in the sample period use interest rate swaps. The number of observations reduces by 10%, and average swap size increases to 26.0% of the outstanding debt. In addition to the interest rate profile of the firm's debt, we attempt to record the amount of floating-rate debt by currency, which has not been done previously to the best of our knowledge. The summary statistics are presented in Panel D of Table 5. It can be seen that the level of floating-rate debt by currency is quite similar, which is 57.7%, 56.7% and 60.9% for UK, US and EU debt, respectively.

Comparing this with other studies, we see that UK firms tend to have more floating-rate debt as a percentage of the firm's total debt, regardless of whether swaps are considered or not. Faulkender (2005) builds a dataset of 275 debt issuances from US firms in the chemical industry for a six-year period. Of the observations, 34.2% are floating-rate loans. After incorporating swaps, only 31.6% of the issuances have a floating rate exposure. In a later study, Chernenko and Faulkender (2011) construct a sample of US non-financial firms during a 10-year period (1993-2003) and report an

average of 41.6% of floating-rate debt before considering swaps. After the effect of swaps, this level decreases to 38.3%. In a recent study, Bretscher et al. (2018) extend the sample period from 10 to 20 years (1994-2014) and find that 37.4% of the outstanding debt is initially floating, as opposed to 35.8% after the incorporation of swaps. Ippolito et al. (2018) also obtain data on the percentage of floating-rate debt from CIQ. Their sample consists of US firms from 2003 to 2008. Across the entire sample, floating-rate debt before considering swaps represents on average 38.3% of total debt. Among US studies, Chava and Purnanandam (2007) do record a high level of 58.0% and 57.0% floating-rate debt prior and after the effect of swaps, respectively. However, they collect data for fiscal year 1996-1997 only. Summary information on floating-rate debt usage in previous empirical studies is provided in Table 6.

In addition, these statistics show that there are more swap activities in the UK and the magnitude of swap usage by UK firms is larger. Faulkender (2005) finds that of the debt issuances, only 11% are swapped. Chernenko and Faulkender (2011) show that a swap was used in only 27% of firm-years and the average interest rate swap is equivalent to only 7% of the firm's total debt. Bretscher et al. (2018) report that for the average firm-year, swap size corresponds to 7% of the outstanding debt. In their sample, only 63% of firms are swap users. These studies are, however, consistent with our findings that a net average of the firm-year's debt is swapped to fixed, or in other words, firms tend to be fixed-rate payers.

We then present some observations about floating-rate debt graphically. We first look at how debt mix varies across industries. It can be seen clearly from Figure 1 that utilities and real estate are two industry sectors with the lowest percentages of floating-rate debt, whereas firms in the information technology sector have the highest amount of floating-rate debt as a percentage of their total debt. The distribution is fairly stable with or without the effect of swaps.

We attempt to explain the variation in floating-rate debt by breaking down the sample period into pre- and post-crisis (Figure 2). We see that before the 2007 financial crisis, firms did not substantially change the share of debt that was floating as the mean percentages of initial and final floating-rate debt are almost the same. However, after the crisis, for the mean firm-year, 55.7% of the outstanding debt was floating, as opposed to 57.9% prior to the effect of swaps. This suggests that firms tend to swap to a fixed interest rate exposure. Jointly, these observations provide us the motivation to

examine the impact of financial crisis on firms' hedging strategies. To the best of our knowledge, we are the first to highlight this variation in the debt mix of firms.

Table 7 provides further summary statistics for measures of potential hedging benefits, market condition variables and control variables. Information on firm characteristics are obtained from CIQ while interest rates are sourced from Datastream. For the mean firm-year in our sample, the interest rate sensitivity of cash flow is negative, suggesting that firms generate more cash when interest rates are lower. Stock returns are positively correlated with interest rates by contrast. Overall, about 64% of the outstanding debt is borrowed from banks while this number for bond debt is only 25%.

Looking at the market pricing variables, the spread between 3-month Treasury bill and 10-year Treasury bond rates is on average 84 basis points (bp), ranging from a low of -138 bp to a high of 367 bp. The movement of term spread over the sample period can also be seen in Figure 3. The average 3-month Treasury bill rate fluctuated between 3.8% and 5.7% from 1999 to 2008 before plummeting to 1.2% in 2009. There was also a downward trend in the 10-year Treasury bond rate. Consequently, the average term spread was 200 bp in 2009, as opposed to -80 bp in 2008. If firms are trying to reduce their cost of capital in response to market conditions, then their interest rate choice should vary with these changes.

In Figure 4, we keep only firms that exist in all years over the sample periods and plot the patterns of the firms' choice of final interest rate exposure. It can be seen that before 2007, there was an upward trend in the percentage of floating-rate debt after incorporating swaps, as opposed to a downward trend in the later period, consistent with firms increasing their interest rate exposure. These observations, again, suggest that the financial crisis may have had an impact on the firms' choice of interest rate exposure, and breaking down the sample period into before and after the crisis may provide additional insight.

Comparing the swap users sample with the non-users sample, we note that swap users are larger and more likely to get access to capital markets. As pointed out by Chernenko and Faulkender (2011), these differences are consistent with "… swap users having greater financial sophistication and a low cost of accessing derivatives products" (p.1738). Leverage ratios average 28.3% for the swap users sample and 19.8% for the sample of non-users. The results are presented in Table 8.

V. Empirical Findings

A. **Multivariate Analysis**

We begin with multivariate regression analysis without distinguishing between cross-sectional and time-series variations. These specifications are reported to provide a benchmark against which we can compare the results from specifications estimated in previous studies and our panel specifications.[4] The first set of results, reported in columns 1-6 of Table 9 , examines the share of debt that is floating before incorporating the effect of swaps. Larger firms and those with credit rating use less floating-rate debt. Because most corporate bonds carry a fixed rate while bank loans usually carry a floating rate, firms with more bonds in their debt structure have more fixed-rate debt and those with more bank debt outstanding are more likely to have a floating interest rate exposure. Looking at the macroeconomic variables, the coefficient on credit spread is statistically significant, indicating that as lower-rated bonds become more expensive relative to higher-rated bonds, firms use more bank debt, which tends to be short-term and floating. Apart from the above findings, most of our key variables have an insignificant effect on the firm's initial interest rate exposure. Altogether, these results suggest that the key drivers of initial debt structure are the sources of debt. Firm size and credit rating might be a proxy for access to the bond markets.

Firms may use interest rate swaps to alter the initial interest sensitivity of their debt. The final interest rate exposure, incorporating the effect of swaps, best reflects their interest rate risk management activities. Therefore, we conduct the OLS analysis again using the final floating-rate debt percentages as the dependent variables in columns 7-12 of Table 9. Firms that use interest rate swaps have less floating-rate debt, most likely the result of these firms swapping to a fixed interest rate. Given that firms can manage their risk by means other than derivatives, this illustrates that floating-rate debt acts a substitute to interest rate swaps. In addition, firms with more debt and R&D expenses are less likely to use floating-rate debt. A potential interpretation is that interest rate risk is more costly for these types of firms. Firms with more debt may be more concerned about suffering financial distress, and thus should be more concerned about interest rate volatility, whereas those with more growth options, proxied by R&D expenses, should borrow lower levels of floating-rate debt to avoid the costs involved in raising external funds when financing new projects.

[4] For the purpose of comparison, we present results using the same models that were used in Chernenko and Faulkender (2011) in Table A22-Table A26 in the appendices.

Importantly, the average firm is matching the interest rate exposure of its cash flows to that of its liabilities, as shown by the positive and significant coefficients on cash flow beta. Firms with cash flows that are positively correlated with interest rates reduce the variability of their cash flows by swapping toward a floating interest rate, as predicted by hedging theories. Conversely, those with negative interest rate exposure of cash flows are more likely to swap toward a fixed interest rate exposure. As a robustness check, we examine alternative measures of interest rate exposure to determine whether firms are really matching the interest rate sensitivity of their assets to that of their liabilities, or whether the measure is misspecified. We follow the approach adopted by Antoniou et al. (2009) and employ stock returns instead of cash flows. Specifically, we measure the asset sensitivity to changes in both long- and short-term interest rates. In contrast to the lack of such a finding in Antoniou et al. (2009), the coefficient sign of short-term stock return beta is positive with marginal significance, consistent with firms hedging the interest rate exposure of their assets.

Another thing to notice is that, contrary to the results of most previous studies, it does not appear that our sample firms are timing the market. If that is the case, the sign of the coefficient for the term spread variable should be positive, indicating that firms have more floating-rate debt when the yield curve is steep. Instead, the negative coefficient of the term spread suggests that there is no evidence of market timing. Consistent with the earlier OLS results of initial interest rate exposure, credit spread affects the percentage of final floating-rate debt firms have. Responses to changes in credit market conditions are most likely the results of firms having less bonds in the debt structure as bonds become relatively more expensive. We attempt to interpret this result by examining the determinants of the source of funds. The results are presented in Table A9 in the appendices. Consistent with Faulkender (2005), we find that credit spread is a significant determinant of where firms raise their funds. As the credit market becomes risker, firms are less likely to borrow from the public debt market.

Consistent with the results for initial interest rate exposure, bank-dependent firms have higher levels of floating-rate debt. A potential interpretation is that "…adjustable-rate debt provides a mechanism for depository institutions to minimize their ex ante exposure to rising interest rates" (Vickery, 2008). Conversely, firms with credit rating and more bonds in their debt structure are less likely to float. Given that once the debt funds are raised, firms can use interest rate swaps to change their exposure, these results show that the source of debt is a strong determinant of the chosen interest rate exposure.

Looking at control variables, the coefficient of the long-term debt variable is negative and significant at better than 5%, consistent with Rokkanen (2007), who argues that increasing maturity may reduce the likelihood of floating-rate debt. In addition, smaller firms tend to have a floating interest rate exposure, most likely the result of these firms borrowing from banks at floating interest rates. This suggests that firms may not entirely overcome the clientele effect documented in prior research, even in the presence of the interest rate swap market.

This essay looks at how firms decide on the fixed versus floating mix of debt. Potential factors that may affect this decision, such as maturity structure and source of debt, reflect other elements of the mix of debt and may be jointly determined. This results in simultaneity bias, one of the three causes of endogeneity as shown by Roberts and Whited (2011). To solve this problem, we follow Vickery (2008) and Chava and Purnanandam (2007) and present the results estimated in two different ways as a robustness check. Further details of these results are discussed in the appendices. Although this may not be an identification strategy, the main results are robust after controlling for potential endogenous variables.

Our results suggest that firms are hedging when selecting the interest rate exposure of their debt. However, the choices of those exposures differ between before and after the crisis, as illustrated in the summary statistics. Therefore, we repeat the OLS analysis conducted above using two separate sample periods, i.e. 1999-2006 and 2007-2015, in an attempt to explain the effect of the 2007 financial crisis on the firms' interest rate exposure. The first set of results, reported in Table 10, examine the initial and final floating-rate debt percentages in the pre-crisis period. Looking at columns 1-6 of Table 10, the first thing to notice is that we do not find a positive coefficient for the cash flow beta variable as predicted by hedging theories. Instead, term spread appears to be the key determinant of the initial interest rate exposure. Statistically, the estimated coefficient of this variable is positive and significant at better than 1%. This result suggests that firms use more floating-rate debt when long-term interest rates are relatively expensive as compared with short-term interest rates, consistent with these firms timing the market. Otherwise, the source of debt funds remains as a significant determinant of the initial interest rate exposure. Smaller and more profitable firms have more floating-rate debt. The profitability finding is consistent with the argument put forward by Vickery (2008) and Oberoi (2018) that more profitable firms are less financially constrained.

Looking at the results of final floating-rate debt percentages in columns 7-12 of Table 10, we find that, in contrast to the earlier results, term spread does not affect firms' choice of debt types. As the difference between long- and short-term interest rate increases, firms do not tend to have a floating interest rate exposure. The coefficients on the short- and long-term interest rate sensitivity of the firms' stock returns are positive and statistically significant, indicating that firms select their interest rate exposure in a manner consistent with hedging. Specifically, those that face a positive exposure will have more floating-rate debt to reduce the volatility of stock returns resulting from interest rate movements.

The second set of results, reported in Table 11, examine the initial and final floating-rate debt percentages in the post-crisis period. As shown in columns 1-6 of Table 11, we find a negative association between term spread and floating-rate debt. When there is a steep yield curve, firms that select a fixed interest rate exposure will have to pay higher interest costs than those with a floating exposure, at least in the short term. However, given the cost advantage, it does not appear that firms are timing the market. Instead, firms with high leverage ratios have less floating-rate debt, potentially consistent with hedging theories. Apart from these results, the source of debt funds remains an important determinant of the firms' debt mix. Larger firms are less likely to have a floating interest rate exposure.

Looking at the OLS results of final floating-rate debt in columns 7-12 of Table 11, we find further evidence that hedging is the primary objective of firms in the post-crisis period. The average firm is matching the interest rate exposure of their cash flows to that of their liabilities. Those with cash flows that are positively correlated with interest rates have more floating-rate debt than those with cash flows that are either negatively correlated or uncorrelated. In addition, interest rate swap is negatively correlated with floating-rate debt. Firms that use more interest rate swaps are less likely to have a floating interest rate exposure, most likely the result of these firms swapping toward fixed. Also, firms with more debt have significantly less floating-rate debt, as predicted by hedging theories. When credit spread is higher, firms tend to use more floating-rate debt. Debt maturity also affects the share of floating-rate debt firms have.

Overall, these results show changes in risk preferences before and after the financial crisis. We find evidence of market timing when examining the initial interest rate debt mix in the pre-crisis period but no evidence of market timing in the post-crisis period. Similarly, there is weak evidence of hedging when we look at the final interest debt

mix before the crisis but strong evidence of hedging after the crisis. These results suggest that firms became more cautious after the financial crisis.

Although these above results are suggestive, they do not distinguish between cross-sectional and time-series variations and may be difficult to interpret. Chernenko and Faulkender (2011) point out that if a result is entirely driven by time-series variation, a panel specification that includes cross-sectional variation may obscure its effect. Consequently, the OLS approach can be misleading. In the next sections, we will decompose the cross-sectional and time-series variations in the percentage of floating-rate debt firms use.

B. **Cross-Sectional Variation**

In this section, following Chernenko and Faulkender (2011), we assume that the optimal hedge ratio remains constant over time and deviations from this ratio driven by speculation are zero on average. We then use the Fama and MacBeth (1973) and between specifications to examine the firms' hedging activities. The results from Fama and MacBeth (1973) specifications are reported in Table A11 in the appendices. Table A13 reports the results from between specifications. The first thing to notice is that the results from both types of specifications are qualitatively similar to the earlier OLS results.

After accounting for the effect of swaps, both types of specifications suggest that firms are hedging when selecting their interest rate exposure. The coefficient on the sensitivity of the firms' cash flows to interest rate are positive and significant at better than 5%. Firms with cash flows that are positively correlated with interest rates generate more cash when interest rates increase and vice versa. By having floating interest payments on their debt, these firms can match the interest rate exposure of their debt to the sensitivity of their cash flows, thereby reducing the cash flow volatility. This hedging effect, however, has a modest economic magnitude. A one-standard-deviation increase in the interest rate sensitivity of cash flows increases the final floating-rate debt by 5 x 0.7% = 3.5%, or approximately 6% of the average floating-rate debt usage. Also, we find that firms that engage in more interest rate swap contracts, and those with higher leverage ratios, use less floating-rate debt. These firms might find interest rate risk associated with fixed-rate debt relatively less costly, these results could be consistent with hedging motivations. Consistent with the earlier OLS results, we find a negative association between debt maturity and the selection of floating interest rate exposure.

As in the previous section, we repeat the analysis conducted above using two sample periods, i.e. 1999-2006 and 2007-2015, to examine the effect of the 2007 financial crisis on the firms' interest rate exposure. The results from Fama and MacBeth (1973) specifications are presented in Table 12. Table A14 in the appendices reports the results from between specifications. As can be seen from these tables, the results from both types of specifications are qualitatively similar to the earlier OLS results. We find more evidence of hedging after the financial crisis. Firms with cash flows that are positively correlated with interest rates have more floating-rate debt than those with cash flows that are either negatively correlated or uncorrelated. Firms that use more interest rate swaps are less likely to have a floating interest rate exposure and those with more debt have less floating-rate debt. All these results again suggest that firms became more cautious in the post-crisis period.

Firms may be hedging as it is costly to raise external finance for investments. If that is the case, then those with higher investment expenditures should have greater incentive to match the interest rate exposure of their cash flows to that of their liabilities. We test this hypothesis by interacting capital expenditures (CAPEX) and R&D expenditures, both scaled by assets, with the interest rate sensitivity of cash flows in the between regressions. The results are reported in columns 2-3 of Table A15 in the appendices. We do not find that firms with higher capital expenditures engage in greater matching, but the coefficient on the interaction term with R&D expenditures is significant at 10% level. Firms that engage in more R&D appear to be matching the interest rate exposures of their cash flows and liabilities. The R&D variable by itself remains significantly negative, consistent with firms that have more investment activities considering floating-debt more expensive than fixed-rate debt regardless of their interest rate sensitivity. Similarly, if firms are matching the interest rate exposure of their cash flows to that of their liabilities to reduce financial distress costs, we should see that firms with higher leverage ratios have more matching. Column 4 of Table A15 provides the results of interacting leverage with the interest rate sensitivity of cash flows. We do not find that highly leveraged firms engage in greater matching, but these firms continue to use less floating-rate debt.

C. **Time-Series Variation**

Time-series variation in floating-rate debt usage is interpreted as capturing firms' speculative activities. The results of fixed effects specifications are reported in Table A16. Note that because the correlation between interest rates and cash flows for an

individual firm is estimated for the whole sample period, cash flow beta is constant and absorbed by the fixed effects. Consistent with the earlier OLS results and in contrast to the results from prior research, the deviations from average floating-rate debt percentages are negatively correlated with the average term spread. Floating-rate debt usage decreases by up to 1.4% when the spread between 3-month Treasury bill and 10-year Treasury bond rates increases by 1%. Given the average floating-rate debt share of 55.9%, this corresponds to 2.5% less floating-rate debt. These results suggest that, despite the different between long- and short-term rates, firms do not use more floating-rate debt when the yield curve is steep. This finding is inconsistent with firms timing the market. Other results from within specifications are qualitatively similar to the earlier OLS results and those from between specifications.

As in the previous section, we also repeat the analysis conducted above using two sample periods, i.e. 1999-2006 and 2007-2015, to examine the effect of the 2007 financial crisis on the firms' interest rate exposure. The results are presented in Table 12. As can be seen from this table, we find a negative association between term spread and floating-rate debt. When the yield curve is steep, firms with a fixed interest rate exposure will have to pay higher interest costs than those that select a floating exposure, at least in the short term. Given the cost advantage, firms however do not tend to have a floating interest rate exposure. These results suggest that firms became more cautious after the financial crisis, consistent with the earlier OLS results.

D. **Floating-rate Debt by Currency**

As shown in the summary statistics, we attempt to record both the interest rate and currency profile of the firm's debt and find that the level of floating-rate debt by currency is quite similar. This suggests that there might be some attempt to match the interest rate profile of debt across currencies. This might be because a firm's fixed/floating debt mix target is similar across currencies.[5] In Table A18-Table A20 in the appendices, we repeat the earlier OLS analysis using the final floating-rate share of UK debt, US debt and EU debt respectively as the dependent variables. As robustness checks, we use the seemingly unrelated regressions (SUR) model, proposed by Arnold Zellner (1962) in Table 13-Table 15. This is a generalization of a linear regression model that consists of several regression equations, each having its own dependent variable and potentially different sets of exogenous explanatory variables. The model

[5] Examples of qualitative disclosures of fixed-rate debt by currency sourced from annual reports are presented in the appendices.

can be estimated equation-by-equation using standard OLS. Such estimates are consistent; however, they are generally not as efficient as the SUR method, which amounts to feasible generalized least squares with a specific form of the variance-covariance matrix.

Consistent with the results for the total floating percentage, Table 13 shows that firms that engage in more R&D and those with more long-term debt have less UK floating-rate debt. More importantly, we find that firms with more UK debt as a percentage of their total debt are less likely to choose a floating exposure on their UK debt. Firms with more US or EU floating-rate debt have more UK floating-rate debt. The interest rate exposure of the firm's cash flows, however, does not predict whether it chooses a final floating or fixed exposure on its UK debt. When examining the effect of the financial crisis on the level of UK floating-rate debt, we find that, after the crisis, credit rating became more relevant. This might be because firms issue more bonds.

When US floating-debt is used as the dependent variable in Table 14, we find significant evidence that firms are hedging. The estimated coefficient for cash flow beta is positive, indicating that firms are matching the interest rate exposure of their assets to that of their debts. Consistent with the results for the total floating percentage, the final interest rate exposure of US debt is not driven by the slope of the US yield curve. If firms are timing the market, the sign of the coefficient for term spread should be positive. Instead, the coefficients are negative and highly significant. In addition, credit spread remains as a strong determinant of the chosen interest rate exposure. Credit spread is significant for US floating-rate debt because US bond markets are a more important financing source for UK firms. Also, UK firms are more sensitive to changes in the US credit spread than the UK credit spread because UK debt tends to be bank debt rather than bond debt. Similar to the results of UK floating-rate debt, we find that firms with more US debt as a percentage of their total debt are less likely to choose a floating exposure on their US debt.

Consistent with previous results, Table 15 show that firms with more EU debt have lower levels of EU floating-rate debt. Firms that use interest rate swaps have significantly less EU floating-rate debt. There is, however, mixed evidence in support of the hedging theory. An explanation for the negative coefficient on cash flow beta could be because EU debt makes a small contribution to total debt.

Overall, the results suggest that firms are matching the interest rate profile of debt across currencies. Also, there are more alignments in debt structure between currencies after the financial crisis, as suggested by the higher coefficients in the post-crisis period.

E. **Size and Direction of Swap Usage**

Firms use interest rate swaps to modify the initial interest rate exposure of their debt. The final exposure of the firm's debt, after accounting for the effect of swaps, best reflects the implementation of its interest rate risk management programme. To explain the effects of swap usage on the final interest rate exposure of firms, we first look at those that use interest rate swaps at least once over the sample period only. Specifically, in Table 16, we repeat the OLS analysis conducted earlier using the swapped to floating variable as the dependent variable. Not surprisingly, firms that initially use more floating-rate debt are less likely to swap toward floating. Contrary to the results of Chernenko and Faulkender (2011), firms with positive exposure of cash flows to interest rates reduce their cash flow variability by swapping toward a floating-rate exposure. Conversely, those with negative interest rate exposure are more likely to swap toward fixed. We also find that firms do not swap more toward floating when the yield curve is steep. Firms with higher liquidity use more pay-floating interest rate swaps. This finding shows that cash holdings do not impact the level of floating-rate debt but impact changes in floating-rate debt. Otherwise, most of the baseline variables do not appear to be significant predictors of swap usage.

As described in the summary statistics, if a firm used any swaps during a fiscal year, we attempt to determine the directions of swaps outstanding at the fiscal year end. In Table 17, we repeat the OLS analysis conducted previously using the swap direction variables instead of the interest rate swap dummy. The results show that firms that swap toward floating initially have less floating-rate debt as compared to those that do not use swaps. Conversely, firms that use pay-fixed interest rate swaps have a higher initial floating rate exposure relative to firms that do not use interest rate swaps. We find a negative coefficient on the swap into both variable, consistent with firms that swap toward both floating and fixed initially using less floating-rate debt as compared with swap non-users. After the effects of swaps, firms that swap to a floating-rate exposure are no less likely to have floating-rate debt than those that do not use swaps. Firms that swap to a fixed-rate exposure and those that swap to both, by contrast, have significantly less floating-rate debt. We note that the coefficients for these variables now become somewhat similar. These results suggest that regardless of the direction of

swaps that firms undertake, there is a convergence in the interest rate profiles of firms' debt.

As robustness checks, we compare firms that swap toward floating and those that swap toward fixed or both directions. The results show that firms that swap to a fixed-rate exposure and those that swap toward both fixed and floating initially have more floating-rate debt as compared to those that swap to a floating-rate exposure. After the effects of swaps, firms that use pay-fixed interest rate swaps are no more likely to have floating-rate debt than those that swap toward floating. Firms that swap to both directions now have significantly less floating-rate debt. Again, these results show that firms are getting closer to their desired interest rate exposure, regardless of the direction of swaps.

F. **Conclusion**

This essay looks at how firms decide on the fixed versus floating mix of debt. We begin with multivariate regression analysis without distinguishing between cross-sectional and time-series variations. Our results suggest that firms are hedging when selecting the interest rate exposure of their debt. The average firm in our sample is matching the interest rate exposure of its cash flows to that of its liabilities, as predicted by hedging theories. There are changes in firms' risk preferences before and after the 2007 financial crisis. Our results suggest that firms became more cautious after the financial crisis. Assuming that the optimal hedge ratio remains constant over time and deviations from this ratio are driven by speculation, we use the Fama and MacBeth (1973) specifications and between specifications to examine the firms' hedging activities and the fixed effects specifications for capturing firms' speculative activities. The results of all these specifications are consistent with the earlier OLS results.

We further examine the choice of floating-rate debt at the currency level and find that firms are matching the interest rate profile of debt across currencies. Firms with more US or EU floating-rate debt have more UK floating-rate debt. Also, firms with more UK debt as a percentage of their total debt are less likely to choose a floating exposure on their UK debt. The same applies for US and EU floating-rate debt.

As firms use interest rate swaps to modify the interest rate exposure of their debts, we attempt to explain the effects of swap usage on the final interest rate exposure of firms. We first look at those that use interest rate swaps at least once over the sample period and find that firms that initially use more floating-rate debt are less likely to swap toward floating. If a firm used any swaps during a fiscal year, we attempt to

determine the directions of swaps outstanding at the fiscal year end. We then use the swap direction variables as explanatory variables. The evidence shows that there is a convergence in the interest rate profiles of firms' debt. Firms are getting closer to their desired interest rate exposure, regardless of the direction of swaps that firms undertake.

As firms were both hedging and timing the market prior to the crisis, this leads to the question of why corporate treasury employees engage in this type of behavior. It is possible that incentive contracts for managers place great emphasis on current performance, or that managers are reaching retirement age. In that case, by "actively managing" the interest rate exposure of their debts, firms can reduce their interest expense at least in the short term and as a result, report higher earnings. Alternatively, some managers believe that trends in interest rate development are predictable and rely on the forecasts in the selection of fixed- and floating-rate funding. It is, however, questionable whether such behaviors increase shareholder value. These results are also timely given changes in the regulation of financial derivative instruments. Because firms use financial derivatives for both hedging and speculative purposes, any regulatory changes should continue to allow firms to use derivatives for managing risk but not make it too easy for them to disguise speculative transactions as hedging transactions.

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Table 1: Empirical Evidence Relating to the Fixed versus Floating Mix of Debt (in chronological order)

This table presents a summary of empirical studies on the fixed versus floating mix of debt. It provides the source of data and description of the data sample.

Author(s) of Study	Date	Source of Data	Type of Firm	Sample	Country
Hakkarainen, Kasanen & Puttonen	1997	Survey (1994)		84 firms	Finland
Brobst & Huang	2002	10-Ks	Non-financial	55 companies	US
Faulkender	2005	SDC Platinum, DealScan & 10-Ks (1994-1999) (EDGAR)	Chemistry	275 debt issuances 133 firms	US
Servaes & Tufano	2006	Survey (1995)		334 companies	global
Chava & Purnanandam	2007	10-Ks (1996-1997 & 1999-2000)	Non-financial	1,849 firms (1996-1997) 202 firms (1999-2000)	US
Rokkanen	2007	Dealogic database (1999-2006)	Non-financial	1,327 bond-issues 418 firms	EMU
Vickery	2008	Survey (1987,1993,1998 & 1997-2004)	Small and medium-size	3,248 loans	US
Antoniou, Zhao & Zhou	2009	SDC Platinum (1986-2004)	Non-financial, public	742 debt issues 217 firms	UK
Barry, Mann, Mihov & Rodríguez	2009	Thompson Financial's SDC New Issues database (1970-2006) & DealScan (1987-2003)	Non-financial	17,249 public debt issues 13,415 private debt issues 5,325 144A issues 59,710 loans	US
Chernenko & Faulkender	2011	10-Ks (1993-2003) (EDGAR)	Non-financial	11,261 firm-years	US
Oberoi	2018	10-Ks (1990-2000) (EDGAR & Lexis-Nexis)	Non-financial	82 firms	US

Table 2: Summary of Dependent Variables and Econometric Methodology in Previous Empirical Studies

This table presents a summary of dependent variables and econometric methodology in recent empirical studies. It provides the variable type and description and whether the measurement of the variable controls for the impact of derivatives and the firm's total debt.

Author(s) of Study	Date	Type	Description	Control for interest rate derivatives	Type of debt	Methodology
Faulkender	2005	binary	A dummy equal to 1 if the final exposure of the debt funds is floating	Yes	incremental	probit
Chava & Purnanandam	2007	continuous	Net floating-to-total debt ratio	Yes	total	OLS
Rokkanen	2007	binary	A dummy equal to 1 if debt is issued as floating rate	No	incremental	probit
Vickery	2008	binary/ continuous	A dummy equal to 1 if the firm's most recent loan is a fixed-rate loan Fixed-rate loans share	No	incremental	probit/OLS
Antoniou, Zhao & Zhou	2009	binary	A dummy equal to 1 if the yield type of the debt is floating	No	incremental	probit
Barry, Mann, Mihov & Rodríguez	2009	binary	A dummy equal to 1 if debt is issued as fixed rate or floating rate	No	incremental	logit
Chernenko & Faulkender	2011	continuous	Final floating-rate debt	Yes	total	OLS, Fama-Macbeth (1973), between, fixed effects
Oberoi	2018	continuous	Net fixed rate debt/ total debt	Yes	total	beta regression

Table 3: Variable Definitions and Summary of Hypotheses

This table presents the explanatory variables for the analysis of fixed/floating debt mix. It provides the definitions of the variables and the signs of the estimated coefficients as predicted by each hypothesis.

Explanatory variable	Variable description	Hypothesis			
		Hedging	Market conditions	Firm controls	Loan controls
Interest rate swaps	A dummy variable equal to 1 if the firm use interest rate swaps during the fiscal year and 0 otherwise	-			
Cash flow beta	The estimated exposure of the corresponding firm's cash flow to LIBOR	+			
Short-term stock return beta	The estimated exposure of the corresponding firm's stock return to short-term interest rates	+			
Long-term stock return beta	The estimated exposure of the corresponding firm's stock return to long-term interest rates	+			
CAPEX/Assets (%)	Capital expenditures scaled by book assets	-			
R&D/Assets (%)	R&D expenditures scaled by book assets	-			
Book leverage	Total debt divided by total assets	-			
Term spread (%)	The difference between the 10-year Treasury bond and 3-month Treasury bill rates		+		
Credit spread (%)	The difference in yield between BBB- and AAA-rated debt		+		
Size	Natural logarithm of assets			±	
Return on assets (ROA)	EBITDA divided by total assets			±	
Current ratio	Current assets to current liabilities			±	
Credit rating	A dummy variable equal to 1 if the firm has credit rating				-
Bank debt (%)	The percentage of bank debt to total debt				+
Bond debt (%)	The percentage of bond debt to total debt				-
Long-term debt (%)	The percentage of long-term debt to total debt				-

Table 4: Frequency Distribution of Derivative Usage by UK Firms 1999-2015

This table reports frequency distribution of derivative usage by UK non-financial firms. The data is hand-collected from annual reports over the 1999-2015 period. IR, FC and CP derivatives are interest rate, foreign currency and commodity derivatives, respectively.

Derivative Categories	Frequency	Percentage
Panel A: Derivative Users and Non-users		
Derivative Users	5,306	82.44
Non-users	1,130	17.56
Total	6,436	100.00
Panel B: Types of Derivatives		
IR Derivatives	4,299	66.80
FC Derivatives Only	877	13.63
FC & CP Derivatives	88	1.37
CP Derivatives Only	42	0.65
Non-users of Derivatives	1,130	17.56
Total	6,436	100.00
Panel C: IR Derivative Users		
Disclose Types of IR Derivatives	4,071	94.70
Do not Disclose Types of IR Derivatives	228	5.30
Total	4,299	100.00
Panel D: Types of IR Derivatives[6]		
IR Swaps	3,887	95.48
IR Forwards Only	119	2.92
IR Forwards & Options	10	0.25
IR Options Only	55	1.35
Total	4,071	100.00
Panel E: IR Swap Direction		
Swap into floating	503	12.94
Swap into fixed	1,277	32.85
Swap into both	402	10.34
Cannot determine direction	1,705	43.86
Total	3,887	100.00

[6] As a percentage of interest rate derivative users that disclose type of interest rate derivatives

Table 5: Floating-Rate Debt and Swap Usage by UK Firms 1999-2015

This table provides summary statistics for floating-rate debt and interest rate swap usage by UK non-financial firms. The sample period is 1999-2015. Floating-rate debt (pre-swap) and floating-rate debt (net of swap) are the percentages of outstanding debt that is floating before and after accounting for the effect of swaps, respectively. Swapped to floating is the net percentage of debt that is swapped to a floating interest rate exposure. Absolute swapped to floating is the amount of interest rate swaps outstanding at the fiscal year end as a percentage of the total debt. Swap users are defined as firms that use interest rate swaps at least once during the sample period.

Variable	Obs	Mean	Median	Std. Dev.	Min	Max
Panel A: Full Sample						
Floating-rate debt (pre-swap) (%)	2,767	56.63	67.42	41.64	0.00	100.00
Floating-rate debt (net of swap) (%)	5,190	55.85	54.96	35.77	0.00	100.00
Panel B: Subsample of Firms with Available Data on Floating-rate Debt both Pre- and Net of Swap						
Floating-rate debt (pre-swap) (%)	2,427	57.74	70.62	41.31	0.00	100.00
Swapped to floating (%)	2,427	-0.67	0.00	39.28	-100.00	100.00
|Swapped to floating (%) |	2,427	24.19	7.86	30.96	0.00	100.00
Floating-rate debt (net of swap) (%)	2,427	57.07	56.74	38.01	0.00	100.00
Panel C: Subsample of Swap Users						
Floating-rate debt (pre-swap) (%)	2,147	55.95	62.45	40.91	0.00	100.00
Swapped to floating (%)	2,147	-0.50	0.00	40.87	-100.00	100.00
|Swapped to floating (%) |	2,147	26.35	11.67	31.24	0.00	100.00
Floating-rate debt (net of swap) (%)	2,147	55.45	53.31	36.95	0.00	100.00
Panel D: Floating-rate Debt by Currency						
UK floating-rate debt	3,571	57.73	60.15	39.22	0.00	100.00
US floating-rate debt	2,104	56.69	59.90	40.11	0.00	100.00
EU floating-rate debt	1,798	60.90	77.65	41.05	0.00	100.00
Other floating-rate debt	1,861	70.97	96.99	38.07	0.00	100.00

Table 6: Summary Statistics in Previous Empirical Studies

This table reports summary statistics for interest rate swap usage and fixed/floating-rate debt percentages in previous empirical studies. All the numbers are in percentages. The medians are in parentheses.

Author(s) of Study	Date	Interest rate swap users (%)	Fixed-rate debt				Floating-rate debt			
			Pre-swap		Net of swap		Pre-swap		Net of swap	
			As a % of total debt issues	As a % of total debt	As a % of total debt issues	As a % of total debt	As a % of total debt issues	As a % of total debt	As a % of total debt issues	As a % of total debt
Faulkender	2005	10.9% of total debt issues					34.2		31.6	
Chava & Purnanandam	2007							58.0 (61.0)		57.0 (58.0)
Rokkanen	2007		60.9				39.1			
Vickery	2008		52.0							
Antoniou, Zhao & Zhou	2009		67.0				33.0			
Barry, Mann, Mihov & Rodríguez	2009						5.9			
Chernenko & Faulkender	2011	26.6% of total firm-years						41.6 (33.3)		38.3 (30.8)
Bretscher	2018	63.0% of all firms						37.4		35.8
Ippolito	2018							38.3		
Oberoi	2018									

Table 7: Descriptive Statistics of Explanatory Variables

This table reports summary statistics for variables that are used to explain variation in floating-rate debt. The sample period is 1999-2015. Cash flow and stock return betas are the interest rate sensitivities of free cash flow and stock returns, respectively. Betas are estimated using at least 5 observations. Book leverage is total debt divided by total assets. Term spread is the difference between the 10-year Treasury bond and 3-month Treasury bill rates. Credit spread is the difference in yield between BBB- and AAA-rated debt. Size is the natural logarithm of assets. Return on assets (ROA) is EBITDA divided by total assets. Current ratio is current assets to current liabilities. Credit rating is a dummy variable equal to 1 if the firm has a credit rating.

Variable	Obs	Mean	Median	Std. Dev.	Min	Max
Cash flow beta	5,009	-0.530	-0.165	4.985	-93.370	36.273
Short-term stock return beta	5,172	0.098	0.019	0.855	-7.031	32.920
Long-term stock return beta	5,172	0.003	0.000	0.389	-3.552	5.129
CAPEX/Assets (%)	4,845	5.030	3.542	5.676	0.004	96.929
R&D/Assets (%)	5,036	1.606	0.000	5.330	0.000	87.780
Book leverage	4,816	0.254	0.235	0.186	0.000	3.883
Term spread (%)	5,190	0.838	0.929	1.468	-1.379	3.666
Credit spread (%)	5,190	1.296	1.226	0.680	0.655	3.376
Size	5,040	6.732	6.603	1.737	0.220	12.175
Return on assets	4,946	5.062	5.101	6.635	-94.919	40.635
Current ratio	5,016	1.597	1.250	2.126	0.055	85.305
Credit rating	5,182	0.164	0.000	0.371	0.000	1.000
Bank debt (%)	3,407	64.253	85.947	38.736	0.000	100.000
Bond debt (%)	3,407	25.343	0.000	34.809	0.000	100.000
Long-term debt (%)	4,357	77.470	85.965	24.399	0.014	100.000

Table 8: Test of Difference in Means and Medians between Interest Rate Swap Users and Non-users

This table presents the results of t test on the equality of means and Wilcoxon rank-sum test on the equality of medians between interest rate swap users and non-users. Swap users are defined as firms that use interest rate swaps during the fiscal year. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

Variable	Interest rate swap non-users			Interest rate swap users			Difference	
	Mean	Median	Obs	Mean	Median	Obs	Mean	Median
Cash flow beta	-1.076	-0.165	1,393	-0.297	-0.137	3,397	-0.779***	-1.236
Short-term stock return beta	0.110	0.012	1,408	0.100	0.023	3,545	0.01	-1.244
Long-term stock return beta	0.000	0.000	1,408	0.002	0.000	3,545	-0.003	-0.105
CAPEX/Assets (%)	4.562	3.049	1,356	5.214	3.810	3,270	-0.651***	-4.696***
R&D/Assets (%)	2.611	0.000	1,398	1.157	0.000	3,416	1.454***	7.152***
Book leverage	0.198	0.153	1,324	0.283	0.266	3,272	-0.084***	-19.248***
Term spread (%)	1.033	1.203	1,420	0.668	0.559	3,548	0.365***	7.874***
Credit spread (%)	1.409	1.226	1,420	1.242	1.226	3,548	0.166***	9.63***
Size	6.002	5.953	1,400	7.108	7.008	3,418	-1.106***	-19.976***
Return on assets	4.946	5.426	1,371	5.132	4.946	3,357	-0.186	2.356**
Current ratio	1.922	1.395	1,395	1.429	1.184	3,399	0.493***	10.756***
Credit rating	0.067	0.000	1,420	0.210	0.000	3,540	-0.144***	-12.183***
Bank debt (%)	73.835	96.409	1,024	58.498	70.672	2,206	15.337***	12.753***
Bond debt (%)	14.669	0.000	1,024	31.233	7.124	2,206	-16.564***	-13.467***
Long-term debt (%)	74.335	86.453	1,082	78.716	85.835	3,091	-4.381***	-0.063

Table 9: OLS Regressions of Initial and Final Floating-rate Debt 1999-2015

This table reports the results of OLS regressions of initial and final floating-rate debt defined as the percentage of outstanding debt that is floating before and after accounting for the effect of interest rate swaps, respectively. The sample period is 1999-2015. Standard errors are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Initial						Final					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Interest rate swaps	1.301	1.094	-1.638	-1.758	-1.579	-1.753	-5.290**	-5.218**	-7.380***	-6.925**	-9.313***	-8.998***
	(2.699)	(2.714)	(2.518)	(2.537)	(2.519)	(2.532)	(2.374)	(2.374)	(2.786)	(2.809)	(2.465)	(2.505)
Cash flow beta	0.308		0.345		0.289		0.332		0.789***		0.901***	
	(0.478)		(0.359)		(0.356)		(0.337)		(0.160)		(0.144)	
Short-term stock return beta		0.923		2.233		2.254		0.935*		0.750		1.342
		(1.561)		(1.726)		(1.399)		(0.544)		(1.333)		(1.221)
Long-term stock return beta		1.117		2.688		2.704		2.349		2.250		1.997
		(2.726)		(2.349)		(2.359)		(1.437)		(1.885)		(1.905)
CAPEX/Assets (%)	0.020	0.032	-0.168	-0.156	-0.534*	-0.525*	-0.136	-0.148	-0.090	-0.101	-0.291	-0.310
	(0.360)	(0.360)	(0.318)	(0.318)	(0.317)	(0.317)	(0.150)	(0.148)	(0.216)	(0.220)	(0.205)	(0.206)
R&D/Assets (%)	-1.084**	-1.079**	-0.608*	-0.615*	-0.713*	-0.715*	-0.630**	-0.618**	-0.360	-0.369	-0.475**	-0.478**
	(0.459)	(0.454)	(0.325)	(0.326)	(0.379)	(0.374)	(0.272)	(0.273)	(0.237)	(0.248)	(0.205)	(0.211)
Book leverage	-15.494**	-15.879**	-0.236	-1.232	9.389	8.734	-12.732**	-12.686**	-6.729	-7.988	-1.402	-1.862
	(6.469)	(6.325)	(6.251)	(6.179)	(6.035)	(6.006)	(5.755)	(5.733)	(6.822)	(6.952)	(5.736)	(6.221)
Term spread (%)	-0.692	-0.829	-0.003	-0.152	-0.001	-0.130	-1.315**	-1.445***	-1.199*	-1.427**	-1.015*	-1.249**
	(0.670)	(0.669)	(0.594)	(0.590)	(0.609)	(0.604)	(0.533)	(0.527)	(0.614)	(0.615)	(0.615)	(0.616)
Credit spread (%)	3.284***	3.229***	2.585***	2.588***	0.861	0.905	2.460***	2.364***	1.649*	1.506*	1.042	0.899
	(0.977)	(0.968)	(0.943)	(0.948)	(0.960)	(0.955)	(0.787)	(0.784)	(0.853)	(0.854)	(0.832)	(0.833)
Size	-9.788***	-9.565***	-4.433***	-4.267***	-2.559**	-2.449**	-3.040***	-2.781***	-0.820	-0.406	-0.640	-0.171
	(1.257)	(1.262)	(1.271)	(1.244)	(1.228)	(1.196)	(0.732)	(0.738)	(0.917)	(0.919)	(0.870)	(0.880)

ROA	0.254	0.222	0.033	0.006	0.092	0.079	0.084	0.084	0.168	0.094	0.092	0.014
	(0.289)	(0.296)	(0.245)	(0.245)	(0.208)	(0.213)	(0.162)	(0.163)	(0.214)	(0.220)	(0.180)	(0.187)
Current ratio	-1.449	-1.517	-1.835	-1.875	-2.425*	-2.448*	0.601	0.511	0.968	1.226	0.279	0.477
	(1.659)	(1.667)	(1.373)	(1.338)	(1.274)	(1.256)	(1.230)	(1.238)	(1.381)	(1.397)	(0.973)	(0.997)
Credit rating	-23.807***	-23.694***					-6.514**	-6.943***				
	(4.261)	(4.207)					(2.728)	(2.682)				
Bank debt (%)			0.587***	0.584***					0.231***	0.235***		
			(0.046)	(0.046)					(0.035)	(0.035)		
Bond debt (%)					-0.654***	-0.652***					-0.303***	-0.313***
					(0.045)	(0.045)					(0.037)	(0.038)
Long-term debt (%)	0.076	0.079	0.057	0.059			-0.146***	-0.145***	-0.158***	-0.166***		
	(0.052)	(0.053)	(0.052)	(0.052)			(0.038)	(0.038)	(0.047)	(0.046)		
Constant	85.872***	113.901***	30.109**	34.653***	87.761***	88.850***	77.002***	87.751***	51.409***	50.689***	71.720***	67.547***
	(19.624)	(14.828)	(13.690)	(11.674)	(10.715)	(8.492)	(7.724)	(9.530)	(10.549)	(9.051)	(9.202)	(9.181)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	No	No	No	No	No	No	No	No	No	No
Observations	2139	2158	1889	1903	2153	2167	3859	3934	2743	2760	3049	3065
Adjusted R_2	0.263	0.266	0.433	0.433	0.384	0.387	0.100	0.099	0.150	0.141	0.157	0.147

Table 10: OLS Regressions of Initial and Final Floating-rate Debt (Pre-Crisis)

This table reports the results of OLS regressions of initial and final floating-rate debt defined as the percentage of outstanding debt that is floating before and after accounting for the effect of interest rate swaps, respectively. The sample period is 1999-2006. Standard errors are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Initial						Final					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Interest rate swaps	2.142	1.794	0.281	0.131	1.019	1.251	0.033	0.131	-2.636	-2.343	-5.422*	-4.925
	(4.264)	(4.262)	(3.932)	(3.943)	(3.711)	(3.717)	(2.736)	(2.726)	(3.234)	(3.251)	(2.987)	(2.997)
Cash flow beta	-1.075**		-0.700		-0.873*		0.179		-0.065		0.327	
	(0.460)		(0.524)		(0.515)		(0.281)		(0.500)		(0.392)	
Short-term stock return beta		1.093		1.743		1.976		1.016*		0.888		1.437
		(1.783)		(1.843)		(1.550)		(0.528)		(1.440)		(1.315)
Long-term stock return beta		2.903		3.464		4.917*		3.551**		2.817		2.821
		(3.716)		(2.899)		(2.831)		(1.632)		(2.158)		(2.194)
CAPEX/Assets (%)	-0.600	-0.488	-0.755	-0.680	-1.402***	-1.319***	-0.117	-0.141	-0.105	-0.093	-0.270	-0.300
	(0.559)	(0.571)	(0.490)	(0.502)	(0.473)	(0.489)	(0.120)	(0.116)	(0.186)	(0.177)	(0.195)	(0.183)
R&D/Assets (%)	-0.531*	-0.627*	-0.190	-0.257	-0.393	-0.476	-0.332	-0.313	-0.023	-0.054	-0.151	-0.152
	(0.279)	(0.327)	(0.234)	(0.253)	(0.267)	(0.299)	(0.265)	(0.260)	(0.391)	(0.381)	(0.301)	(0.298)
Book leverage	0.444	4.028	8.531	9.602	9.844	6.017	-7.665	-7.668	-2.164	-1.976	3.533	3.544
	(12.385)	(12.160)	(9.872)	(9.830)	(7.539)	(8.050)	(6.649)	(6.559)	(8.313)	(8.344)	(6.593)	(6.745)
Term spread (%)	1.295	1.199	3.689**	3.398*	3.118*	2.861	0.903	0.987	-0.229	-0.239	-0.031	-0.050
	(1.838)	(1.834)	(1.802)	(1.808)	(1.819)	(1.803)	(0.743)	(0.734)	(1.167)	(1.161)	(1.185)	(1.178)
Credit spread (%)	9.697	8.119	10.552*	8.134	14.731**	12.517**	2.558	1.478	3.038	2.354	2.647	1.820
	(6.278)	(6.460)	(5.745)	(5.954)	(5.680)	(5.719)	(2.300)	(2.300)	(3.576)	(3.696)	(3.449)	(3.595)
Size	-10.293***	-10.125***	-3.285*	-3.087*	-3.761**	-3.427*	-3.010***	-2.778***	-1.226	-1.119	-2.030**	-1.867*
	(1.796)	(1.852)	(1.676)	(1.730)	(1.749)	(1.768)	(0.850)	(0.842)	(1.028)	(1.028)	(0.995)	(0.992)

ROA	0.846**	0.806**	0.258	0.147	0.307	0.343	0.123	0.137	0.336	0.273	0.288	0.269
	(0.342)	(0.323)	(0.269)	(0.290)	(0.213)	(0.218)	(0.171)	(0.168)	(0.249)	(0.242)	(0.199)	(0.198)
Current ratio	-0.782	-0.625	-0.493	-0.442	-1.643	-1.521	-0.828	-1.162	1.349	1.183	1.135	1.111
	(2.112)	(2.130)	(1.612)	(1.582)	(1.903)	(1.914)	(1.111)	(1.104)	(1.474)	(1.475)	(0.878)	(0.904)
Credit rating	-21.667***	-22.414***					-1.686	-2.323				
	(5.705)	(5.704)					(2.971)	(2.907)				
Bank debt (%)			0.604***	0.610***					0.172***	0.171***		
			(0.057)	(0.056)					(0.039)	(0.039)		
Bond debt (%)					-0.576***	-0.587***					-0.160***	-0.164***
					(0.064)	(0.063)					(0.043)	(0.043)
Long-term debt (%)	0.012	0.017	-0.011	-0.007			-0.103**	-0.101**	-0.112**	-0.112**		
	(0.077)	(0.077)	(0.072)	(0.072)			(0.041)	(0.040)	(0.048)	(0.048)		
Constant	118.900***	112.538***	18.962	21.942	67.037***	81.998***	73.900***	78.281***	53.463***	57.845***	73.743***	79.462***
	(22.293)	(18.043)	(19.783)	(20.320)	(18.113)	(17.711)	(10.526)	(9.847)	(15.756)	(16.753)	(14.897)	(12.259)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	No	No	No	No	No	No	No	No	No	No
Observations	660	666	595	601	686	692	1928	1986	1147	1156	1294	1303
Adjusted R_2	0.209	0.204	0.383	0.384	0.326	0.329	0.062	0.062	0.074	0.070	0.064	0.063

Table 11: OLS Regressions of Initial and Final Floating-rate Debt (Crisis and Post-Crisis)

This table reports the results of OLS regressions of initial and final floating-rate debt defined as the percentage of outstanding debt that is floating before and after accounting for the effect of interest rate swaps, respectively. The sample period is 2007-2015. Standard errors are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Initial						Final					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Interest rate swaps	1.473	1.105	-2.401	-2.622	-3.067	-3.349	-8.526***	-8.510**	-10.602***	-10.436***	-12.778***	-12.704***
	(3.369)	(3.384)	(3.090)	(3.124)	(3.098)	(3.121)	(3.281)	(3.289)	(3.614)	(3.678)	(3.343)	(3.406)
Cash flow beta	0.543		0.515		0.474		0.363		0.972***		0.989***	
	(0.426)		(0.334)		(0.315)		(0.402)		(0.148)		(0.147)	
Short-term stock return beta		-1.442		0.813		-0.970		-1.792		0.435		0.547
		(3.442)		(4.465)		(2.733)		(3.065)		(3.358)		(2.833)
Long-term stock return beta		-3.447		0.825		-0.806		-0.621		1.649		-0.020
		(3.671)		(3.644)		(3.339)		(3.528)		(4.110)		(3.901)
CAPEX/Assets (%)	0.097	0.123	-0.097	-0.055	-0.335	-0.311	-0.276	-0.247	-0.313	-0.243	-0.453	-0.394
	(0.387)	(0.386)	(0.346)	(0.349)	(0.335)	(0.335)	(0.331)	(0.336)	(0.332)	(0.340)	(0.296)	(0.305)
R&D/Assets (%)	-1.319*	-1.322*	-0.874	-0.886	-0.792	-0.817	-1.086*	-1.073*	-0.814	-0.832	-0.933*	-0.985*
	(0.749)	(0.748)	(0.699)	(0.709)	(0.641)	(0.643)	(0.602)	(0.601)	(0.574)	(0.578)	(0.563)	(0.575)
Book leverage	-19.290***	-20.542***	-3.394	-5.155	14.386*	13.428*	-17.204*	-17.758*	-7.153	-10.039	-1.925	-4.702
	(6.745)	(6.648)	(7.431)	(7.423)	(7.858)	(7.692)	(9.182)	(9.289)	(9.862)	(10.186)	(8.823)	(9.127)
Term spread (%)	-1.743***	-1.859***	-1.119*	-1.214**	-0.761	-0.900	-1.854***	-1.966***	-0.895	-1.073*	-0.540	-0.729
	(0.643)	(0.650)	(0.606)	(0.597)	(0.583)	(0.578)	(0.577)	(0.574)	(0.618)	(0.616)	(0.591)	(0.591)
Credit spread (%)	1.535	1.453	0.854	1.023	-0.674	-0.639	2.707***	2.728***	2.293**	2.442**	1.823*	1.924*
	(1.059)	(1.075)	(1.087)	(1.122)	(1.099)	(1.108)	(0.939)	(0.953)	(1.008)	(1.011)	(0.999)	(0.994)
Size	-10.335***	-9.599***	-5.267***	-4.793***	-1.997	-1.705	-3.126***	-2.658**	-0.517	0.281	0.351	1.157
	(1.459)	(1.475)	(1.552)	(1.495)	(1.449)	(1.376)	(1.064)	(1.075)	(1.263)	(1.258)	(1.212)	(1.196)

ROA	-0.127	-0.156	0.002	-0.079	-0.053	-0.145	0.135	0.131	0.284	0.125	0.126	-0.033
	(0.378)	(0.401)	(0.332)	(0.341)	(0.302)	(0.309)	(0.311)	(0.318)	(0.310)	(0.322)	(0.271)	(0.279)
Current ratio	-1.323	-1.740	-2.858	-2.746	-3.488**	-3.290**	2.270	2.041	0.968	1.278	-0.608	-0.281
	(2.130)	(2.105)	(1.872)	(1.759)	(1.591)	(1.561)	(1.882)	(1.857)	(1.834)	(1.786)	(1.558)	(1.558)
Credit rating	-24.352***	-24.432***					-10.356***	-10.696***				
	(4.862)	(4.783)					(3.827)	(3.808)				
Bank debt (%)			0.576***	0.574***					0.273***	0.277***		
			(0.057)	(0.056)					(0.051)	(0.051)		
Bond debt (%)					-0.701***	-0.696***					-0.390***	-0.399***
					(0.055)	(0.053)					(0.052)	(0.052)
Long-term debt (%)	0.096	0.100	0.079	0.082			-0.187***	-0.187***	-0.189***	-0.198***		
	(0.069)	(0.069)	(0.062)	(0.063)			(0.061)	(0.060)	(0.067)	(0.067)		
Constant	128.200***	100.823***	31.687**	48.478**	96.878***	93.470***	102.692***	81.511***	19.645	28.851**	67.336***	59.979***
	(18.108)	(24.443)	(15.806)	(20.332)	(10.511)	(9.692)	(12.303)	(12.513)	(16.071)	(13.170)	(12.911)	(13.032)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	No	No	No	No	No	No	No	No	No	No
Observations	1479	1492	1294	1302	1467	1475	1931	1948	1596	1604	1755	1762
Adjusted R_2	0.309	0.303	0.468	0.463	0.430	0.427	0.151	0.151	0.205	0.192	0.234	0.222

Table 12: Fama-Macbeth (1973) and Fixed-effects Regressions of Final Floating-rate Debt (Pre- & Post-Crisis)

This table reports the results of Fama-Macbeth (1973) and fixed-effects regressions of final floating-rate debt defined as the percentage of outstanding debt that is floating after accounting for the effect of interest rate swaps. The sample periods are 1999-2006 and 2007-2015. Standard errors are adjusted for clustering by firm in fixed-effects regressions. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Fama-Macbeth (1973)				Fixed-effects	
	1999-2006		2007-2015		1999-2006	2007-2015
	(1)	(2)	(3)	(4)	(5)	(6)
Interest rate swaps	2.072	3.450	-8.952**	-9.114**	-2.784	-7.527*
	(2.754)	(3.135)	(2.996)	(2.952)	(2.962)	(3.916)
Cash flow beta	0.532		0.873***			
	(0.410)		(0.223)			
Short-term stock return beta		0.607		-2.453		
		(0.822)		(11.011)		
Long-term stock return beta		4.978***		5.279		
		(1.451)		(5.080)		
CAPEX/Assets (%)	0.234	0.170	-0.015	-0.020	-0.144	-0.304
	(0.178)	(0.173)	(0.149)	(0.187)	(0.153)	(0.299)
R&D/Assets (%)	-0.392	-0.452	-1.286***	-1.264***	0.791**	-0.520
	(0.310)	(0.301)	(0.254)	(0.277)	(0.340)	(0.546)
Book leverage	-8.858*	-10.768**	-23.024**	-24.160***	6.445	-3.025
	(4.575)	(4.047)	(7.809)	(7.341)	(8.608)	(9.985)
Term spread (%)					-0.148	-1.353**
					(0.736)	(0.531)

Credit spread (%)					3.464	2.088***
					(2.389)	(0.804)
Size	-3.927***	-3.798***	-2.665***	-2.195***	1.558	3.118
	(0.538)	(0.546)	(0.369)	(0.300)	(2.581)	(3.640)
ROA	0.111	0.154	0.236*	0.284**	-0.406*	-0.285
	(0.173)	(0.145)	(0.125)	(0.109)	(0.242)	(0.263)
Current ratio	0.401	0.202	1.982	2.312*	-1.147	-0.093
	(1.815)	(1.924)	(1.246)	(1.133)	(1.749)	(0.931)
Credit rating	-0.295	-0.976	-10.270***	-11.269***	-2.872	-22.436***
	(2.792)	(2.867)	(1.649)	(1.698)	(4.618)	(7.009)
Long-term debt (%)	-0.119***	-0.118***	-0.167***	-0.172***	-0.111**	-0.117**
	(0.032)	(0.027)	(0.031)	(0.030)	(0.048)	(0.046)
Constant	90.392***	89.548***	98.697***	94.655***	54.483***	53.565*
	(6.773)	(6.389)	(5.527)	(4.637)	(17.555)	(27.370)
Industry FE	No	No	No	No	No	No
Year FE	No	No	No	No	No	No
Observations	1928	1986	1931	1948	1988	1952
Adjusted R_2					0.013	0.046

Table 13: Seemingly Unrelated Regressions of Final UK Floating-rate Debt

This table reports the results of seemingly unrelated regressions of final UK floating-rate debt defined as the percentage of UK debt that is floating after accounting for the effect of interest rate swaps. Standard errors are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	1999-2015		1999-2006		2007-2015	
	(1)	(2)	(3)	(4)	(5)	(6)
UK debt (%)	-0.259***	-0.247***	-0.142**	-0.145**	-0.329***	-0.327***
	(0.044)	(0.044)	(0.061)	(0.059)	(0.062)	(0.061)
US floating-rate debt (%)	0.118***	0.100***	0.071	0.042	0.143***	0.153***
	(0.035)	(0.034)	(0.048)	(0.046)	(0.048)	(0.048)
EU floating-rate debt (%)	0.344***	0.352***	0.194***	0.208***	0.492***	0.487***
	(0.033)	(0.032)	(0.043)	(0.042)	(0.047)	(0.046)
Interest rate swaps	-2.036	-2.607	0.666	-0.856	0.367	1.278
	(3.238)	(3.210)	(4.881)	(4.810)	(4.214)	(4.205)
Cash flow beta	-1.300		-2.293*		0.209	
	(0.943)		(1.211)		(1.480)	
Short-term stock return beta		-1.155		0.377		-14.212**
		(1.842)		(1.970)		(7.013)
Long-term stock return beta		3.829		6.132*		-9.286
		(3.100)		(3.625)		(6.317)
CAPEX/Assets (%)	-0.261	-0.129	-0.746*	-0.505	0.107	-0.084
	(0.348)	(0.337)	(0.452)	(0.438)	(0.538)	(0.522)
R&D/Assets (%)	-1.988***	-1.960***	-2.234***	-2.197***	-2.045***	-1.942***
	(0.487)	(0.482)	(0.723)	(0.719)	(0.638)	(0.629)

Book leverage	0.096	4.955	14.678	18.136	-9.218	-10.341
	(7.926)	(7.596)	(11.889)	(11.713)	(11.252)	(10.064)
Term spread (%)	-1.161	-1.112	-4.424**	-3.849**	1.350	1.051
	(0.948)	(0.938)	(1.869)	(1.846)	(1.123)	(1.150)
Credit spread (%)	1.643	1.690	5.943	4.704	0.211	-1.111
	(1.630)	(1.626)	(5.205)	(5.158)	(1.932)	(2.031)
Size	-1.172	-0.963	-1.115	-0.642	-2.489	-2.681*
	(1.074)	(1.060)	(1.458)	(1.429)	(1.533)	(1.517)
ROA	0.342	0.235	0.381	0.208	0.636	0.625
	(0.291)	(0.284)	(0.373)	(0.357)	(0.457)	(0.454)
Current ratio	0.624	0.797	1.068	1.270	0.613	0.052
	(2.037)	(2.026)	(2.888)	(2.870)	(2.584)	(2.585)
Credit rating	-3.024	-3.500	5.894	4.755	-18.596***	-19.070***
	(3.619)	(3.575)	(4.672)	(4.594)	(5.447)	(5.424)
Long-term debt (%)	-0.101*	-0.103*	-0.113	-0.111	-0.096	-0.092
	(0.055)	(0.055)	(0.071)	(0.070)	(0.080)	(0.080)
Constant	51.160***	47.419***	39.006**	36.358**	71.484***	76.027***
	(13.575)	(13.318)	(18.356)	(18.053)	(19.752)	(19.301)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	No	No	No	No
Observations	889	901	573	585	316	316
R_2	0.213	0.212	0.144	0.143	0.483	0.490

Table 14: Seemingly Unrelated Regressions of Final US Floating-rate Debt

This table reports the results of seemingly unrelated regressions of final US floating-rate debt defined as the percentage of US debt that is floating after accounting for the effect of interest rate swaps. Standard errors are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	1999-2015		1999-2006		2007-2015	
	(1)	(2)	(3)	(4)	(5)	(6)
US debt (%)	-0.155***	-0.128***	-0.173***	-0.159***	-0.232***	-0.213***
	(0.043)	(0.043)	(0.053)	(0.053)	(0.075)	(0.073)
UK floating-rate debt (%)	0.114***	0.099***	0.047	0.027	0.244***	0.257***
	(0.031)	(0.032)	(0.037)	(0.038)	(0.059)	(0.060)
EU floating-rate debt (%)	0.577***	0.587***	0.461***	0.487***	0.618***	0.611***
	(0.028)	(0.029)	(0.035)	(0.036)	(0.051)	(0.051)
Interest rate swaps	5.038*	6.434**	-5.182	-4.427	9.720**	9.473**
	(3.061)	(3.098)	(4.318)	(4.391)	(4.745)	(4.769)
Cash flow beta	5.529***		5.964***		3.245*	
	(0.887)		(1.048)		(1.692)	
Short-term stock return beta		-2.819		-2.432		9.131
		(1.788)		(1.810)		(8.041)
Long-term stock return beta		-1.551		-1.865		6.166
		(3.015)		(3.281)		(7.060)
CAPEX/Assets (%)	-0.084	-0.539*	0.252	-0.202	-0.442	-0.621
	(0.329)	(0.325)	(0.396)	(0.395)	(0.596)	(0.585)
R&D/Assets (%)	0.151	-0.207	0.589	0.646	-0.665	-0.937
	(0.468)	(0.472)	(0.642)	(0.659)	(0.723)	(0.715)

Book leverage	5.018	-8.399	1.114	-4.172	-1.619	-11.772
	(7.525)	(7.372)	(10.543)	(10.708)	(12.516)	(11.436)
Term spread US (%)	-2.799**	-2.728**	-0.721	-0.523	-6.530***	-6.345***
	(1.115)	(1.133)	(1.485)	(1.525)	(2.055)	(2.192)
Credit spread US (%)	6.966**	6.502*	-1.013	0.183	9.444**	10.267**
	(3.370)	(3.438)	(8.399)	(8.769)	(4.221)	(4.258)
Size	-1.517	-2.282**	-0.211	-1.226	-1.900	-2.044
	(1.019)	(1.025)	(1.312)	(1.324)	(1.657)	(1.658)
ROA	0.379	0.472*	0.044	0.322	0.494	0.398
	(0.279)	(0.278)	(0.329)	(0.325)	(0.509)	(0.509)
Current ratio	0.666	-0.628	1.944	0.795	-0.728	-1.017
	(1.948)	(1.975)	(2.554)	(2.618)	(2.916)	(2.934)
Credit rating	6.297*	7.746**	3.576	5.405	14.768**	16.721***
	(3.449)	(3.474)	(4.140)	(4.190)	(6.232)	(6.278)
Long-term debt (%)	-0.007	0.001	0.007	0.004	-0.019	-0.010
	(0.052)	(0.053)	(0.063)	(0.064)	(0.091)	(0.091)
Constant	20.087	33.046***	26.456	36.276**	27.206	30.956
	(12.356)	(12.331)	(16.652)	(16.775)	(20.037)	(19.896)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	No	No	No	No
Observations	889	901	573	585	316	316
R_2	0.213	0.212	0.144	0.143	0.483	0.490

Table 15: Seemingly Unrelated Regressions of Final EU Floating-rate Debt

This table reports the results of seemingly unrelated regressions of final EU floating-rate debt defined as the percentage of EU debt that is floating after accounting for the effect of interest rate swaps. Standard errors are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	1999-2015		1999-2006		2007-2015	
	(1)	(2)	(3)	(4)	(5)	(6)
EU debt (%)	-0.221***	-0.198***	-0.226***	-0.207***	-0.312***	-0.289***
	(0.052)	(0.052)	(0.073)	(0.072)	(0.078)	(0.077)
UK floating-rate debt (%)	0.316***	0.328***	0.169***	0.185***	0.504***	0.500***
	(0.031)	(0.031)	(0.040)	(0.039)	(0.049)	(0.050)
US floating-rate debt (%)	0.617***	0.609***	0.545***	0.542***	0.556***	0.549***
	(0.030)	(0.030)	(0.042)	(0.040)	(0.044)	(0.045)
Interest rate swaps	-7.253**	-7.994***	-2.689	-1.993	-9.579**	-10.190**
	(3.102)	(3.091)	(4.748)	(4.696)	(4.325)	(4.356)
Cash flow beta	-4.003***		-3.928***		-3.081**	
	(0.919)		(1.165)		(1.545)	
Short-term stock return beta		3.991**		3.927**		2.746
		(1.808)		(1.890)		(7.286)
Long-term stock return beta		1.258		2.699		3.724
		(3.051)		(3.486)		(6.627)
CAPEX/Assets (%)	-0.227	0.113	-0.829*	-0.478	0.222	0.532
	(0.339)	(0.330)	(0.435)	(0.422)	(0.556)	(0.549)
R&D/Assets (%)	0.649	0.935*	-0.903	-0.926	1.831***	2.000***
	(0.482)	(0.478)	(0.699)	(0.697)	(0.662)	(0.658)

Book leverage	5.015	13.323*	-2.794	-1.879	20.658*	31.361***
	(7.754)	(7.465)	(11.481)	(11.329)	(11.516)	(10.367)
Term spread EU (%)	0.414	0.659	-0.366	-0.423	0.887	1.100
	(1.284)	(1.290)	(3.172)	(3.138)	(1.355)	(1.420)
Credit spread EU (%)	0.971	1.176	-0.631	-1.547	1.348	1.795
	(1.506)	(1.511)	(3.862)	(3.863)	(1.618)	(1.705)
Size	-0.231	0.380	-1.037	-0.139	2.309	2.499
	(1.029)	(1.023)	(1.408)	(1.387)	(1.568)	(1.575)
ROA	-0.517*	-0.458	-0.308	-0.306	-0.974**	-0.849*
	(0.285)	(0.280)	(0.359)	(0.343)	(0.481)	(0.480)
Current ratio	-0.108	0.772	1.450	2.219	-0.048	0.452
	(1.977)	(1.978)	(2.754)	(2.745)	(2.641)	(2.666)
Credit rating	-5.463	-6.616*	-4.283	-5.555	-0.730	-2.323
	(3.533)	(3.506)	(4.506)	(4.436)	(5.752)	(5.796)
Long-term debt (%)	-0.019	-0.023	-0.062	-0.053	0.022	0.011
	(0.054)	(0.054)	(0.068)	(0.068)	(0.083)	(0.084)
Constant	18.944	7.805	51.900***	40.560**	-31.354*	-38.407**
	(12.797)	(12.677)	(17.742)	(17.555)	(18.680)	(18.637)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	No	No	No	No
Observations	889	901	573	585	316	316
R_2	0.213	0.212	0.144	0.143	0.483	0.490

Table 16: OLS Regressions of Size of Swap Usage 1999-2015

This table provides the results of the size of swap usage estimated using the sample of swap users. Swap usage is the net percentage of debt that is swapped to a floating interest rate exposure. Swap users are firms that use interest rate swaps at least once during the 1999-2015 sample period. Standard errors in parentheses are adjusted for clustering by firm. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

	1999-2015		1999-2006		2007-2015	
	(1)	(2)	(3)	(4)	(5)	(6)
Initial floating-rate debt (pre-swap) (%)	-0.649***	-0.649***	-0.737***	-0.738***	-0.601***	-0.598***
	(0.041)	(0.042)	(0.048)	(0.049)	(0.053)	(0.052)
Cash flow beta	0.898***		0.363		0.997***	
	(0.250)		(0.603)		(0.254)	
Short-term stock return beta		-0.389		0.792		0.271
		(1.553)		(1.811)		(3.225)
Long-term stock return beta		2.307		4.917		1.470
		(2.040)		(2.996)		(3.510)
CAPEX/Assets (%)	-0.158	-0.148	0.048	0.048	-0.212	-0.182
	(0.310)	(0.317)	(0.383)	(0.384)	(0.361)	(0.368)
R&D/Assets (%)	-0.219	-0.219	-0.194	-0.204	-0.212	-0.223
	(0.212)	(0.228)	(0.387)	(0.391)	(0.466)	(0.477)
Book leverage	-11.180	-13.456*	-3.333	-3.743	-11.433	-15.038
	(7.899)	(7.846)	(9.694)	(9.690)	(9.943)	(10.111)
Term spread (%)	-1.618**	-1.795***	-3.427*	-3.485*	-1.202*	-1.270*
	(0.687)	(0.686)	(1.802)	(1.826)	(0.692)	(0.691)

Credit spread (%)	0.864	0.668	-8.152	-11.144*	1.475	1.624
	(1.022)	(1.017)	(5.609)	(5.819)	(1.189)	(1.194)
Size	-1.234	-0.850	-2.412	-2.328	-0.747	-0.100
	(1.058)	(1.066)	(1.495)	(1.515)	(1.237)	(1.223)
ROA	0.116	0.067	0.308	0.222	0.115	0.141
	(0.230)	(0.235)	(0.310)	(0.314)	(0.317)	(0.322)
Current ratio	2.934**	3.186**	1.316	1.340	4.041**	4.166**
	(1.327)	(1.376)	(1.723)	(1.736)	(1.647)	(1.664)
Credit rating	-0.888	-1.037	-2.861	-3.356	0.675	0.622
	(3.583)	(3.520)	(5.052)	(5.001)	(3.997)	(3.909)
Long-term debt (%)	-0.162***	-0.169***	-0.080	-0.081	-0.220***	-0.223***
	(0.054)	(0.053)	(0.069)	(0.069)	(0.069)	(0.068)
Constant	63.721***	32.204***	52.346**	53.906***	59.316***	20.950
	(14.120)	(9.819)	(23.820)	(18.226)	(17.613)	(13.945)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	No	No	No	No
Observations	1839	1860	584	589	1255	1271
Adjusted R_2	0.405	0.397	0.443	0.441	0.386	0.377

Table 17: OLS Regressions of Floating-rate Debt and Direction of Swap Usage 1999-2015

This table provides the results of the direction of swap usage in comparison with firms that swapped toward floating and firms that do not use interest rate swaps during the fiscal year. The dependent variables are initial and final floating-rate debt. The sample period is 1999-2015. Standard errors in parentheses are adjusted for clustering by firm. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

	Compared to firms that swapped toward floating		Compared to firms that do not use interest rate swaps	
	Initial floating-rate debt (pre-swap) (%)	Final floating-rate debt (net of swaps) (%)	Initial floating-rate debt (pre-swap) (%)	Final floating-rate debt (net of swaps) (%)
Swap into floating			-19.162***	-0.732
			(4.856)	(3.606)
Swap into fixed	29.535***	-4.284	10.194***	-6.528**
	(4.533)	(3.405)	(3.337)	(2.856)
Swap into both	9.627**	-6.640**	-12.549***	-8.115***
	(4.351)	(3.170)	(4.732)	(3.088)
Cannot determine swap direction	16.831***	-4.689	-1.359	-4.828**
	(4.724)	(2.922)	(3.215)	(2.419)
Cash flow beta	-0.387	0.339	0.306	0.334
	(0.252)	(0.235)	(0.429)	(0.333)
CAPEX/Assets (%)	-0.147	-0.113	-0.076	-0.137
	(0.399)	(0.132)	(0.355)	(0.151)
R&D/Assets (%)	-0.818**	0.054	-1.011**	-0.644**
	(0.344)	(0.310)	(0.439)	(0.275)
Book leverage	-18.166**	-5.313	-20.099***	-11.519**
	(7.083)	(6.583)	(6.122)	(5.774)

Term spread (%)	-2.354***	-2.320***	-1.261*	-1.219**
	(0.695)	(0.584)	(0.647)	(0.537)
Credit spread (%)	2.119*	2.282**	2.647***	2.484***
	(1.186)	(0.933)	(0.958)	(0.778)
Size	-9.135***	-3.562***	-7.996***	-3.221***
	(1.281)	(0.772)	(1.279)	(0.765)
ROA	0.380	0.067	0.246	0.073
	(0.346)	(0.176)	(0.268)	(0.162)
Current ratio	-2.248	0.303	-1.536	0.561
	(2.022)	(1.090)	(1.626)	(1.236)
Credit rating	-12.847***	-2.839	-17.822***	-7.335***
	(3.991)	(2.783)	(4.048)	(2.675)
Long-term debt (%)	0.043	-0.203***	0.071	-0.147***
	(0.054)	(0.039)	(0.052)	(0.039)
Constant	93.588***	97.802***	81.388***	77.309***
	(19.064)	(11.093)	(18.848)	(7.949)
Industry FE	Yes	Yes	Yes	Yes
Year FE	No	No	No	No
Observations	1367	2833	2139	3859
Adjusted R_2	0.403	0.109	0.300	0.102

Figure 1: Proportion of Floating-Rate Debt by Industry

This figure presents the frequency distribution of floating-rate debt percentage before and after accounting for the effect of interest rate swaps across industry sectors. The sample period is 1999-2015.

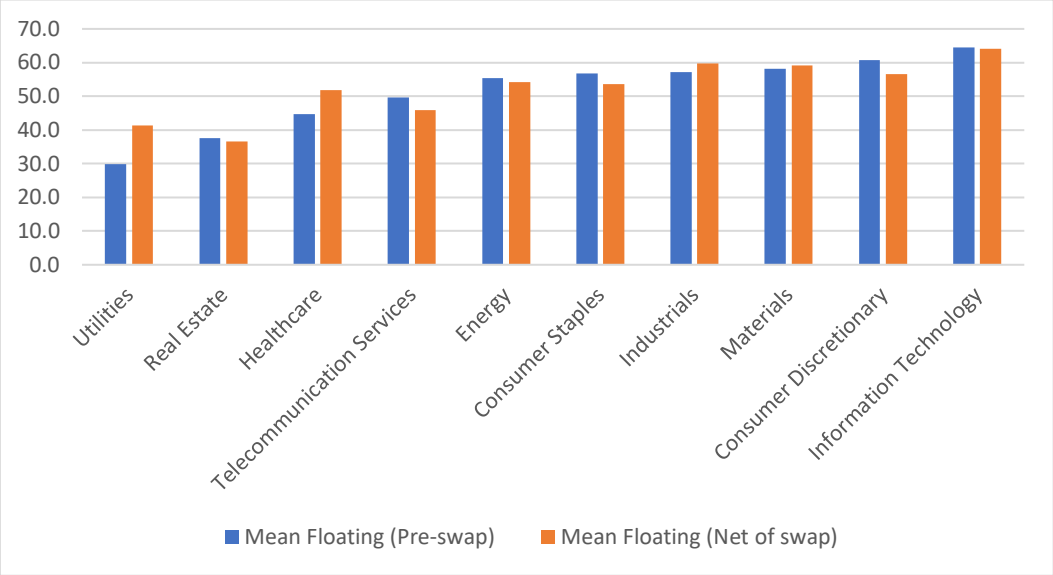
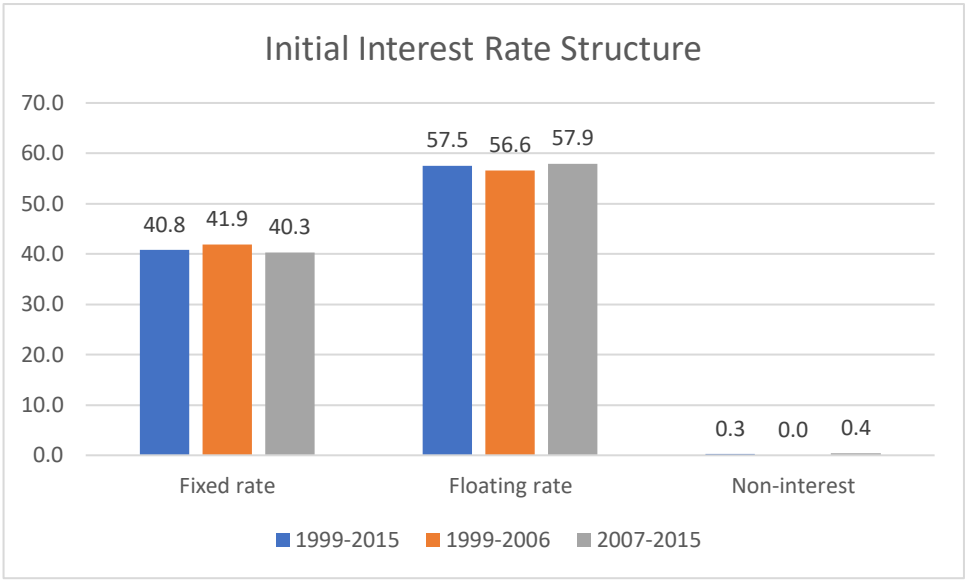


Figure 2: Mean Percentage of Initial and Final Fixed-Rate, Floating-Rate and Non-interest Debt (Pre-Swap and Net of Swap)

These figures present the percentages of fixed-rate, floating-rate and non-interest debt before and after accounting for the effect of interest rate swaps for the average firm-year. The sample period is 1999-2015.



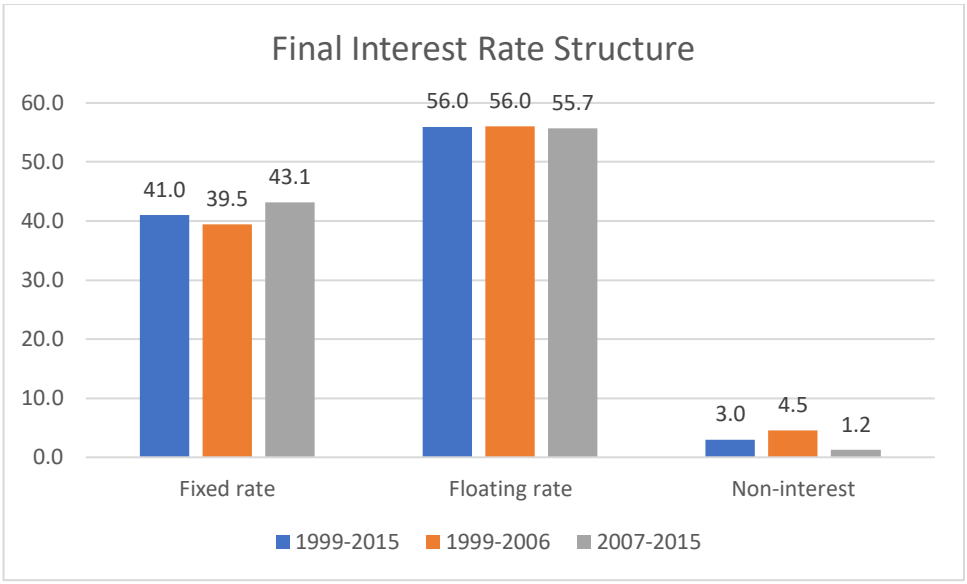


Figure 3: 3-month Treasury Bill Rate, 10-year Treasury Bond Rate and Term Spread 1999-2015

This figure displays the movement in the annual average 3-month Treasury bill rate and 10-year Treasury bond rate over the 1999-2015 period. The average term spread for each year is defined as the 10-year Treasury bond rate minus the 3-month Treasury bill rate.

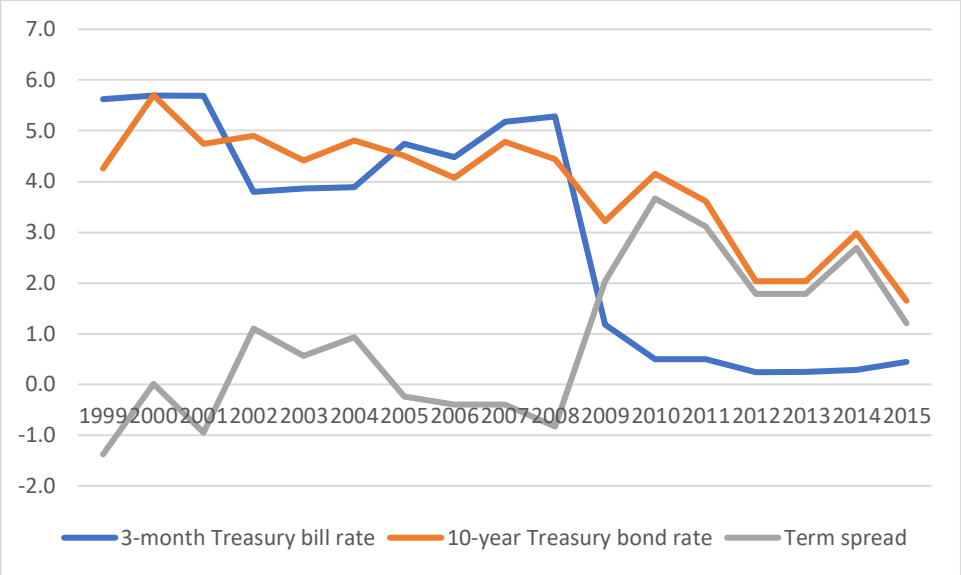
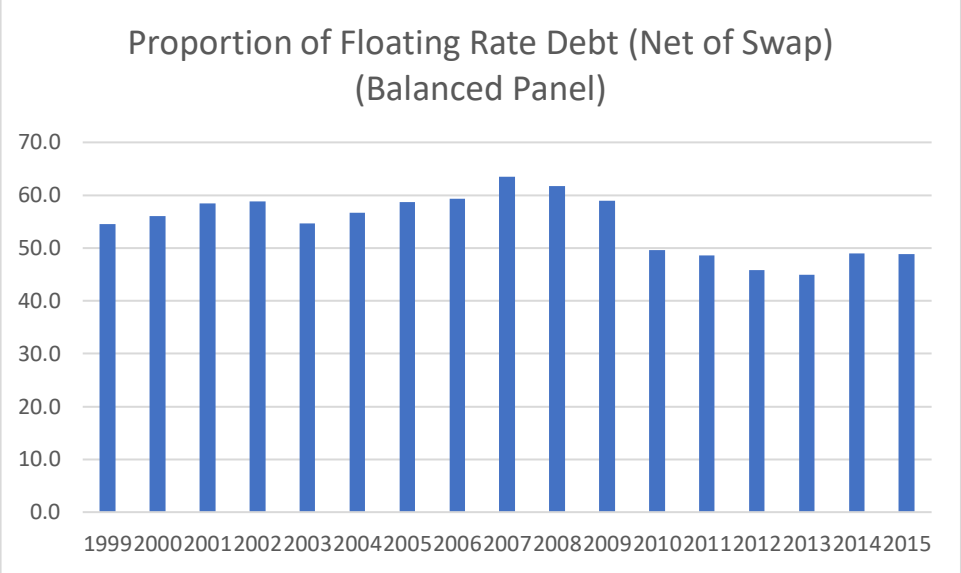


Figure 4: Proportion of Floating-Rate Debt (Net of Swap) (Balanced Panel)

This figure displays the patterns of the firms' choice of final interest rate exposure for a subsample of firms that exist in all 17 years over the 1999-2015 sample period.



Internet Appendix to "The interest rate structure of UK firm's debt: Hedging or market timing?"

This internet appendix contains additional information on the data and more robustness checks. Appendix 1 and 2 provides examples of corporate risk management disclosures sourced from annual reports. Appendix 3 presents additional robustness checks for our analysis.

Internet Appendix 1: Data

This section details how data on floating-rate debt and interest rate swaps were hand-collected and coded. To measure the amount of floating-rate debt, we study discussions about interest rate risk usually found in the "Financial risk management" or "Financial instruments" notes to the financial statements. We get the most precise estimates for those firms that include a table reporting the amount of debt broken down by interest rate exposure. A sample table, taken from BT Group plc's (2015) annual report, is shown in Table A1.

Table A1: BT GROUP PLC'S DISCLOSURE OF INTEREST RATE AND FOREIGN EXCHANGE RISK MANAGEMENT

This table reflects the currency and interest rate profile of loans and borrowings after the impact of hedging. The floating rate loans and borrowings bear interest rates fixed in advance for periods ranging from one day to one year, primarily by reference to LIBOR and EURIBOR quoted rates.

	2015			2014		
At 31 March	Fixed rate interest £m	Floating rate interest £m	Total £m	Fixed rate interest £m	Floating rate interest £m	Total £m
Sterling	7,601	991	8,592	7,946	1,265	9,211
Euro	–	482	482	–	285	285
Total	**7,601**	**1,473**	**9,074**	**7,946**	**1,550**	**9,496**
Ratio of fixed to floating	84%	16%	100%	84%	16%	100%
Weighted average effective fixed interest rate – Sterling	6.3%			6.6%		

Source: BT Group plc's (2015) Annual Report, p.187

When there is no table like the above one, classification of floating-rate debt requires examination of individual debt instruments reported in the "Borrowings" or "Sources of finance" notes to the financial statements. Another example, taken from Centrica plc's (2015) annual report and accounts, is shown in Table A2.

Table A2: CENTRICA PLC'S DISCLOSURE OF BORROWINGS

This table summarizes and classifies borrowings as either fixed or floating. €50 millions of zero-coupon notes have an accrual yield of 4.200%, which will result in a €114 million repayment on maturity.

31 December	Coupon rate %	Principal m	Current £m	Non-current £m	2015 Total £m	Current £m	Non-current £m	2014 Total £m
Bank overdrafts and loans [f]			–	(222)	(222)	(427)	(312)	(739)
Bonds (by maturity date):								
31 March 2015	Floating	$70	–	–	–	(45)	–	(45)
10 September 2015	0.320	¥30,000	–	–	–	(161)	–	(161)
11 September 2015	Floating	£51	–	–	–	(51)	–	(51)
12 September 2015	Floating	€100	–	–	–	(78)	–	(78)
24 October 2016	5.500	£300	(308)	–	(308)	–	(316)	(316)
14 April 2017	Floating	$200	–	(136)	(136)	–	(128)	(128)
19 September 2018	7.000	£400	–	(433)	(433)	–	(444)	(444)
1 February 2019	3.213	€100	–	(74)	(74)	–	(78)	(78)
25 September 2020	Floating	$80	–	(54)	(54)	–	(51)	(51)
22 February 2022	3.680	HK$450	–	(39)	(39)	–	(37)	(37)
10 March 2022	6.375	£500	–	(523)	(523)	–	(528)	(528)
16 October 2023	4.000	$750	–	(525)	(525)	–	(494)	(494)
4 September 2026	6.400	£200	–	(222)	(222)	–	(225)	(225)
16 April 2027	5.900	$70	–	(47)	(47)	–	(45)	(45)
13 March 2029	4.375	£750	–	(739)	(739)	–	(741)	(741)
5 January 2032 [g]	Zero	€50	–	(38)	(38)	–	(41)	(41)
19 September 2033	7.000	£770	–	(763)	(763)	–	(762)	(762)
16 October 2043	5.375	$600	–	(401)	(401)	–	(379)	(379)
12 September 2044	4.250	£550	–	(537)	(537)	–	(536)	(536)
25 September 2045	5.250	$50	–	(33)	(33)	–	(32)	(32)
10 April 2075 [h]	5.250	£450	–	(450)	(450)	–	–	–
10 April 2076 [h]	3.000	€750	–	(550)	(550)	–	–	–
			(308)	(5,564)	(5,872)	(335)	(4,837)	(5,172)

Source: Centrica plc's (2015) Annual Report and Accounts, p.133

To collect data on interest rate swaps, we search the entire notes to the financial statements for any mention of the following keywords: "swap', "risk management", "hedg" or "derivative". If a reference is found, we read the surrounding text to determine whether the firm entered into any interest rate swap during the fiscal year and collect data on the swap position if any. We attempt to obtain data on both the notional amount and direction of swaps outstanding, i.e. whether the firm pays or receives floating rate in its swap transaction and the contract amount. Most firms explicitly disclose if interest rate swaps were used to manage exposures. However, only a few reports the direction or notional amount of swaps. As the dependent variable is the percentage of outstanding debt that has a floating interest rate exposure after accounting for the effect of swaps, we only record debt-related interest rate swaps effective at the fiscal year end and exclude i) swaps for hedging non-debt items, e.g. investments, preference share, operating leases, etc., and ii) forward-starting swaps. Some firms report combined currency interest rate swaps, most of which do not alter the nature of the debt's interest rate exposure and therefore are not included. Only those that change both currency and interest rate are recorded. Further quotes from annual

reports to illustrate how to identify the final interest rate exposure and interest rate swap are provided below.

SABMiller Annual Reports 2014, p.133 & 137

"As at 31 March 2014 42% (2013: 46%) of consolidated gross borrowings were in fixed rates taking into account interest rate swaps and forward rate agreements.

The group's policy is to borrow (directly or synthetically) in floating rates, reflecting the fact that floating rates are generally lower than fixed rates in the medium term... Exposure to movements in interest rates in group borrowings is managed through interest rate derivatives...

The group has entered into several interest rate swaps and cross currency interest rate swaps to pay floating and receive fixed interest which have been designated as fair value hedges to hedge exposure to changes in the fair value of its US dollar and euro fixed rate borrowings."

Intertek Annual Report 2010, p.113

"During the year, the Group increased its proportion of fixed rate debt, repaying its floating rate debt. On repayment of the floating rate debt, the interest rate swaps attached to the relevant tranche of debt became ineffective. Consequently, an amount of £1.9m (2009: £nil) was recycled to the income statement from the hedging reserve. The remaining swaps mature over the next year and have fixed swap rates ranging from 3.3% to 3.8%. At 31 December 2010, the Group had interest rate swaps with a notional contract amount of £64.6m (2009: £88.5m)."

Boots Group Plc Annual Report and Accounts 2004, p.25

"Gross debt comprises a mixture of fixed rate £182.9m (2003 £1.1m) and floating rate, with approximately 50% of the fixed rate debt with maturity greater than one year being converted into floating debt through the use of interest rate swaps."

Tesco Plc Annual Report 1999, p.5

"Derivatives, predominantly forward rate agreements and interest rate swaps and caps, are used to manage the mix of fixed and floating rate debt. The policy is to fix or cap between 30% and 70% of the interest cost on outstanding debt, although a higher

percentage may be fixed within a 12-month horizon. At the year end, after taking account of interest rate swaps, £649m (1998 – £614m) or 38% of our net debt was fixed at an average rate of 8.2% for a period of five years. A further £100m (1998 – £170m) or 6%, was covered by interest caps at an average rate of 8.3% for a period of three years."

Internet Appendix 2: Qualitative disclosures of fixed-rate debt by currency (Annual report and accounts 1999)

Compass Group Plc writes, "…Compass Group has effective borrowings in a number of currencies. The potential exposure to interest rate movements in each of these currencies has been reduced by swapping to, or borrowing at, fixed rates, such that 78% of the Group's debt is fixed for one year, reducing to 59% fixed for the second year and 39% fixed for the third year. This approach is adopted for each currency and it is anticipated that the policy will be consistently applied in future years, maintaining a broad 80%, 60% and 40% split over a three-year period.

As a result of the interest rate hedging policy described above, the Group is not materially exposed to short-term fluctuations in interest rates in any or all of its principal currencies." (p. 24)

BTP Plc writes, "…Interest is paid on borrowings and swaps, predominantly in US Dollar and Euro currencies and received on sterling cash deposits and swaps. To minimise the impact of changes in interest rates the Group fixes the rate of interest on a minimum of 40% of borrowings in each currency and on Sterling deposits." (p.29)

TI Group writes, "…Normally, at least one half of the borrowings in each major currency is hedged at fixed rates for the next 12 months, using long-dated drawings, forward rate agreements, interest rate swaps or collars. In 2000, some 75% of the annual interest cost is hedged in order to minimise the impact of further interest rate increases in some of the currency zones in which the Group trades. In US$ and sterling, which are the two most important currencies to the Group, interest rate hedging is over 85%." (p.26)

Imperial Tobacco writes, "…The group is exposed to fluctuations in interest rates on its borrowings and surplus cash and operates a policy designed to reduce this risk and maintain a cost-efficient balance of fixed and floating rate debt. This is achieved through its financing activities and the use of derivative financial instruments. At the

year-end approximately 80% of sterling gross debt and 41% of euro gross debt was fixed by way of interest rate derivatives." (p.33)

Internet Appendix 3: Additional robustness checks

To solve the endogeneity problem, we follow two papers published in the Journal of Financial Economics. In the first paper by Vickery (2008), endogeneity is a potential concern as lender and loan controls both reflect different features of the loan contract and are jointly determined with the interest rate component. Because no convincing instruments are available, two specifications are estimated, the first excludes almost all the potentially endogenous loan characteristics, and the second includes all these controls. Similarly, in their study, Chava and Purnanandam (2007) use leverage together with Z-score. As firms are likely to make debt mix choice and leverage decision simultaneously, to avoid equation bias, results from three models with different combinations of explanatory variables are presented, of which the first two exclude leverage. In subsequent analysis, Z-score is used as the key proxy for financial distress. Following the approach adopted by the above two papers, we exclude all the potentially endogenous loan characteristics, i.e. leverage, maturity structure and source of debt, and present the results in Table A10 as a robustness check. Although some coefficients are not statistically significant when the potential endogenous variables are included, the main results, as compared to Table 9 , are still robust.

Table A3: Summary of Variables and Hypotheses in Previous Empirical Studies

Variables	Hypotheses		Study
	Fixed	**Floating**	
Hedging			
Interest rate sensitivity			
The correlation between interest rates and cash flows (cash flow beta)		+	Faulkender (2005) Chava and Purnanandam (2007) Chernenko and Faulkender (2011)
The correlation between interest rates and industry output	-		Vickery (2008)
The sensitivity of stock prices to interest rate variability		+	Antoniou et al. (2009)
Financial distress			
R&D expenditures, advertising expenditures, capital expenditures			Faulkender (2005)
Altman Z-score		-	Chava and Purnanandam (2007)
Investment/Growth opportunities			
Market-to-book, R&D expenditures		-	Chava and Purnanandam (2007)
CAPEX and acquisition expenditures, R&D expenditures			Chernenko and Faulkender (2011)

Leverage	-		Faulkender (2005) Vickery (2008) Barry, Mann, Mihov & Rodríguez (2009) Chernenko and Faulkender (2011) Oberoi (2018)
Market conditions			
Yield spread			
Term spread		+	Faulkender (2005) Chava and Purnanandam (2007) Rokkanen (2007) Vickery (2008) Antoniou et al. (2009) Barry, Mann, Mihov & Rodríguez (2009) Chernenko and Faulkender (2011)
Credit spread			Faulkender (2005) Rokkanen (2007) Barry, Mann, Mihov & Rodríguez (2009) Chernenko and Faulkender (2011)
Swap spread			Chernenko and Faulkender (2011)
Level of interest rates			

Nominal interest rate (Treasury yield)		+	Faulkender (2005) Rokkanen (2007) Barry, Mann, Mihov & Rodríguez (2009)
Real interest rate			Vickery (2008) Antoniou et al. (2009)
Changes in current rates relative to past/future rates			Barry, Mann, Mihov & Rodríguez (2009)
State of the economy			
Expectations about future macroeconomic activity (index of leading indicators)		+	Faulkender (2005)
Uncertainty about future state of the economy (inflation, short-term interest rate volatility, the volatility of 10-year interest rate swaps)			Rokkanen (2007)
Inflation rate			Rokkanen (2007) Vickery (2008) Antoniou et al. (2009)
Market return			Barry, Mann, Mihov & Rodríguez (2009)
The economywide percentage of floating-rate debt			Chernenko and Faulkender (2011)
Conditions of the industry			
Industry strength (industrial production index)		+	Faulkender (2005)
Industry competitiveness (Herfindahl-index)			Chava and Purnanandam (2007)
Managerial incentive & Owner characteristics			
Manager's incentive to increase firm-risk (Vega)		+	Chava and Purnanandam (2007)

			Chernenko and Faulkender (2011)
Manager's incentive to decrease firm-risk (Delta)		-	Chava and Purnanandam (2007) Chernenko and Faulkender (2011)
Owner characteristics (a dummy for whether the owner is also the firm's primary manager, the primary owner's age, years of business experience and ownership share, a dummy for whether the firm is majority-owned by a single family, owner wealth)			Vickery (2008)
Firm controls			
Size			Faulkender (2005) Chava and Purnanandam (2007) Antoniou et al. (2009) Barry, Mann, Mihov & Rodríguez (2009) Chernenko and Faulkender (2011)
Financial constraint	+		Vickery (2008)
Size	-		
Age	-		
Strength of banking relationships (the number of financial institutions the firm uses, the length of the firm's relationship with its primary lender, a dummy equal to 1 if the most recent loan is not from the firm's primary lender)	-		
Cash flows relative to investment opportunities (return on assets, annual sales growth)	-		
Profitability			

Profit margin			Faulkender (2005) Oberoi (2018)
EBITDA to total assets, 3-year standard deviations of EBITDA			Barry, Mann, Mihov & Rodríguez (2009)
Liquidity (quick ratio)			Oberoi (2018)
Credit quality (Z-change)		+	Chava and Purnanandam (2007)
Capacity (a dummy for whether the firm had recently been solicited by financial institutions, the firm has only a single lending relationship, a dummy for whether the local bank Herfindahl Index is >1800: concentrated local banking market)			Vickery (2008)
Loan controls			
Source of debt /Lender type (rated debt; 2 dummies, respectively equal to 1 if the loan provider is a bank or a non-financial institution)	+		Chava and Purnanandam (2007) Rokkanen (2007) Vickery (2008) Chernenko and Faulkender (2011)
Lender characteristics			
The distance between the lender and the firm			Vickery (2008)
The main type of interaction between the lender and the firm (2 dummies, respectively equal to 1 if the type of interaction is face to face or telephone)			Vickery (2008)
Bank characteristics (size, liquidity)			Vickery (2008)
Loan size			Vickery (2008) Rokkanen (2007)
Loan maturity	+		Rokkanen (2007) Vickery (2008)

Loan default risk			
Collateral (a dummy for whether the loan is collateralized, 7 dummies for types of collateral pledged)			Vickery (2008)
Loan risk rating (default risk; dummies for each value of the rating, a dummy for whether the bank branch uses risk ratings, a dummy equal to 1 if the branch uses ratings for some loans but not the loan in question; a dummy equal to 1 for high rating debt)	-		Vickery (2008) Antoniou et al. (2009)

Table A4: Summary of Empirical Studies Investigating the Relationship Between Hedging and the Fixed versus Floating Mix of Debt

Author(s) of Study	Date	Multivariate Results	Variables Employed ("√" indicates used in study)									
			CFB	IOB	SPB	AZ	MB	RDE	AE	CE	CAE	L
Faulkender	2005	CFB (N); RDE (N); AE (10%); CE (N); L (N)	√					√	√	√		√
Chava & Purnanandam	2007	CFB (N); AZ (N); MB (10%); RDE (N)	√			√	√	√				
Vickery	2008	IOB (5%); L (1%)		√								√
Antoniou et al.	2009	SPB (N)			√							
Barry, Mann, Mihov & Rodríguez	2009	L (10%)										√
Chernenko & Faulkender	2011	CFB (1%); RDE (1%); CAE (10%); L (1%)	√					√			√	√
Oberoi	2018	L (1%)										√
Total			**3**	**1**	**1**	**1**	**1**	**3**	**1**	**1**	**1**	**5**

Key: CFB = Cash flow beta; IOB = Industry output beta; SPB = Stock price beta; AZ = Altman Z-score; MB = Market-to-book ratio; RDE = R&D expenditures; AE = advertising expenditures; CE = capital expenditures; CAE = CAPEX and acquisition expenditures; L = Leverage.

Table A5: Summary of Empirical Studies Investigating the Relationship Between Market Conditions and the Fixed versus Floating Mix of Debt

Author(s) of Study	Date	Multivariate Results	Variables Employed ("√" indicates used in study)														
			TS	CS	SS	NIR	RIR	CP	FC	LII	SIV	LSV	IFR	MR	EFP	IPI	HI
Faulkender	2005	TS (1%); CS (N); NIR (N); LII (5%); IPI (1%)	√	√		√				√						√	
Chava & Purnanandam	2007	TS (N); HI (N)	√														√
Rokkanen	2007	TS (1%); CS (N); NIR (1%); SIV (N); LSV (10%); IFR (N)	√	√		√					√	√	√				
Vickery	2008	TS (1%); RIR (1%); IFR (10%)	√				√						√				
Antoniou et al.	2009	TS (1%); RIR (5%); IFR (1%)	√				√						√				
Barry, Mann, Mihov & Rodríguez	2009	TS (5%); CS (5%); NIR (5%); CP (1%); FC (1%); MR (N)	√	√		√		√	√					√			
Chernenko & Faulkender	2011	TS (5%); CS (N); SS (5%); EFP (1%)	√	√	√										√		
Total			**7**	**4**	**1**	**3**	**2**	**1**	**1**	**1**	**1**	**1**	**3**	**1**	**1**	**1**	**1**

Other results: Hakkarainen, Kasanen & Puttonen (1997) find that the most frequent answer to how the decision between fixed- and floating-rate funding was made is that decisions are based on interest rate forecasts or interest rate view. Servaes and Tufano (2006) find that the two factors that receive the most support are a comparison of the current level of long-term interest rates to expectations and to the historical norm.

Key: TS = Term spread; CS = Credit spread; SS = Swap spread; NIR = Nominal interest rate; RIR = Real interest rate; CP = Changes in current rates relative to past rates; FC = Changes in future rates relative to current rates; LII = Index of leading indicators; SIV = Short-term interest rate volatility; LSV = The volatility of 10-year interest rate swaps; IFR = Inflation rate; MR = Market return; EFP = The economywide percentage of floating-rate debt; IPI = Industrial production index; HI = Herfindahl-index based on 3-digit SIC code (industry competitiveness).

Table A6: Summary of Empirical Studies Investigating the Relationship Between Managerial Incentive/Owner Characteristics and the Fixed versus Floating Mix of Debt

Author(s) of Study	Date	Multivariate Results	Variables Employed ("√" indicates used in study)		
			V	D	OW
Chava & Purnanandam	2007	V (1%); D (1%)	√	√	
Vickery	2008	OW (10%)			√
Chernenko & Faulkender	2011	V (N); D (1%)	√	√	
Total			**2**	**2**	**1**

Key: V = Vega; D = Delta; OW = Owner wealth.

Table A7: Summary of Empirical Studies Investigating the Relationship Between Firm Controls and the Fixed versus Floating Mix of Debt

Author(s) of Study	Date	Multivariate Results	Variables Employed ("√" indicates used in study)														
			S	A	FI	RPL	SD	ROA	SG	PM	EA	SDE	QR	ZC	MB	IC	FA
Faulkender	2005	L (N); S (5%); PM (5%)	√							√							
Chava & Purnanandam	2007	S (N); ZC (N)	√											√			
Vickery	2008	L (1%); S (1%); A (5%); FI (N); RPL (N); SD (1%); ROA (5%); SG (10%); OW (10%)	√	√	√	√	√	√	√								
Antoniou et al.	2009	S (N); MB (N)	√												√		
Barry, Mann, Mihov & Rodríguez	2009	L (10%); S (10%); MB (5%); IC (1%); FA (10%); EA (10%); SDE (10%)	√								√	√			√	√	√
Chernenko & Faulkender	2011	L (1%); LTD (1%); DR (1%); S (1%)	√														
Oberoi	2018	QR (1%); PM (5%)								√			√				
Total			**6**	**1**	**1**	**1**	**1**	**1**	**1**	**2**	**1**	**1**	**1**	**1**	**2**	**1**	**1**

Key: S = Size; A = Age; FI = Number of financial institutions with which the firm has relationship; RPL = The length of relationship with primary lender; SD = Switch dummy; ROA = Return on assets; SG = Annual sales growth; PM = Profit margin; EA = EBITDA to total assets; SDE = 3-year standard deviations of EBITDA; QR = Quick ratio; ZC = Z-change; MB = market-to-book ratio; IC = Interest coverage; FA = Fixed to total assets ratio.

Table A8: Summary of Empirical Studies Investigating the Relationship Between Loan Controls and the Fixed versus Floating Mix of Debt

Author(s) of Study	Date	Multivariate Results	Variables Employed ("√" indicates used in study)					
			RD	BD	NID	LS	LM	LRR
Chava & Purnanandam	2007	RD (1%)	√					
Rokkanen	2007	LS (1%); LM (1%); LRR (5%)				√	√	√
Vickery	2008	BD (1%), NID (N); LS (1%); LM (5%); LRR (5%)		√	√	√	√	√
Antoniou et al.	2009	LRR (N)						√
Chernenko & Faulkender	2011	RD (1%)	√					
Total			**2**	**1**	**1**	**2**	**2**	**2**

Key: RD = Rated debt; BD = Bank dummy; NID = Non-financial institution dummy; LS = Loan size; LM = The maturity of the loan; LRR = Loan risk rating

Table A9: Determinants of Bond Debt

This table reports the results of OLS regressions of bond debt defined as the amount of corporate bonds as a percentage of total debt. The sample period is 1999-2015. Standard errors are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)
Interest rate swaps	-0.581	-0.556	-0.260	-0.224
	(1.830)	(1.849)	(1.871)	(1.890)
Cash flow beta	-0.135		-0.151	
	(0.271)		(0.283)	
Short-term stock return beta		-0.315		-0.561
		(0.920)		(0.962)
Long-term stock return beta		3.171*		3.577*
		(1.829)		(1.945)
CAPEX/Assets (%)	-0.149	-0.155	-0.169	-0.175
	(0.156)	(0.157)	(0.166)	(0.166)
R&D/Assets (%)	0.728**	0.731**	0.889***	0.896***
	(0.298)	(0.292)	(0.310)	(0.303)
Book leverage	27.149***	26.746***	33.427***	32.866***
	(5.908)	(5.835)	(5.986)	(5.930)
Term spread (%)	1.008**	0.989**	0.982**	0.944**
	(0.463)	(0.458)	(0.474)	(0.467)
Credit spread (%)	-1.464**	-1.411**	-1.943***	-1.887***
	(0.701)	(0.695)	(0.712)	(0.706)
Size	8.477***	8.413***	11.522***	11.513***
	(1.005)	(1.014)	(0.833)	(0.835)
ROA	-0.117	-0.088	-0.031	0.007
	(0.199)	(0.201)	(0.230)	(0.232)
Current ratio	-0.994	-1.049	-1.433	-1.536
	(1.144)	(1.159)	(1.237)	(1.253)
Credit rating	22.857***	23.039***		
	(4.111)	(4.081)		
Long-term debt (%)	0.170***	0.173***	0.170***	0.173***
	(0.033)	(0.033)	(0.032)	(0.032)
Constant	-56.914***	-56.553***	-73.618***	-73.604***
	(10.684)	(10.660)	(10.861)	(10.773)
Industry FE	Yes	Yes	Yes	Yes
Year FE	No	No	No	No
Observations	3032	3049	3032	3049
Adjusted R_2	0.421	0.428	0.380	0.387

Table A10: OLS Regressions of Initial and Final Floating-rate Debt 1999-2015 (Controlling for Endogeneity)

This table reports the results of OLS regressions of initial and final floating-rate debt excluding potentially endogenous loan characteristics. The sample period is 1999-2015. Standard errors are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Initial		Final	
	(1)	(2)	(3)	(4)
Interest rate swaps	-0.974	-1.274	-6.696***	-6.598***
	(2.783)	(2.782)	(2.199)	(2.205)
Cash flow beta	0.351		0.491	
	(0.483)		(0.347)	
Short-term stock return beta		1.583		0.351
		(1.371)		(0.607)
Long-term stock return beta		0.815		1.116
		(2.613)		(1.445)
CAPEX/Assets (%)	-0.225	-0.210	-0.229	-0.258*
	(0.348)	(0.348)	(0.151)	(0.147)
R&D/Assets (%)	-1.187***	-1.181***	-0.486**	-0.474**
	(0.449)	(0.441)	(0.222)	(0.220)
Term spread (%)	-0.485	-0.604	-1.187**	-1.351***
	(0.670)	(0.670)	(0.528)	(0.521)
Credit spread (%)	2.775***	2.725***	1.948**	1.829**
	(1.013)	(1.005)	(0.758)	(0.755)
Size	-11.880***	-11.618***	-4.241***	-4.034***
	(1.057)	(1.056)	(0.637)	(0.640)
ROA	0.318	0.279	0.173	0.181
	(0.254)	(0.262)	(0.142)	(0.144)
Current ratio	-1.065	-1.142	-0.278	-0.513
	(1.600)	(1.609)	(0.592)	(0.715)
Constant	124.606***	123.123***	86.215***	74.021***
	(13.301)	(13.211)	(9.341)	(5.537)
Industry FE	Yes	Yes	Yes	Yes
Year FE	No	No	No	No
Observations	2409	2428	4443	4537
Adjusted $R2$	0.198	0.202	0.078	0.074

Table A11: Cross-sectional Variation in Final Floating-rate Debt 1999-2015: Fama and MacBeth (1973) Specifications

This table reports the results from Fama and MacBeth (1973) specifications that explain the cross-sectional variation in final floating-rate debt defined as the percentage of outstanding debt that is floating after accounting for the effect of interest rate swaps. The sample period is 1999-2015. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Interest rate swaps	-3.764	-3.202	-7.163***	-6.664**	-7.185***	-6.706**
	(2.414)	(2.605)	(2.349)	(2.434)	(2.319)	(2.410)
Cash flow beta	0.712***		0.668**		0.709***	
	(0.223)		(0.239)		(0.217)	
Short-term stock return beta		-1.013		-0.035		0.056
		(5.690)		(5.139)		(4.917)
Long-term stock return beta		5.137*		6.795*		6.578*
		(2.696)		(3.457)		(3.272)
CAPEX/Assets (%)	0.102	0.070	-0.060	-0.053	-0.183	-0.190
	(0.116)	(0.127)	(0.134)	(0.141)	(0.118)	(0.125)
R&D/Assets (%)	-0.865***	-0.882***	-0.747**	-0.775**	-0.692**	-0.714**
	(0.222)	(0.222)	(0.262)	(0.270)	(0.240)	(0.252)
Book leverage	-16.358***	-17.858***	-8.603*	-11.394**	-6.595	-9.185**
	(4.856)	(4.520)	(4.245)	(4.200)	(4.044)	(4.057)
Natural log of assets	-3.259***	-2.949***	-0.510	-0.132	-0.298	0.136
	(0.347)	(0.354)	(0.416)	(0.442)	(0.449)	(0.462)

ROA	0.177	0.223**	0.292**	0.237**	0.350**	0.295**
	(0.103)	(0.088)	(0.117)	(0.102)	(0.122)	(0.105)
Current ratio	1.238	1.319	1.706	2.053*	1.571	1.892
	(1.062)	(1.083)	(1.197)	(1.160)	(1.228)	(1.189)
Credit rating	-5.576**	-6.425***				
	(1.968)	(2.026)				
Bank debt (%)			0.284***	0.282***		
			(0.044)	(0.045)		
Bond debt (%)					-0.336***	-0.340***
					(0.046)	(0.046)
Long-term debt (%)	-0.144***	-0.147***	-0.137***	-0.146***	-0.072***	-0.080***
	(0.022)	(0.021)	(0.021)	(0.020)	(0.021)	(0.019)
Constant	94.789***	92.251***	58.512***	56.100***	79.478***	76.660***
	(4.313)	(3.808)	(6.152)	(6.001)	(5.349)	(4.989)
Industry FE	No	No	No	No	No	No
Year FE	No	No	No	No	No	No
Observations	3859	3934	2743	2760	2743	2760
R_2	0.084	0.081	0.143	0.131	0.159	0.149

Table A12: Cross-sectional Variation in Final Floating-rate Debt Pre- & Post-Crisis: Fama and Macbeth (1973) Specifications

This table reports the results of Fama-Macbeth (1973) specifications that explain the cross-sectional variation in final floating-rate debt defined as the percentage of outstanding debt that is floating after accounting for the effect of interest rate swaps. The sample periods are 1999-2006 and 2007-2015. Standard errors are adjusted for clustering by firm in fixed-effects regressions. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	1999-2006				2007-2015			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Interest rate swaps	-2.652	-1.497	-2.382	-1.301	-10.672***	-10.682***	-10.921***	-10.910***
	(2.855)	(3.010)	(2.536)	(2.710)	(3.182)	(3.137)	(3.192)	(3.166)
Cash flow beta	0.038		0.155		1.158***		1.139***	
	(0.422)		(0.384)		(0.133)		(0.133)	
Short-term stock return beta		0.577		0.789		-0.512		-0.514
		(0.929)		(0.829)		(9.352)		(8.949)
Long-term stock return beta		2.714*		2.775*		9.970		9.535
		(1.163)		(1.368)		(6.013)		(5.666)
CAPEX/Assets (%)	0.115	0.115	-0.008	-0.023	-0.196	-0.184	-0.319**	-0.320*
	(0.235)	(0.225)	(0.194)	(0.192)	(0.151)	(0.179)	(0.139)	(0.162)
R&D/Assets (%)	-0.118	-0.197	-0.161	-0.232	-1.236***	-1.225***	-1.104***	-1.090***
	(0.366)	(0.382)	(0.316)	(0.338)	(0.288)	(0.315)	(0.291)	(0.324)
Book leverage	-3.168	-4.907	-1.666	-2.994	-12.831*	-16.440**	-10.430	-14.001**
	(5.352)	(5.266)	(5.373)	(5.203)	(6.184)	(5.946)	(5.786)	(5.697)
Size	-0.752	-0.665	-1.128	-0.935	-0.321	0.283	0.347	0.969*
	(0.630)	(0.672)	(0.652)	(0.652)	(0.579)	(0.582)	(0.552)	(0.516)

ROA	0.299	0.192	0.330	0.244	0.287*	0.271*	0.365**	0.335**
	(0.210)	(0.177)	(0.218)	(0.184)	(0.141)	(0.126)	(0.148)	(0.129)
Current ratio	2.214	2.319	2.272	2.388	1.311	1.846	1.026	1.507
	(1.989)	(2.092)	(2.115)	(2.207)	(1.557)	(1.386)	(1.528)	(1.352)
Bank debt (%)	0.300**	0.293**			0.272***	0.274***		
	(0.101)	(0.103)			(0.023)	(0.022)		
Bond debt (%)			-0.303**	-0.305**			-0.362***	-0.367***
			(0.102)	(0.102)			(0.028)	(0.026)
Long-term debt (%)	-0.105**	-0.110**	-0.067	-0.072*	-0.162***	-0.174***	-0.076**	-0.087***
	(0.035)	(0.032)	(0.037)	(0.033)	(0.024)	(0.022)	(0.026)	(0.024)
Constant	51.642***	52.194***	79.496***	78.689***	63.855***	59.138***	79.464***	75.081***
	(11.348)	(11.565)	(9.723)	(9.403)	(6.550)	(6.275)	(6.343)	(5.539)
Industry FE	No	No	No	No	No	No	No	No
Year FE	No	No	No	No	No	No	No	No
Observations	1147	1156	1147	1156	1596	1604	1596	1604
R_2	0.080	0.077	0.078	0.077	0.198	0.177	0.227	0.209

Table A13: Cross-sectional Variation in Final Floating-rate Debt 1999-2015: Between Specifications

This table reports the results from between specifications that explain the cross-sectional variation in final floating-rate debt defined as the percentage of outstanding debt that is floating after accounting for the effect of interest rate swaps. The sample period is 1999-2015. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Interest rate swaps	-4.684	-4.169	-9.664**	-8.924**	-10.263***	-9.566**
	(3.660)	(3.579)	(3.985)	(4.051)	(3.923)	(3.979)
Cash flow beta	0.302		0.749***		0.743***	
	(0.189)		(0.282)		(0.277)	
Short-term stock return beta		1.372		1.253		1.893
		(2.558)		(4.063)		(3.986)
Long-term stock return beta		1.474		0.040		2.605
		(5.568)		(5.875)		(5.753)
CAPEX/Assets (%)	-0.086	-0.116	-0.400	-0.384	-0.536*	-0.529*
	(0.259)	(0.250)	(0.307)	(0.313)	(0.303)	(0.309)
R&D/Assets (%)	-0.778***	-0.689**	-0.391	-0.452	-0.453	-0.499*
	(0.282)	(0.282)	(0.296)	(0.301)	(0.286)	(0.291)
Book leverage	-16.654**	-12.514	3.800	5.247	6.173	7.803
	(8.427)	(8.256)	(9.467)	(9.545)	(9.318)	(9.372)
Size	-3.615***	-3.111***	-0.656	-0.227	-0.138	0.363
	(0.973)	(0.969)	(1.086)	(1.097)	(1.054)	(1.062)

ROA	0.535**	0.617***	0.825***	0.568*	0.852***	0.625**
	(0.232)	(0.222)	(0.306)	(0.307)	(0.301)	(0.301)
Current ratio	-1.268	-1.806	-0.955	-0.888	-0.835	-0.793
	(1.387)	(1.374)	(1.616)	(1.642)	(1.586)	(1.608)
Credit rating	-3.955	-7.136				
	(4.700)	(4.483)				
Bank debt (%)			0.261***	0.270***		
			(0.050)	(0.051)		
Bond debt (%)					-0.352***	-0.369***
					(0.055)	(0.055)
Long-term debt (%)	-0.106*	-0.121*	-0.183***	-0.198***	-0.080	-0.091
	(0.064)	(0.062)	(0.064)	(0.065)	(0.063)	(0.064)
Constant	96.046***	92.982***	62.937***	60.451***	77.764***	75.328***
	(7.918)	(7.870)	(10.426)	(10.602)	(8.225)	(8.407)
Industry FE	No	No	No	No	No	No
Year FE	No	No	No	No	No	No
Observations	3859	3934	2743	2760	2743	2760
Adjusted R_2	0.100	0.095	0.170	0.145	0.197	0.176

Table A14: Cross-sectional Variation in Final Floating-rate Debt Pre- & Post-Crisis: Between Specifications

This table reports the results from between specifications that explain the cross-sectional variation in final floating-rate debt defined as the percentage of outstanding debt that is floating after accounting for the effect of interest rate swaps. The sample periods are 1999-2006 and 2007-2015. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	1999-2006						2007-2015					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Interest rate swaps	9.191**	6.503	2.022	1.851	2.279	2.171	-6.580	-6.277	-9.581**	-9.339**	-10.547**	-10.308**
	(4.500)	(4.420)	(4.955)	(4.957)	(4.949)	(4.939)	(4.515)	(4.503)	(4.349)	(4.424)	(4.310)	(4.380)
Cash flow beta	0.350		-0.278		-0.208		0.320		1.016***		1.000***	
	(0.340)		(0.484)		(0.482)		(0.242)		(0.329)		(0.326)	
Short-term stock return beta		0.882		-0.201		0.042		2.517		5.922		5.834
		(2.093)		(2.913)		(2.885)		(9.600)		(8.692)		(8.600)
Long-term stock return beta		5.886		6.204		7.146		-1.924		6.907		6.667
		(4.599)		(5.030)		(4.985)		(10.002)		(9.360)		(9.263)
CAPEX/Assets (%)	-0.059	-0.186	-0.198	-0.161	-0.349	-0.323	-0.329	-0.273	-0.621*	-0.548	-0.676*	-0.608
	(0.250)	(0.241)	(0.350)	(0.346)	(0.350)	(0.344)	(0.392)	(0.396)	(0.375)	(0.386)	(0.372)	(0.382)
R&D/Assets (%)	-0.617**	-0.448*	-0.259	-0.268	-0.320	-0.307	-1.328***	-1.363***	-1.249***	-1.340***	-1.208***	-1.295***
	(0.242)	(0.248)	(0.275)	(0.279)	(0.271)	(0.274)	(0.427)	(0.429)	(0.418)	(0.427)	(0.414)	(0.423)
Book leverage	-21.422***	-15.420*	-3.752	-1.287	-2.504	0.143	-14.923	-15.103	1.430	0.575	-0.362	-1.189
	(8.004)	(7.900)	(9.986)	(9.984)	(10.015)	(9.980)	(12.457)	(12.499)	(11.623)	(11.830)	(11.436)	(11.625)
Size	-4.745***	-4.128***	-1.974*	-1.967*	-2.017*	-1.887	-1.662	-1.342	0.881	1.509	1.136	1.815
	(1.002)	(1.006)	(1.173)	(1.182)	(1.151)	(1.152)	(1.316)	(1.335)	(1.302)	(1.316)	(1.284)	(1.297)
ROA	0.318	0.498**	0.483	0.388	0.511*	0.435	0.930**	0.899**	0.937**	0.742*	1.044**	0.851**
	(0.211)	(0.205)	(0.306)	(0.304)	(0.304)	(0.301)	(0.407)	(0.411)	(0.408)	(0.412)	(0.404)	(0.408)
Current ratio	-2.188	-3.010**	-0.202	-0.273	-0.244	-0.328	1.346	1.580	0.823	1.153	0.619	0.926
	(1.340)	(1.352)	(1.727)	(1.739)	(1.725)	(1.732)	(1.975)	(1.987)	(1.882)	(1.934)	(1.864)	(1.913)

Credit rating	1.104	-3.048					-14.463**	-15.330**				
	(4.574)	(4.413)					(5.919)	(5.928)				
Bank debt (%)			0.175***	0.169***					0.351***	0.360***		
			(0.052)	(0.053)					(0.060)	(0.060)		
Bond debt (%)					-0.209***	-0.215***					-0.407***	-0.420***
					(0.059)	(0.060)					(0.064)	(0.064)
Long-term debt (%)	-0.067	-0.076	-0.134*	-0.134*	-0.066	-0.067	-0.206**	-0.211**	-0.240***	-0.259***	-0.114	-0.130
	(0.063)	(0.061)	(0.069)	(0.069)	(0.068)	(0.068)	(0.085)	(0.084)	(0.082)	(0.083)	(0.083)	(0.085)
Constant	92.618***	90.902***	66.719***	67.828***	78.838***	78.720***	90.242***	87.212***	51.168***	46.959***	73.975***	70.100***
	(7.677)	(7.655)	(10.693)	(10.768)	(8.637)	(8.667)	(11.107)	(11.462)	(13.469)	(13.892)	(10.940)	(11.312)
Industry FE	No	No	No	No	No	No	No	No	No	No	No	No
Year FE	No	No	No	No	No	No	No	No	No	No	No	No
Observations	1928	1986	1147	1156	1147	1156	1931	1948	1596	1604	1596	1604
Adjusted R_2	0.111	0.099	0.092	0.085	0.095	0.093	0.115	0.110	0.217	0.191	0.231	0.207

Table A15: Cross-sectional Variation in Final Floating-rate Debt 1999-2015: Between Specifications Interactions

This table reports the results from between specifications that explain the cross-sectional variation in final floating-rate debt. In columns 2-4, cash flow betas are interacted with measures of investment and leverage. The sample period is 1999-2015. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)
Interest rate swaps	-4.684	-4.242	-3.569	-4.401
	(3.660)	(3.668)	(3.695)	(3.747)
Cash flow beta	0.302	0.100	0.177	0.218
	(0.189)	(0.234)	(0.200)	(0.301)
Cash flow beta # CAPEX/Assets (%)		0.042		
		(0.029)		
Cash flow beta # R&D/Assets (%)			0.057*	
			(0.030)	
Cash flow beta # Book leverage				0.236
				(0.661)
CAPEX/Assets (%)	-0.086	-0.031	-0.076	-0.079
	(0.259)	(0.262)	(0.259)	(0.260)
R&D/Assets (%)	-0.778***	-0.754***	-0.894***	-0.794***
	(0.282)	(0.282)	(0.288)	(0.286)
Book leverage	-16.654**	-15.333*	-22.424**	-17.721**
	(8.427)	(8.464)	(8.926)	(8.948)
Size	-3.615***	-3.642***	-3.653***	-3.623***
	(0.973)	(0.972)	(0.970)	(0.974)
ROA	0.535**	0.561**	0.679***	0.566**
	(0.232)	(0.232)	(0.243)	(0.248)
Current ratio	-1.268	-1.250	-0.739	-1.213
	(1.387)	(1.386)	(1.410)	(1.397)
Credit rating	-3.955	-4.330	-3.570	-3.901
	(4.700)	(4.701)	(4.691)	(4.707)
Long-term debt (%)	-0.106*	-0.115*	-0.095	-0.105
	(0.064)	(0.064)	(0.064)	(0.064)
Constant	96.046***	95.862***	94.672***	95.817***
	(7.918)	(7.909)	(7.928)	(7.952)
Industry FE	No	No	No	No
Year FE	No	No	No	No
Observations	3859	3859	3859	3859
Adjusted R_2	0.100	0.103	0.106	0.099

Table A16: Time-series Variation in Final Floating-rate Debt 1999-2015: Within Specifications

This table reports the results from within specifications that explain the time-series variation in final floating-rate debt defined as the percentage of outstanding debt that is floating after accounting for the effect of interest rate swaps. The sample period is 1999-2015. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)
Interest rate swaps	-5.318**	-6.355**	-6.693**
	(2.271)	(2.667)	(2.639)
CAPEX/Assets (%)	-0.187	-0.199	-0.242*
	(0.144)	(0.147)	(0.146)
R&D/Assets (%)	0.025	0.118	0.105
	(0.656)	(0.791)	(0.766)
Book leverage	-4.725	-9.526	-7.283
	(6.119)	(7.165)	(7.203)
Term spread (%)	-1.379***	-1.161**	-0.953*
	(0.515)	(0.580)	(0.575)
Credit spread (%)	1.787**	1.361*	0.974
	(0.719)	(0.785)	(0.778)
Size	-0.392	0.707	1.667
	(1.854)	(2.454)	(2.404)
ROA	-0.328*	-0.112	-0.096
	(0.189)	(0.227)	(0.229)
Current ratio	-1.341	0.333	0.208
	(1.394)	(1.592)	(1.563)
Credit rating	-10.706**		
	(4.904)		
Bank debt (%)		0.207***	
		(0.042)	
Bond debt (%)			-0.289***
			(0.050)
Long-term debt (%)	-0.123***	-0.132***	-0.109***
	(0.036)	(0.041)	(0.041)
Constant	77.456***	55.387***	68.156***
	(13.095)	(18.576)	(17.328)
Industry FE	No	No	No
Year FE	No	No	No
Observations	3940	2764	2764
Adjusted $R2$	0.026	0.048	0.060

Table A17: Time-series Variation in Final Floating-rate Debt Pre- & Post-Crisis: Within Specifications

This table reports the results from within specifications that explain the time-series variation in final floating-rate debt defined as the percentage of outstanding debt that is floating after accounting for the effect of interest rate swaps. The sample periods are 1999-2006 and 2007-2015. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	1999-2006		2007-2015	
	(1)	(2)	(3)	(4)
Interest rate swaps	-6.065	-6.209	-8.428*	-9.080**
	(3.763)	(3.781)	(4.622)	(4.531)
CAPEX/Assets (%)	-0.054	-0.059	-0.405	-0.492*
	(0.174)	(0.172)	(0.274)	(0.271)
R&D/Assets (%)	1.295***	1.277***	-0.325	-0.306
	(0.384)	(0.377)	(0.698)	(0.624)
Book leverage	11.809	13.946	-3.481	1.802
	(10.479)	(10.457)	(12.284)	(12.359)
Term spread (%)	0.752	0.721	-0.807	-0.425
	(1.118)	(1.116)	(0.564)	(0.554)
Credit spread (%)	-0.723	-0.620	1.928**	1.090
	(3.729)	(3.752)	(0.880)	(0.864)
Size	1.879	2.165	2.767	4.351
	(5.656)	(5.754)	(4.175)	(4.017)
ROA	0.177	0.123	-0.131	-0.159
	(0.417)	(0.420)	(0.270)	(0.278)
Current ratio	6.529**	6.677**	0.551	0.810
	(2.610)	(2.626)	(1.051)	(1.055)
Bank debt (%)	0.180***		0.265***	
	(0.046)		(0.064)	
Bond debt (%)		-0.195***		-0.438***
		(0.050)		(0.072)
Long-term debt (%)	-0.144**	-0.138**	-0.094*	-0.062
	(0.063)	(0.064)	(0.051)	(0.048)
Constant	33.945	47.718	32.842	48.294
	(38.156)	(38.884)	(31.270)	(29.658)
Industry FE	No	No	No	No
Year FE	No	No	No	No
Observations	1156	1156	1608	1608
Adjusted R_2	0.034	0.032	0.072	0.118

Table A18: OLS Regressions of UK Floating-rate Debt

This table reports the results of OLS regressions of UK floating-rate debt defined as the percentage of UK debt that is floating after accounting for the effect of interest rate swaps. Standard errors are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	1999-2015	1999-2006	2007-2015
UK debt (%)	-0.251***	-0.130	-0.346***
	(0.065)	(0.082)	(0.090)
US floating-rate debt (%)	0.098**	0.059	0.116
	(0.049)	(0.058)	(0.075)
EU floating-rate debt (%)	0.208***	0.109*	0.336***
	(0.053)	(0.062)	(0.088)
Interest rate swaps	-3.402	-0.082	-1.354
	(4.611)	(6.070)	(6.696)
Cash flow beta	-1.430	-2.349	0.184
	(1.248)	(1.601)	(1.485)
CAPEX/Assets (%)	-0.370	-0.838	0.034
	(0.539)	(0.575)	(0.809)
R&D/Assets (%)	-1.974***	-2.360**	-1.943***
	(0.675)	(1.044)	(0.720)
Book leverage	2.201	14.447	-1.553
	(11.736)	(17.668)	(11.874)
Term spread (%)	-1.614	-4.671**	0.741
	(1.033)	(1.812)	(1.246)
Credit spread (%)	2.455	6.136	1.302
	(1.641)	(5.379)	(1.941)
Size	-1.656	-1.226	-3.183
	(1.596)	(2.118)	(2.139)
ROA	0.326	0.354	0.651
	(0.374)	(0.402)	(0.651)
Current ratio	0.877	1.454	0.823
	(2.990)	(4.273)	(2.650)
Credit rating	-3.839	5.695	-20.949***
	(5.157)	(5.894)	(7.142)
Long-term debt (%)	-0.121	-0.124	-0.124
	(0.091)	(0.111)	(0.101)
Constant	58.191***	32.816	64.236***
	(20.276)	(25.908)	(24.174)
Industry FE	Yes	Yes	Yes
Year FE	No	No	No
Observations	889	573	316
Adjusted R_2	0.209	0.112	0.466

Table A19: OLS Regressions of US Floating-rate Debt

This table reports the results of OLS regressions of US floating-rate debt defined as the percentage of US debt that is floating after accounting for the effect of interest rate swaps. Standard errors are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	1999-2015	1999-2006	2007-2015
US debt (%)	-0.143**	-0.178**	-0.164
	(0.070)	(0.084)	(0.128)
UK floating-rate debt (%)	0.093**	0.037	0.201**
	(0.044)	(0.045)	(0.093)
EU floating-rate debt (%)	0.343***	0.248***	0.413***
	(0.045)	(0.054)	(0.072)
Interest rate swaps	2.803	-7.045	6.580
	(5.161)	(6.368)	(6.684)
Cash flow beta	5.151***	5.679***	2.885
	(1.315)	(1.428)	(2.780)
CAPEX/Assets (%)	-0.247	0.049	-0.520
	(0.436)	(0.533)	(0.723)
R&D/Assets (%)	0.126	0.288	-0.642
	(0.612)	(0.799)	(0.662)
Book leverage	8.557	0.968	7.705
	(10.233)	(15.106)	(15.581)
Term spread US (%)	-4.000***	-1.165	-7.971***
	(1.515)	(1.669)	(2.614)
Credit spread US (%)	10.476**	-0.907	14.620**
	(4.609)	(6.853)	(6.405)
Size	-2.418	-0.560	-2.737
	(1.591)	(2.282)	(1.920)
ROA	0.323	-0.041	0.473
	(0.422)	(0.524)	(0.734)
Current ratio	0.914	2.706	-0.869
	(2.605)	(3.320)	(3.386)
Credit rating	4.811	3.004	10.417
	(4.611)	(5.842)	(7.578)
Long-term debt (%)	-0.043	-0.023	-0.063
	(0.061)	(0.073)	(0.113)
Constant	52.722**	21.648	43.836**
	(20.407)	(20.539)	(18.688)
Industry FE	Yes	Yes	Yes
Year FE	No	No	No
Observations	889	573	316
Adjusted R_2	0.241	0.190	0.386

Table A20: OLS Regressions of EU Floating-rate Debt

This table reports the results of OLS regressions of EU floating-rate debt defined as the percentage of EU debt that is floating after accounting for the effect of interest rate swaps. Standard errors are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	1999-2015	1999-2006	2007-2015
EU debt (%)	-0.238**	-0.234*	-0.364***
	(0.100)	(0.134)	(0.129)
UK floating-rate debt (%)	0.189***	0.090	0.342***
	(0.051)	(0.057)	(0.083)
US floating-rate debt (%)	0.369***	0.292***	0.388***
	(0.050)	(0.064)	(0.070)
Interest rate swaps	-8.461*	-5.065	-9.925
	(4.839)	(5.689)	(6.519)
Cash flow beta	-3.161**	-2.760*	-2.653
	(1.299)	(1.508)	(2.014)
CAPEX/Assets (%)	-0.442	-0.950	0.181
	(0.611)	(0.670)	(0.881)
R&D/Assets (%)	0.359	-1.146	1.400*
	(0.849)	(1.271)	(0.778)
Book leverage	9.385	-1.616	28.998**
	(10.053)	(14.017)	(12.639)
Term spread EU (%)	-0.798	-1.835	0.022
	(1.608)	(3.272)	(1.549)
Credit spread EU (%)	2.081	-0.782	2.415
	(1.606)	(4.265)	(1.782)
Size	-1.370	-1.632	1.300
	(1.633)	(2.041)	(2.237)
ROA	-0.391	-0.316	-0.874
	(0.427)	(0.438)	(0.670)
Current ratio	0.380	2.258	0.505
	(2.516)	(3.676)	(3.374)
Credit rating	-5.809	-3.138	-5.824
	(6.020)	(6.745)	(8.600)
Long-term debt (%)	-0.068	-0.090	-0.044
	(0.063)	(0.073)	(0.101)
Constant	40.334**	48.964*	10.583
	(18.573)	(25.015)	(26.101)
Industry FE	Yes	Yes	Yes
Year FE	No	No	No
Observations	889	573	316
Adjusted R_2	0.261	0.162	0.480

Table A21: OLS Regressions of Size of Swap Usage Pre- & Post-Crisis

This table provides the results of the size of swap usage estimated using the sample of swap users. Swap usage is the net percentage of debt that is swapped to a floating interest rate exposure. Swap users are firms that use interest rate swaps at least once during the 1999-2015 sample period. Standard errors in parentheses are adjusted for clustering by firm. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

	1999-2006				2007-2015			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Initial floating-rate debt (pre-swap) (%)	-0.797***	-0.797***	-0.794***	-0.801***	-0.663***	-0.659***	-0.717***	-0.712***
	(0.055)	(0.056)	(0.056)	(0.057)	(0.064)	(0.063)	(0.066)	(0.066)
Cash flow beta	0.906		0.892		1.059***		1.083***	
	(0.885)		(0.900)		(0.263)		(0.263)	
Short-term stock return beta		0.806		0.720		0.738		0.488
		(2.072)		(2.078)		(3.426)		(3.436)
Long-term stock return beta		6.423**		6.724**		3.013		3.669
		(3.171)		(3.229)		(3.945)		(3.899)
CAPEX/Assets (%)	0.001	-0.048	-0.094	-0.147	-0.178	-0.140	-0.257	-0.216
	(0.419)	(0.414)	(0.419)	(0.413)	(0.370)	(0.378)	(0.366)	(0.374)
R&D/Assets (%)	-0.107	-0.105	-0.145	-0.131	-0.105	-0.114	-0.015	-0.033
	(0.419)	(0.432)	(0.380)	(0.394)	(0.491)	(0.511)	(0.499)	(0.520)
Book leverage	-1.942	-3.601	-1.011	-2.441	-7.520	-11.740	-4.310	-8.541
	(9.839)	(10.423)	(10.046)	(10.587)	(11.168)	(11.364)	(11.155)	(11.365)
Term spread (%)	-2.458	-2.292	-2.351	-2.104	-0.735	-0.865	-0.642	-0.790
	(1.965)	(1.967)	(1.970)	(1.971)	(0.713)	(0.716)	(0.702)	(0.707)

Credit spread (%)	-7.383	-10.944*	-6.997	-10.487*	1.118	1.295	0.838	1.044
	(5.894)	(6.215)	(5.918)	(6.227)	(1.285)	(1.290)	(1.266)	(1.272)
Size	-1.042	-1.055	-1.030	-0.934	0.111	0.750	1.363	1.883
	(1.621)	(1.640)	(1.634)	(1.652)	(1.370)	(1.323)	(1.488)	(1.408)
ROA	0.286	0.221	0.334	0.278	0.116	0.127	0.149	0.143
	(0.317)	(0.322)	(0.319)	(0.322)	(0.328)	(0.331)	(0.342)	(0.342)
Current ratio	1.335	1.452	1.344	1.444	3.730**	3.949**	3.168*	3.543**
	(1.748)	(1.803)	(1.757)	(1.808)	(1.751)	(1.741)	(1.724)	(1.685)
Bank debt (%)	0.154**	0.146**			0.098*	0.093		
	(0.067)	(0.067)			(0.059)	(0.057)		
Bond debt (%)			-0.163**	-0.170**			-0.225***	-0.216***
			(0.073)	(0.075)			(0.075)	(0.073)
Long-term debt (%)	-0.078	-0.087	-0.055	-0.062	-0.215***	-0.221***	-0.174**	-0.180**
	(0.073)	(0.073)	(0.074)	(0.074)	(0.076)	(0.074)	(0.074)	(0.073)
Constant	39.457*	42.205**	53.268***	55.183***	49.032**	45.732**	49.584***	46.690**
	(20.332)	(20.623)	(18.475)	(18.915)	(19.582)	(19.742)	(18.047)	(18.190)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	No	No	No	No	No	No
Observations	526	531	526	531	1104	1115	1104	1115
Adjusted R_2	0.449	0.445	0.449	0.447	0.398	0.387	0.408	0.397

Table A22: OLS Regressions of Final Floating-rate Debt 1999-2015 (Same as Model 5 Table 3 Chernenko and Faulkender (2011))

	(1)	(2)	(3)	(4)	(5)	(6)
Cash flow beta	0.316		0.761***		0.770***	
	(0.333)		(0.155)		(0.150)	
Short-term stock return beta		0.825		0.289		0.305
		(0.576)		(1.308)		(1.304)
Long-term stock return beta		2.839**		3.273*		3.476*
		(1.434)		(1.795)		(1.846)
CAPEX/Assets (%)	-0.195	-0.210	-0.155	-0.171	-0.249	-0.268
	(0.156)	(0.153)	(0.221)	(0.224)	(0.215)	(0.219)
R&D/Assets (%)	-0.591**	-0.577**	-0.321	-0.329	-0.278	-0.283
	(0.258)	(0.259)	(0.236)	(0.245)	(0.224)	(0.231)
Book leverage	-18.338***	-18.211***	-11.468*	-12.577*	-9.122	-10.247
	(5.777)	(5.737)	(6.713)	(6.792)	(6.594)	(6.663)
Term spread %)	-0.904*	-1.003*	-0.921	-1.153*	-0.736	-0.962
	(0.532)	(0.525)	(0.613)	(0.613)	(0.610)	(0.611)
Credit spread (%)	2.685***	2.600***	1.968**	1.798**	1.637*	1.473*
	(0.790)	(0.787)	(0.863)	(0.862)	(0.856)	(0.854)
Size	-3.856***	-3.634***	-1.687*	-1.298	-1.251	-0.830
	(0.734)	(0.735)	(0.893)	(0.893)	(0.864)	(0.865)
ROA	0.221	0.222	0.325	0.261	0.376*	0.318
	(0.170)	(0.171)	(0.222)	(0.226)	(0.227)	(0.229)
Current ratio	0.643	0.596	1.286	1.495	1.268	1.475
	(1.122)	(1.128)	(1.190)	(1.194)	(1.161)	(1.164)
Credit rating	-6.399**	-6.737**				
	(2.710)	(2.659)				
Bank debt (%)			0.247***	0.251***		
			(0.034)	(0.034)		
Bond debt (%)					-0.320***	-0.326***
					(0.037)	(0.038)
Long-term debt (%)	-0.156***	-0.155***	-0.171***	-0.177***	-0.103**	-0.108**
	(0.037)	(0.037)	(0.045)	(0.044)	(0.045)	(0.045)
Constant	97.650***	81.846***	51.630***	52.587***	68.727***	70.771***
	(9.338)	(7.328)	(10.010)	(8.944)	(10.048)	(7.759)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	No	No	No	No
Observations	4034	4109	2883	2900	2883	2900
Adjusted R_2	0.107	0.106	0.158	0.150	0.174	0.167

Table A23: Cross-sectional Variation in Final Floating-rate Debt 1999-2015: Fama and Macbeth (1973) Specifications (Same as Model 1 Table 4 Chernenko and Faulkender (2011))

	(1)	(2)	(3)	(4)	(5)	(6)
Cash flow beta	0.740***		0.668**		0.702***	
	(0.235)		(0.243)		(0.220)	
Short-term stock return beta		-2.780		-2.492		-1.886
		(3.022)		(3.564)		(3.405)
Long-term stock return beta		7.394**		8.125**		8.175**
		(2.985)		(3.391)		(3.500)
CAPEX/Assets (%)	0.063	0.013	-0.082	-0.092	-0.193*	-0.217*
	(0.111)	(0.116)	(0.124)	(0.130)	(0.109)	(0.115)
R&D/Assets (%)	-0.714***	-0.717***	-0.581**	-0.589**	-0.523**	-0.530**
	(0.193)	(0.190)	(0.225)	(0.226)	(0.208)	(0.215)
Book leverage	-20.073***	-21.885***	-11.454**	-14.333***	-9.751*	-12.528**
	(5.968)	(5.773)	(4.831)	(4.889)	(4.681)	(4.798)
Size	-3.970***	-3.628***	-1.397***	-0.957**	-1.185***	-0.682*
	(0.386)	(0.381)	(0.340)	(0.343)	(0.367)	(0.360)
ROA	0.273**	0.316***	0.356***	0.300**	0.416***	0.362***
	(0.114)	(0.104)	(0.118)	(0.107)	(0.123)	(0.111)
Current ratio	1.255	1.195	2.211*	2.378**	2.235*	2.377**
	(1.033)	(1.047)	(1.108)	(1.070)	(1.126)	(1.090)
Credit rating	-5.268**	-6.128***				
	(1.906)	(1.990)				
Bank debt (%)			0.290***	0.289***		
			(0.045)	(0.046)		
Bond debt (%)					-0.344***	-0.348***
					(0.046)	(0.046)
Long-term debt (%)	-0.162***	-0.163***	-0.162***	-0.169***	-0.095***	-0.101***
	(0.022)	(0.020)	(0.022)	(0.022)	(0.020)	(0.018)
Constant	99.809***	97.763***	61.515***	59.166***	82.782***	80.055***
	(4.797)	(4.392)	(5.674)	(5.536)	(4.815)	(4.501)
Industry FE	No	No	No	No	No	No
Year FE	No	No	No	No	No	No
Observations	4034	4109	2883	2900	2883	2900
R_2	0.094	0.086	0.155	0.143	0.171	0.161

Table A24: Cross-sectional Variation in Final Floating-rate Debt 1999-2015: Between Specifications (Same as Model 2 Table 4 Chernenko and Faulkender (2011))

	(1)	(2)	(3)	(4)	(5)	(6)
Cash flow beta	0.275		0.654**		0.658**	
	(0.188)		(0.281)		(0.276)	
Short-term stock return beta		1.005		-0.741		-0.109
		(2.545)		(4.010)		(3.937)
Long-term stock return beta		3.567		0.856		3.546
		(5.539)		(5.855)		(5.743)
CAPEX/Assets (%)	-0.104	-0.160	-0.370	-0.393	-0.469	-0.499
	(0.261)	(0.252)	(0.304)	(0.310)	(0.300)	(0.305)
R&D/Assets (%)	-0.561**	-0.478*	-0.180	-0.249	-0.270	-0.324
	(0.275)	(0.275)	(0.290)	(0.295)	(0.282)	(0.286)
Book leverage	-28.656***	-23.737***	-7.060	-4.976	-5.663	-3.447
	(8.029)	(7.883)	(8.995)	(9.078)	(8.837)	(8.897)
Size	-4.960***	-4.503***	-1.843*	-1.495	-1.530	-1.110
	(0.928)	(0.927)	(1.032)	(1.034)	(0.994)	(0.994)
ROA	0.666***	0.762***	1.074***	0.846***	1.119***	0.918***
	(0.225)	(0.216)	(0.292)	(0.292)	(0.287)	(0.286)
Current ratio	-1.978*	-2.247*	-0.285	-0.220	0.174	0.250
	(1.170)	(1.162)	(1.295)	(1.313)	(1.279)	(1.293)
Credit rating	-1.473	-4.614				
	(4.666)	(4.455)				
Bank debt (%)			0.290***	0.296***		
			(0.049)	(0.050)		
Bond debt (%)					-0.372***	-0.386***
					(0.053)	(0.053)
Long-term debt (%)	-0.137**	-0.151**	-0.184***	-0.199***	-0.077	-0.088
	(0.062)	(0.060)	(0.062)	(0.063)	(0.062)	(0.062)
Constant	108.026***	105.065***	63.377***	62.234***	80.843***	79.587***
	(7.591)	(7.534)	(10.409)	(10.546)	(8.102)	(8.236)
Industry FE	No	No	No	No	No	No
Year FE	No	No	No	No	No	No
Observations	4034	4109	2883	2900	2883	2900
Adjusted $R2$	0.143	0.135	0.201	0.179	0.225	0.207

Table A25: Cross-sectional Variation in Final Floating-rate Debt 1999-2015: Between Specifications Interactions (Same as Model 4-6 Table 4 Chernenko and Faulkender (2011))

	(1)	(2)	(3)	(4)
Cash flow beta	0.275	0.051	0.135	0.026
	(0.188)	(0.232)	(0.197)	(0.290)
Cash flow beta # CAPEX/Assets (%)		0.047		
		(0.029)		
Cash flow beta # R&D/Assets (%)			0.067**	
			(0.029)	
Cash flow beta # Book leverage				0.721
				(0.641)
CAPEX/Assets (%)	-0.104	-0.037	-0.100	-0.085
	(0.261)	(0.264)	(0.260)	(0.262)
R&D/Assets (%)	-0.561**	-0.540**	-0.694**	-0.614**
	(0.275)	(0.274)	(0.280)	(0.279)
Book leverage	-28.656***	-27.041***	-34.635***	-31.436***
	(8.029)	(8.075)	(8.414)	(8.399)
Size	-4.960***	-4.962***	-4.923***	-4.929***
	(0.928)	(0.927)	(0.925)	(0.928)
ROA	0.666***	0.692***	0.820***	0.751***
	(0.225)	(0.225)	(0.234)	(0.238)
Current ratio	-1.978*	-1.958*	-1.571	-1.866
	(1.170)	(1.168)	(1.179)	(1.174)
Credit rating	-1.473	-1.934	-0.998	-1.276
	(4.666)	(4.667)	(4.651)	(4.668)
Long-term debt (%)	-0.137**	-0.146**	-0.124**	-0.133**
	(0.062)	(0.062)	(0.062)	(0.062)
Constant	108.026***	107.900***	106.924***	107.551***
	(7.591)	(7.579)	(7.575)	(7.601)
Industry FE	No	No	No	No
Year FE	No	No	No	No
Observations	4034	4034	4034	4034
Adjusted R_2	0.143	0.146	0.150	0.144

Table A26: Time-series Variation in Final Floating-rate Debt 1999-2015: Within Specifications (Same as Table 5 Chernenko and Faulkender (2011))

	(1)	(2)	(3)
CAPEX/Assets (%)	-0.250*	-0.225	-0.278**
	(0.150)	(0.141)	(0.141)
R&D/Assets (%)	0.067	0.142	0.131
	(0.624)	(0.750)	(0.724)
Book leverage	-4.285	-10.967	-8.875
	(5.962)	(7.172)	(7.230)
Term spread (%)	-1.332***	-1.180**	-0.968*
	(0.507)	(0.576)	(0.570)
Credit spread (%)	1.955***	1.633**	1.254
	(0.724)	(0.783)	(0.776)
Size	0.031	0.960	1.950
	(1.827)	(2.387)	(2.331)
ROA	-0.289	-0.092	-0.065
	(0.186)	(0.220)	(0.221)
Current ratio	-1.275	0.250	0.136
	(1.223)	(1.359)	(1.328)
Credit rating	-12.615**		
	(4.968)		
Bank debt (%)		0.216***	
		(0.042)	
Bond debt (%)			-0.296***
			(0.049)
Long-term debt (%)	-0.128***	-0.144***	-0.119***
	(0.035)	(0.040)	(0.040)
Constant	71.694***	50.376***	63.371***
	(12.859)	(17.987)	(16.723)
Industry FE	No	No	No
Year FE	No	No	No
Observations	4118	2906	2906
Adjusted $R2$	0.024	0.047	0.059

Chapter 3: The Determinants of Corporate Foreign Currency Debt Use by UK Firms

Abstract

In this essay, we study a sample of large UK firms and examine their decisions to use foreign currency denominated debt. We hand-collect data from annual reports to calculate the percentage of outstanding debt that is denominated in foreign currency after accounting for the effect of swaps. Data on the firm's initial foreign exchange exposure were sourced from S&P Capital IQ. The results support the view that firms with more foreign currency exposure have higher levels of foreign currency debt or swap more of their debts into foreign currencies, consistent with risk management motivation. Foreign denominated debt can be used to reduce the firm's foreign currency exposure by acting as a natural hedge to foreign sales/assets. The firm's use of foreign currency debt is positively related to its size. This is not surprising given that larger firms are more likely to have international operations and relatively more direct access to international capital markets. The results are robust when we examine the percentage of debt held in two main currencies, i.e. the US dollar and the euro. The evidence also shows that interest rate differentials between sterling and the US dollar/euro are positively related to the amount of debt swapped to US/EU debt. Firms might do this in order to exploit lower interest rates. We further examine the directions of foreign currency swaps that firms undertake and find that there is a convergence in the currency profiles of their debts. Firms that swap into sterling initially have more foreign currency debt compared to swap non-users and those that swap into foreign currency initially have less foreign currency debt compared to those that swap into sterling. We also find evidence of the effects of foreign currency swap use on default probability. Specifically, firms that use more foreign currency swaps have higher probability of default and those that swap into foreign currency are more likely to default compared to swap non-users.

Keywords: Foreign currency borrowing, derivatives, foreign currency swaps, debt structure, hedging, speculation, default probabilities.

JEL CODES: F23, G32.

1. Introduction

Debt is an important component of a company's capital structure, and the rationale for its use has been one of the most examined topics in the area of corporate finance. Finance theorists have long recognised that the reduction in a corporation's tax liability due to the deductibility of interest expense is one of the most important financial benefits of debt in the capital structure decision process. On the other hand, as debt levels rise, the associated costs such as financial distress are likely to increase. This has generated much debate in academic circles as to the determinants of the optimal capital structure of the firm. Recent academic debate on the determinants of capital structure policy has shifted away from an examination of total debt to that of the currency mix of debt and the fixed-floating interest mix of debt. The foreign currency debt mix is important for many firms and in particular multinationals, which generate some of their revenues in foreign currency and are therefore exposed to movements of currencies in which these revenues are denominated.

The level of foreign currency debt usage is markedly higher outside the US, consistent with the fact that international trade is lower in the US than in many other countries.[1] This suggests that foreign currency debt usage, which might be used to finance foreign trade activity, may also be relatively less important for US firms. For example, Judge (2006) notes that the UK economy is much more open to international influences than the US economy. In view of these differences, Judge (2006) suggests that a greater emphasis on currency exposure and foreign exchange hedging by UK firms is expected. Consistent with this, they find a higher proportion of UK hedgers hedge currency risk than US hedgers (93% versus 79%). Berkman et al. (1997) find that, in comparison with US firms, New Zealand firms hedge more financial risk across all size categories. They attribute this finding to a higher currency risk exposure in New Zealand. Since foreign currency debt can be used for financing foreign operations and as a tool for foreign currency hedging, it is not unreasonable to expect that this pattern would also apply to the use of foreign currency debt. In relation to the Finnish economy, Hakkarainen et al. (1997b) write, "The Finnish foreign exchange markets have been highly volatile, and the exchange rate regime has been altered several times in recent years. Most of the often heavily indebted firms are highly dependent on foreign trade and most firms carry foreign-exchange denominated debt" (p.25). Differences in

[1] Proportion of foreign currency debt users in samples of empirical studies are presented in Table 5.

foreign currency debt use seem to be partitioned on the basis of openness of the economy. Foreign currency debt seems to be more prevalent in economies that are relatively more open and hence where firms have a greater level of international involvement.

In perfect capital markets and when the covered interest rate parity holds, which currency the firm borrows does not matter as all currencies are fairly priced. In this study, we relax some of these assumptions and attempt to determine when firms issue debt in foreign currency or swap it into a foreign currency, what factors they consider to be important. Debt markets are becoming global. The amount of debt raised in foreign currencies has increased dramatically. Choice of currency denomination of debt is important as it throws light on a firm's risk management activities. Debt characteristics such as foreign currency debt mix and interest rate mix have been of interest to corporate treasurers for many years, but until recently, the lack of reliable data has limited research on these issues. Also, the empirical literature on the use of foreign currency debt by firms has not yet reached a consensus regarding the determinants of foreign currency debt use. Currency denomination of debt is complicated by the firm's ability to convert foreign currency debt into local currency debt using foreign currency derivatives.

This essay adds to the empirical evidence by examining the determinants of foreign currency debt use employing a large sample of UK non-financial firms. UK data is particularly well suited for studying the role of foreign debt as the UK has a more open economy than most industrial countries. According to the World Bank, in 2015, exports of goods and services constituted 27.6% of gross domestic product (GDP) in the UK whereas the corresponding figure was 12.6% in the US. Therefore, many UK firms are likely to benefit from using foreign debt for hedging purposes. In fact, the level of foreign debt usage is markedly higher in the UK than in many other countries. Bartram et al. (2009) find that over 85% of UK firms use foreign debt whereas this number in the US is 66%. In a review of empirical studies on the frequency of foreign debt usage, Clark and Judge (2008) observe a lower level of about 22% foreign debt users in samples of US studies whereas in other countries such as the UK over 65% of firms indicate raising foreign debt.

The topic of foreign exchange risk management has commanded a great deal of attention from researchers. Most of this attention focuses on the use of foreign currency derivatives and its potential impact on firm value. However, this is just one aspect of

an integrated hedging policy. Funding in currencies where the firm operates to hedge exposure is an alternative. In a study based on responses from Danish non-financial firms, Aabo (2006) finds that the majority of firms regard foreign debt equally important as or even more important than currency derivatives in managing exchange rate risk. Examining the role of foreign debt as a hedging instrument provides a comprehensive understanding of a firm's risk management activities and hence complements the existing literature. Also, a firm that issues local currency debt and then swaps it for a foreign currency has the same foreign exchange exposure as one that raises foreign currency debt. It is the combination of the initial foreign exchange exposure of the debt and the firm's currency swap activities that determines the firm's overall foreign exchange exposure. A number of studies, however, look at the initial foreign exchange exposure of the debt instruments only (see, for example, Keloharju and Niskanen (2001) and Kedia and Mozumda (2003)). In this essay, we hand-collect data from annual reports to calculate the percentage of outstanding debt that is denominated in foreign currency after incorporating the effect of swaps. Data on the firm's initial foreign exchange exposure were sourced from S&P Capital IQ (CIQ). The data is completely unique, to the best of our knowledge.

We begin by examining the determinants of the choice of foreign currency debt. We first control for firm characteristics that affect foreign debt use at the aggregate level and then include proxies for currency differences. Our results suggest that foreign exchange exposure, proxied by greater foreign sales, and firm size are the key drivers of foreign currency debt use. We then look at the relation between foreign operations and foreign debt at the currency level and control for firm incentives to lower interest costs by including the interest rate differential between the local and foreign currency. The results provide additional support for the effect of foreign operations and firm size on the use of foreign currency debt. To check for the results' robustness across time, we estimate the model for subperiods 2001-2006 and 2007-2015 and find evidence that, before the financial crisis, firms tended to borrow more in euros which on average have a lower interest rate than sterling in an attempt to lower interest costs.

Next, using data on the firm's initial and final currency debt mix, we calculate the net share of the firm's total debt that is swapped to foreign currency and investigate the decision to swap into foreign currency. Consistent with the results from the previous section, firms with greater level of exposure have a higher share of their debt that is swapped to foreign currency. In addition, direct costs of debt are an important

determinant of foreign currency swap use at the currency level. An increase in the differential between the UK and US/EU interest rates increases the net US dollar/euro swap percentage.

If a firm discloses in its annual reports that it used any foreign currency swaps during the fiscal year, we attempt to determine the directions of swaps and use the swap direction variables as one of the explanatory variables. Our results show that firms that swap into sterling initially have more foreign currency debt compared to those that do not use swaps, and firms that swap into foreign currency initially have less foreign currency debt compared to those that swap into sterling. After incorporating the effect of swaps, we find that regardless of the direction of swaps that firms undertake, there is a convergence in the currency profiles of firms' debt.

Finally, we analyse the relationship between foreign currency swap use and the probability of default. We find evidence that firms that use foreign currency swaps have higher probabilities of default, controlling for other firm characteristics that may drive firm default. We further examine the effects of swap directions and find a higher likelihood of bankruptcy for firms that swap into foreign currency compared to those that do not use foreign currency swaps. The effects of swap use on default probability vary over time, consistent with the prevailing macroeconomic and financial conditions. We find a greater impact of swap use on the probability of default during periods of economic downturn and smaller differences in the default risk between swap users and non-users during favourable macroeconomic conditions.

2. Hypothesis on the use of foreign currency debt

A number of empirical studies have examined the determinants of foreign currency debt use. Although there are different interpretations, a set of stylized facts has clearly emerged. In this section, we discuss possible explanations for the currency choice of debt.

2.1. Hedging

Firms employ various techniques to safeguard their financial well-being and minimize fluctuations in cash flows. Foreign denominated debt can be used to reduce the firm's foreign currency exposure by acting as a natural hedge to foreign revenues. If a firm has foreign currency revenues from, say, exports or foreign operations, it can issue foreign debt whose cash outflows can be used to hedge the foreign currency exposure created by the foreign revenues. Where a company has extensive overseas investments, it may borrow in foreign currencies to protect the balance sheet. If the

foreign subsidiary does the borrowing, the net equity investment in the subsidiary will be reduced. If the parent company borrows in the foreign currency and switches into sterling, it will have a gain (or loss) to offset against any loss (or gain) on translating the net equity investment of the foreign subsidiary. The foreign currency debt protects shareholders' funds from the effect of currency movements on the net assets of the group.

Kedia and Mozumdar (2003) argue that firms should issue debt in the currencies in which they have exposure or those highly correlated with the currency of their underlying exposure. The former hedge is referred to as a straight hedge while the latter is a cross hedge. They also note that issuing foreign debt can only offset exposure to foreign exchange rates through the revenue side. If the exposure arises from the cost side, foreign debt increases rather than hedges foreign exchange exposure.

Servaes and Tufano (2006) argue that firms should have their liabilities in the same currency as their assets, thereby reducing the amount of foreign currency translation and the effect of exchange rate volatility on cash flows. Hedging the book value of a foreign asset by issuing the same amount of debt in that currency is known as net investment hedging. In that case, there is no earnings volatility as variations in the book value of the debt are equal to those in the book value of the asset. Servaes and Tufano (2006) note that if the amount of debt is less than the book value of the asset, firms have to mark-to-market the excess and adjust the equity account on the balance sheet with the difference. This does not lead to earning volatility but generally causes balance sheet volatility. On the other hand, if the amount of debt is more than the book value of the asset, firms also have to mark-to-market the excess and make the adjustment via the profit and loss statement instead. This makes profits more volatile.

2.2. Speculation

Some firms borrow in currencies other than those in which their assets are held, and revenue is earned. They might do this in order to exploit lower interest rates. This poses additional risk through the currency mismatch of assets and liabilities. This risk can be hedged by matching foreign assets with foreign currency borrowings indirectly via foreign currency swaps.

Keloharju and Niskanen (2001) argue that if a financial manager believes that the interest rate differential between two currencies, after adjusting for risk, does not reflect the expected change in exchange rates, he or she may decide to deviate from a hedging strategy. Hakkarainen et al. (1997a) document that 72% of the CFOs of large Finnish

firms believe that exchange rates can be predicted to some extent in the short run and up to 53% in the long run. While the psychology of judgement finds that people tend to be overconfident, the fact that the international Fisher effect does not hold may also motivate the managers' belief. Viren (1988), among other researchers, reports evidence that during the period 1980-1987 the uncovered interest rate parity did not exist in Finland or was much weaker compared to more developed markets such as Sweden and Switzerland.

Allayannis et al. (2003) discuss the predictions of the static trade-off theory about the currency denomination of debt which suggests that leverage should decrease with costs of debt and increase with benefits of debt. Direct costs of issuing debt vary across markets. The difference between local and foreign lending rates is the most obvious of these costs. Miller and Puthenpurackal (2002) find that when the relative interest cost is low, foreign firms tend to use the Yankee market to raise debt. Graham and Harvey (2001) report that 44% of firms that responded to their survey consider lower foreign interest rates to be important or very important in the decision to issue foreign debt.

2.3. Agency cost

Myers (1977) and Graham and Harvey (2001) discuss the agency costs in relation to the conflicts between bondholders and equity holders in firms with risky debt outstanding. They argue that managers acting on behalf of shareholders' best interests may underinvest and pass up positive net present value (NPV) projects if they think that the profits shall be passed on to bondholders. In addition, growing firms are less likely to possess enough revenues to act as collateral, making it very difficult and risky for them to take on large amounts of debt at such a stage in their development. Tangible assets can act as collateral for loans thereby reducing the agency costs of debt. The empirical implication therefore is that there is a positive relationship between asset tangibility and a negative relationship between the growth proxy variables and the likelihood (and level) of foreign currency debt use.

Allayannis et al. (2003) argue that because borrowers and lenders generally do not have the same information sets, lenders must undertake costly monitoring. Thus, agency theory may explain the use of foreign currency debt. Firms with high costs of monitoring should borrow more from the local market if local lenders can collect information on local firms at a low cost as implied by Diamond (1984). Similarly, Hietala (1989) argues that domestic investors have lower costs of gathering

information. The informational disadvantage of foreign investors implies that if that is the case, firms are less likely to issue foreign debt (Kedia and Mozumdar, 2003).

Agency theory can also lead to another explanation for foreign currency debt use. Allayannis et al. (2003) extend the logic of Ross (1977) and argue that if a firm incurs extra costs when accessing foreign capital due to increased regulatory scrutiny or distress costs, then firms can signal their creditworthiness by taking on these potential costs. In other words, firms that use foreign currency debt can effectively send a signal about the firm's credit quality to investors. The signalling theory by Titman and Trueman (1986) also implies that a firm may decide to borrow from a high-quality (possibly foreign) lender to signal its own quality to outside investors. Allayannis et al. (2003) therefore expect that firms with foreign equity and thus a reputation in foreign markets are more likely to use foreign currency debt.

2.4. Pecking order

Myers and Majluf (1984) suggest that firms tend to rely on internal sources of finance, and if external funds are required, firms would prefer debt to equity. Thus, they expect more profitable firms to have less debt. Extending the pecking order hypothesis, Allayannis et al. (2003) argue that, if local investors have better information than foreign investors, firms would first borrow locally before approaching foreign lenders. Once debt markets are drained, firms would then turn to local equity markets and finally to foreign equity markets. They therefore argue that the relationship between profitability and leverage should be strongest for local debt. As a result, an inverse relation between profitability and the decision to issue foreign currency debt is expected. Similarly, firms with a foreign equity listing may have moved down the pecking order and are likely to have lower levels of foreign currency debt.

2.5. Market depth (and liquidity)

Allayannis et al. (2003) argue that if local currency debt markets are not large or deep enough to satisfy the needs of borrowers, firms with access to foreign lenders will seek to obtain funds abroad. They find that the lack of market depth is a popular explanation for foreign currency debt use in East Asian firms. Another theory proposed under the market depth theory for the explanation of foreign currency debt use is the maturity structure of debt. Allayannis et al. (2003) argue that firms may issue foreign debt as a means of obtaining long-term debt if for example the costs of issuing long-term debt locally are high. Data on the effective maturity of derivatives is, however, not available. Even if it were available, it may be impossible to accurately describe

managers' intentions because many firms roll over short-term positions to hedge currency exposure associated with long-term debt.

Kedia and Mozumdar (2003) consider market liquidity and argue that in a liquid debt market, transaction costs should be reduced and firms can issue securities with lower yields. They therefore expect firms to use foreign debt if the underlying debt market is highly liquid.

2.6. Taxes

Shapiro (1984) shows that in Finland unrealized exchange rate losses on foreign debt are tax deductible immediately, while the government permits taxes on exchange rate gains to be deferred until realized. It is argued that such tax laws encourage firms to borrow in foreign currency, provided that the expected before-tax borrowing costs in the local and foreign currency are equal. Shapiro (1984) also argues that the weaker the Finnish markka, the lower the tax shield from foreign debt. Keloharju and Niskanen (2001) therefore hypothesize that when the interest rate differential between the markka and its basket is larger, firms will have smaller incentives to raise foreign currency debt.[2]

Kedia and Mozumdar (2003) argue that taxes affect firms' currency of debt in two ways. First, the cost of issuing foreign debt includes the foreign interest rate and the exchange rate gain or loss on the principal and interest. If there are differences in the tax treatment of the exchange rate gain or loss and the interest, firms would have preference for the currency of debt. Shapiro (1984) finds that if the exchange rate loss on the principal is not tax deductible, firms are likely to raise debt in the weaker currency. Such conditions arise in the UK. Conversely, Hodder and Senbet (1990) suggest that if the exchange rate gain or loss is treated as ordinary income and not deferred, as in the US, there is no currency preference. Second, firms have incentives to arbitrage differences in tax rates across countries. Specifically, firms are likely to issue debt and thus reduce the tax burden in countries with high tax rates. Newberry and Dhaliwal (2001) find evidence that the currency denomination of debt is partly determined by jurisdiction-specific tax-loss carryforwards and the availability of foreign tax credits. US multinationals also use foreign debt to achieve income shifting between subsidiaries.

[2] The Finnish markka was pegged to a basket of 12 currencies during the sample period.

Servaes and Tufano (2006), however, note that the location of the reporting entity that issues the debt is more relevant than the currency of the debt. They suggest denominating debt in the currency of the entity getting the tax deduction. Also, if firms borrow in a specific currency to gain tax advantages, such a decision should be made as a part of their overall tax optimization strategy. Allayannis et al. (2003) find it difficult to identify relevant variables to tax benefits of foreign debt due to the lack of detailed information on the currency of the debt, whether the debt is the firm's liability or a foreign subsidiary's liability instead. In addition, some of the foreign currency debt could be issued in the local market by local or foreign banks.

2.7. Legal barriers/regimes

Legal barriers include a variety of restrictions, ranging from differences in tax treatment between domestic and foreign investments to capital controls, ownership and security law. Shapiro (1984) finds that in some countries, tax laws encourage firms to borrow in foreign currency, regardless of its strength. It is also possible that profits from a jurisdiction cannot be repatriated to the home country due to capital controls. In that case, to avoid having profits in that jurisdiction, the firm may locate a large share of its debt there (Servaes and Tufano, 2006). Again, the location of the entity making the interest payments is more relevant than the currency of the debt. Servaes and Tufano (2006) suggest issuing the debt in the currency of the entity that services the debt. The complexity of capital control regimes, however, makes it difficult to control for legal barriers.

The degree of creditor protection provided by legal regimes is different among countries (Porta et al., 1998). Kedia and Mozumdar (2003) argue that in equilibrium, these differences will be reflected in the borrowing costs. Thus, firms are more likely to borrow in currencies of countries that belong to the legal regimes with strong creditor rights.

3. Empirical evidence on the use of foreign currency debt

The empirical literature on firms' use of foreign currency debt has not yet reached a consensus regarding the determinants of foreign currency debt use. In this section, we discuss empirical evidence from previous studies investigating why firms use foreign currency debt.

3.1. Hedging

Allayannis and Ofek (2001) examine a firm's decision to use foreign debt and its decision on how much foreign debt to use. They note that foreign debt represents cash

outflows and thus can only be used for hedging if the firm has cash inflows in a foreign currency from, say, exports or operations abroad. Their results show that the ratio of foreign sales to total sales is positively associated with a firm's decision to issue foreign debt. Exporters, however, are not likely to use foreign debt. They then consider only those firms that decided to issue foreign debt and find that firms with more foreign sales use larger amounts of foreign debt. Keloharju and Niskanen (2001) use the share of exports of net sales to measure currency exposure and find evidence consistent with firms raising foreign currency debt to hedge their exposure. They, however, note that this result is also consistent with firms that export more having a better international reputation and thus better ability to raise foreign debt. Similarly, they include a multinational dummy variable for whether the firm has foreign subsidiaries or not and expect this variable to be positive. The result is insignificant.

Allayannis et al. (2003) find that firms with higher foreign EBIT or more foreign cash use more foreign currency debt. As predicted by the risk management hypothesis, foreign cash flow provides a natural hedge against exchange rate movements. Kedia and Mozumdar (2003) use the ratio of foreign sales to total sales, foreign assets to total assets and foreign income to total income as proxies for a firm's foreign exchange exposure. They also include the ratio of foreign subsidiaries to total subsidiaries at the aggregate level and the individual-country level to measure the intensity of the firm's foreign operations and thus its exposure. Kedia and Mozumdar (2003) find that, except for foreign income, an increase in the fraction of aggregate foreign operations increases the probability of issuing foreign debt. They then examine the relation between foreign subsidiaries and foreign debt at the currency level. The results provide further evidence that foreign operations affect foreign debt issuance, consistent with the hedging hypothesis.

Brown et al. (2011) use three dummy variables for whether the firm exports, if it conducts domestic sales to foreign-owned companies or multinationals, and if more than 50% of its ownership is in foreign hands. These variables are indicators of the currency denomination of a firm's revenues. The results show that, holding other variables at the means, the probability of denominating a loan in foreign currency increases by 9 percent points for exporters and 25 percent points for foreign firms. Mora et al. (2013) find that exporters in Lebanon are more likely to have dollar debt (by 8.1 percent points) while being an importer is associated with an 10.1 percent points lower likelihood of dollar debt. These results are in line with the risk management view

because cash flows of exporters are naturally hedged against currency risk while those of importers are more vulnerable.

3.2. Speculation

Keloharju and Niskanen (2001) find that the larger the differential between the Finnish markka and its basket interest rates, the larger firms' incentives to raise foreign currency debt. This is opposite to what was previously predicted by their tax hypothesis. Their explanation for the results is that the sample firms' financial managers may have believed that the costs of finance could be reduced by borrowing foreign currency which has a lower interest rate than the Finnish markka. Thus, the interest rate differential captures the effect of speculation.

Allayannis et al. (2003) show that the difference between local lending rates and LIBOR is positively associated with the use of foreign currency debt. This finding supports the static trade-off theory prediction that direct costs of debt are a determinant of foreign currency debt use.

Brown et al. (2011) calculate the interest rate differential between the local and foreign currency in the transition economies as the difference between the domestic Treasury bill rate and the Eurepo rate.[3] They find evidence that countries with high interest rate differentials to the euro have higher levels of foreign currency loans. However, the economic relevance of country-level interest rate differentials for the prevalence of foreign currency borrowing is weaker than that of firm-level foreign currency revenues. The results suggest that a one-standard-deviation increase in the interest rate differential from its mean increases foreign currency borrowing by merely 4.4 percent points.

3.3. Agency cost

Allayannis et al. (2003) argue that loans associated with tangible assets are preferable among foreign lenders since it is costly to monitor borrowers. Thus, they expect a positive relation between the level of foreign currency debt and asset tangibility (as proxied by the ratio of fixed assets to total assets). They also suggest that firms with more growth opportunities have greater information asymmetries and use the market-to-book ratio as a proxy for growth potential. Firms with high market-to-book value of equity are therefore expected to borrow more from the local market. Given the results from previous studies, Allayannis et al. (2003) also predict that family

[3] The euro is used as the reference currency as it is shown that most foreign currency loans are denominated in euros.

affiliation is a determinant of foreign currency debt use. They argue that there are more incentives for large shareholders to monitor management and thus reduce agency conflicts. The results show that asset tangibility is positively related to foreign debt levels while the coefficient on the ratio of market-to-book is negative, consistent with the agency theory. There is no significant relation between family affiliation and foreign debt use.

Kedia and Mozumdar (2003) argue that there are less information asymmetries between domestic and foreign investors for firms that operate in foreign countries. Thus, debt issued by firms with foreign subsidiaries is likely to be in higher demand among foreign investors. The ratio of foreign subsidiaries to total subsidiaries could therefore proxy for information barriers. They also identify other firm characteristics that are able to facilitate the flow of information to foreign investors. These are the ratio of fixed assets to total assets (asset tangibility) and research and development (R&D) expenses to sales, size and credit rating. Information asymmetries are likely to be greater for firms with low asset tangibility and high levels of R&D. Larger firms and firms with superior credit rating are likely to face foreign investors who are less informationally disadvantaged. The results provide support for the effect of information barriers. The coefficients on fraction of foreign subsidiaries and firm size are highly significant at the aggregate level. There is further evidence at the currency level as the coefficient of credit rating is also significant.

Mora et al. (2013) argue that when information is asymmetric and monitoring is costly, large and transparent firms with more collateral are more likely to have access to dollar credit. Their results show that small firms (less than five employees) are less likely to borrow in dollars by 14.5 percent points, whereas a one-standard-deviation increase in the borrower's net worth is associated with a 16 percent point higher likelihood of dollar debt. In addition, Mora et al. (2013) find evidence that firms in the manufacturing and services sectors are less likely to incur dollar debt, in comparison with firms in the trade and construction sectors. Their explanation for this finding is that borrowers in the trade and construction sectors have more tangible assets that can act as collateral for loans. Firms in the manufacturing and services sectors, in contrast, may have machinery-specific or human capital that cannot be easily pledged. In addition to the collateral hypothesis, Mora et al. (2013) hypothesize that more profitable firms borrow in dollars to signal their quality to creditors and the borrower of a dollar loan should also ensure higher ex post profits. The results, however, do not provide

support for the signalling hypothesis. In fact, higher probability is associated with a decrease in the dollar debt likelihood.

3.4. Pecking order

Allayannis et al. (2003) use a dummy variable that equals one if the firm is listed on a foreign stock exchange to measure its access to the foreign equity market. The foreign equity listing dummy is negatively related to foreign currency debt levels. This may be explained as a preference for equity as predicted by the pecking order hypothesis.

3.5. Market depth (and liquidity)

Allayannis et al. (2003) use firm size and the ratio of committed capital expenditures to sales as proxies for the probability that local currency debt markets are exhausted. They also calculate the percentage of long-term debt in total debt and take the difference between the long-term debt percentage for foreign and local currency to control for maturity structure. Their results provide strong support for the market depth hypothesis as the coefficients on all these variables are highly significant and positively related to foreign currency debt levels. Kedia and Mozumdar (2003) use the amount of nonconvertible debt issuance normalized by the GDP to measure liquidity in the underlying debt markets. They find no evidence in support of the market liquidity hypothesis.

3.6. Taxes

Keloharju and Niskanen (2001) do not find evidence in support of the tax hypothesis. In fact, the differential between the Finnish markka and its basket interest rates is positively related to the probability of raising foreign currency debt. This finding suggests that the foreign debt issue decision is affected by speculative motives. Kedia and Mozumdar (2003) use tax rates and net operating loss carryforward normalized by sales to proxy for firms' incentives to arbitrage tax differences across countries. They argue that firms with a tax loss carryforward have more incentives to shift interest deductions to a foreign country and are therefore more likely to raise foreign currency debt. The results at the aggregate and currency level, however, show no evidence in support of the tax arbitrage-based rationale for foreign debt use.

3.7. Legal barriers/regimes

Kedia and Mozumdar (2003) classify their sample firms into the English, French, German and Scandinavian system countries as proposed by Porta et al. (1998). They expect lower debt issuance in currencies of the French system countries where creditor rights and law enforcement are weak. There is, however, no evidence to support this

rationale as the coefficients on the dummy variables for French and German legal regimes are not significant.

A summary of previous studies on foreign currency debt use is provided in Table 1. Table 2 summarizes dependent variables and econometric methodology used in these studies. As can be seen from these tables, most studies rely on annual reports or surveys to obtain data on foreign currency debt use. A dummy variable which takes the value of one if the firm has any foreign debt and zero otherwise is commonly used as the dependent variable, and logit/probit regression is mostly used to explain the likelihood of using foreign debt.

4. Data and methodology

4.1. Sample selection and foreign currency debt

We examine the decision to use foreign currency debt by the top 500 UK firms classified by market value during the 1999-2015 period. Annual reports are used to obtain data on derivatives use and currency denomination of debt after incorporating the effects of foreign currency swaps. Financial and non-financial firms whose annual reports we could not obtain are excluded from the sample. Data not available in annual reports were sourced from S&P CIQ.

Using annual reports, we search the entire footnotes to financial statements for any mention of the following keywords: “risk management”, “hedg”, or “derivative”. If a reference is found, we read the surrounding text and record whether a firm used any derivative instruments during a fiscal year and, if any, the notional amounts of derivatives outstanding at the fiscal year end. Table 3 provides the frequency distribution of derivative use by UK firms over the sample period. Of our firm-year observations, 82.4% are derivative users and of these, 78.3% use foreign currency derivatives. Of 93.9% foreign currency derivative users that disclose types of derivatives, 43.5% use foreign currency swaps. We attempt to determine the directions of swaps and find only 52% of swap users that report swap positions. Of these, 48.3% swap into foreign currency while 37.1% swap into sterling and the rest swap to both. To the best of our knowledge, we are the first to collect data on swap directions. This allows us to provide additional insight into the effects of swap usage on the firm’s foreign exchange exposure.

In addition to derivative use, we also record the amount of foreign currency debt after accounting for the effects of foreign currency swaps from annual reports. We divide this amount by the firm’s total debt to construct our dependent variable. Overall,

after keeping observations that have positive book value of debt and dropping those with missing data on foreign currency debt, we are left with 4,646 firm-year observations. We also download data on the share of firms' debt that is denominated in foreign currency before incorporating the effects of foreign currency swaps from S&P CIQ. The CIQ database provides detailed information on debt and capital structure from the notes to financial statements in annual reports. Most previous studies are only able to examine the firm's choice of currency at the time of the debt issue. Firms may swap the debt back into sterling or another currency. However, very few firms provide details of swaps they entered which should be taken into account when currency-wise breakdown of debt is constructed. Our data, therefore, allows us to shed light on firms' foreign exchange risk management activities.

Using data on the firm's initial and final currency debt mix, we calculate the net foreign currency swap percentage as the final foreign currency debt percentage minus the initial foreign currency debt percentage. It is the net share of the firm's total debt that is swapped to foreign currency, the absolute value of which represents the amount of foreign currency swaps outstanding at the fiscal year end as a percentage of the firm's total debt. If a firm uses foreign currency swaps, then its initial foreign currency debt (pre-swap) should be different from its final foreign currency debt (net of swap). In untabulated statistics, we test the difference in means between these two variables for a subsample of swap users and find that they are significantly different. Given that we use data from two sources, the foreign currency debt variables prove to be measured with precision and serve as good approximations of the firm's foreign currency exposure.

Panel A of Table 4 provides summary statistics of initial and final foreign currency debt for the full sample. On average, the percentages of outstanding debt that is denominated in foreign currency before and after accounting for the effects of swaps are 39.7% and 46.1%, respectively. Given that some firm-years are included in our database but not the CIQ database and vice versa, we also report summary statistics for the subsample of firms with available data on both initial and final currency debt mix in Panel B of Table 4. Prior to the effects of foreign currency swaps, the mean (median) percentage of foreign currency debt is 40.3% (22.3%). After some firms swap into sterling and others swap into foreign currency, 47.6% (48.5%) of the outstanding debt is denominated in foreign currency. The average amount of foreign currency swaps is equivalent to 24.4% of the firm's total debt, and a net share of 7.3% is swapped to

foreign currency. Although the mean foreign currency swap percentage is relatively small, the standard deviation is 39.3%, indicating considerable variation in swap usage across firms and over time. The summary statistics for the subsample of swap users are reported in Panel C of Table 4. This sample includes firms that use foreign currency swaps at least once in the sample period. The number of observations reduces by 50%, and the average swap size increases to 27.9% of the outstanding debt.

Table 5 provides details of the frequency of foreign currency debt use reported in previous studies. In order to compare with other studies, we create a dummy variable which is equal to one if the percentage of foreign currency debt (net of swap) is greater than zero. Untabulated statistics show that 73.1% of our firm-year observations are foreign debt users. From Table 5 it is clear that the level of foreign debt use is markedly higher in the UK. Allayannis and Ofek (2001) and Kedia and Mozumdar (2003) show the percentage of firms using foreign currency debt in the US at about 22.0% whereas Clark and Judge (2008) report that 51.6% of UK firms use foreign currency, and the corresponding number in our study is 73.1%. In other countries, such as the East Asia region, Allayannis et al. (2003) find that 61.8% of firms indicate using foreign currency debt. This difference in foreign currency debt use between UK firms and non-UK firms is consistent with the fact that international trade is higher in the UK than in many other countries. This suggests that foreign currency debt usage, which might be used to finance foreign trade activity, may also be relatively more important for UK firms.

In addition to the aggregate foreign currency debt, we also record the amount of outstanding debt denominated in individual currencies (pre and net of swap). Measurement problems may be associated with debt denominated in small currencies. Therefore, we restrict our attention to debt use in sterling, the US dollar and the euro. These currencies account for 92.4% of total foreign debt use by our sample firms. A category named “other foreign debt” records debt use in all other currencies. Table 6 displays how total debt is distributed across the three main currencies. We also report the firm’s sales and assets by region. From this table it is not surprising that sterling is the most commonly used currency for the denomination of debt. Among foreign currencies, the US dollar is the most popular, which accounts for about 20% and 25% of total debt before and after incorporating the effects of foreign currency swaps, respectively. Keloharju and Niskanen (2001) note that, ideally, they would like to study how companies use foreign currency loans to hedge their net exposures in each currency. However, due to the lack of data on the sample firms’ net exposures by

currency, they use the ratio of exports to net sales as a crude measure of currency exposure. To the best of our knowledge, we are the first to collect data on firms' foreign exchange exposure at the currency level. This allows us to further examine their decision to use each individual currency.

4.2. Empirical proxies for explanatory variables

We use the following firm-specific and economy-wide variables as proxies for the determinants of foreign currency debt use. Explanatory variables are categorised into 'hedging' and 'speculation' purposes. Hypotheses based on related theory and evidence are presented in Table 7. Table 8 provides summary statistics for explanatory variables.

Hedging Foreign exchange exposure is defined as the sensitivity of the firm value to movements in exchange rates. It was first estimated by Jorion (1990) as the regression coefficient of equity value on changes in exchange rates, controlling for market returns. Despite measurement problems, Jorion (1990) shows that there is a positive correlation between a firm's foreign exchange exposure and the degree of its foreign involvement which is proxied by the share of its sales in foreign countries. Based on this evidence and following Allayannis and Ofek (2001) and Kedia and Mozumdar (2003), we use the percentage of total sales abroad and total assets held in foreign countries as proxies for firms' overall foreign exchange exposure. These variables capture foreign involvement at aggregate level only and are unable to proxy for activities at individual country level. Therefore, we also measure the percentage of a firm's sales and assets by region. These variables capture exposure at the currency level. Table 8 shows that on average, firms generate 46.1% of total sales abroad and hold about 44.2% of their assets in foreign countries. Both proxies of foreign exchange exposure are positively correlated with each other.

We also rely on empirical evidence that shows firm characteristics associated with hedging motivations. Froot et al. (1993) suggest that with costly external finance and diminishing marginal returns to investment, firms will hedge to reduce cash flow variability and those with tighter financial constraints are more likely to hedge. We use the current ratio as a proxy for financial constraints. Firms may also wish to hedge to reduce the costs of bankruptcy. The lower the firm value under liquidation and the higher the value of growth options, the higher the bankruptcy costs. Following Kedia and Mozumdar (2003) and Allayannis et al. (2003), we use the ratio of fixed assets to total assets (asset tangibility) as a measure of the firm value under liquidation. We also use R&D expenditures scaled by sales and the market-to-book ratio to proxy for

investment opportunities. Firms with low asset tangibility and more growth options are more likely to hedge with foreign debt.

Nance et al. (1993) point out that a firm could substitute its hedging policy with other financial policies such as restricting its dividends. Following Keloharju and Niskanen (2001), we hypothesize that there is a positive relation between dividend yield and the probability of firms using foreign debt for hedging.

Speculation The expected costs of finance could affect the firm's choice between local and foreign currency denominated debt. It is possible that financial managers do not believe that the international Fisher effect holds at the time of debt issuance and that they can reduce the borrowing costs by raising foreign currency debt which, on average, have lower interest rates relative to local currency debt. Thus, the difference between local and foreign interest rates is expected to be positively related to the use of foreign debt. We measure interest rate differentials as the difference between 3-month GBP LIBOR and USD/EUR LIBOR interest rates.

The interest rate differential also captures the effect of taxes, which is opposite to what is predicted by the speculation hypothesis. Shapiro (1984) and Keloharju and Niskanen (2001) argue that the larger the difference in interest rates between local and foreign currency, the smaller the tax savings from raising foreign debt and hence expect the coefficient for this variable to be negative.

Agency cost Kedia and Mozumdar (2003) argue that asset tangibility and growth options could proxy for information asymmetries along with being a proxy for hedging motives. Allayannis et al. (2003) show evidence that due to the high costs of monitoring borrowers, foreign lenders in East Asia tend to provide loans associated with fixed assets. Also, if informational asymmetries are greater for firms with growth potential, such firms would get more favourable terms from local lenders. Thus, in contrast to the above predictions from the hedging motives, the agency cost hypothesis predicts that firms with low asset tangibility and more growth options are likely to use less foreign debt. In addition, Kedia and Mozumdar (2003) propose that firm size and credit quality are likely to be valid proxies for the level of information asymmetry, with large firms and those with credit rating having the lowest information asymmetries. In line with Keloharju and Niskanen (2001) and Kedia and Mozumdar (2003), we use the natural log of total assets to proxy for firm size and create a dummy variable which takes a value of 1 when the firm has any credit rating. Significant positive coefficients for size and credit rating are consistent with the agency cost hypothesis.

Agency theory can also lead to a signalling explanation for foreign currency debt use. Mora et al. (2013) argue that more profitable firms borrow in foreign currency to send a signal to creditors that they are good. We use return on assets to control for profitability and expect more profitable firms to hold more foreign currency debt.

Market depth and liquidity The lack of local currency market depth is considered a reason why firms with access to foreign currency debt markets, on average, maintain higher levels of debt. Following Allayannis et al. (2003), we use size to proxy for the probability of firms exhausting local currency lending markets.

Table 9 reports the test of difference in means and medians between foreign currency debt users and non-users. We find that firms with some foreign debt are larger than those with no foreign debt, both as measured by total sales and assets. Foreign debt users also have higher levels of foreign operation proxied by the share of total sales in foreign countries and the share of total assets held abroad. Firms using foreign debt have lower levels of liquidity and R&D expenditure than those that do not.

4.3. Estimation methodology

We begin by fitting a model to explain the determinants of the choice of foreign currency debt. We first control for firm characteristics that affect foreign debt use at the aggregate level and then include proxies for currency differences. To check for the results' robustness across time, we estimate the model for subperiods 2001-2006 and 2007-2015. Our regression model takes the general form as follows:

$$Foreign\ debt(\%)_{it} = \gamma_0 + \gamma_1 \times Foreign\ sales(\%)_{it} + \gamma_2 \times Natural\ log\ of\ assets_{it} + \gamma_3 \times Asset\ tangibility_{it} + \gamma_4 \times Current\ ratio_{it} + \gamma_5 \times R\&D/sales_{it} + \gamma_6 \times Market - to - book/assets_{it} + \gamma_7 \times ROA_{it} + \gamma_8 \times Dividend\ yield_{it} + \gamma_9 \times Credit\ rating_{it} + \gamma_{10} \times Interest\ rate\ differentials_{it} + \varepsilon_{it} \qquad (1).$$

Next, we calculate the net share of the firm's total debt that is swapped to foreign currency and investigate the decision to swap into foreign currency. We repeat the ordinary least squares (OLS) analysis conducted previously using the swap direction variables as one of the explanatory variables. Finally, we analyse the relationship between foreign currency swap use and the probability of default. We run an OLS regression in the general form as follows:

$$PD_{it}\ (or\ EDF_{it}) = \beta_0 + \beta_1 Swaps_{it} + \beta_2 Leverage_{it} + \beta_3 Size_{it} + \beta_4 Profitability_{it} + \beta_5 Liquidity_{it} + \beta_6 Price\ volatility_{it} + \beta_7 Excess\ return_{it} + \varepsilon_{it}. \quad (2).$$

5. Results

5.1. Foreign currency debt use by UK firms

5.1.1. Aggregate foreign currency debt

In this section, we discuss the determinants of the choice of foreign currency debt. We first control for firm characteristics that affect foreign debt use at the aggregate level and then include proxies for currency/country differences.

As shown in Table 10, foreign sales are highly significant in explaining foreign debt levels. A 1% increase in the percentage of foreign sales increases the level of foreign debt after incorporating the effect of foreign currency swaps by 0.619%. In untabulated results, we replace foreign sales with foreign assets and obtain a similar result. A 1% increase in the percentage of foreign assets increases the level of foreign debt after accounting for the effect of foreign currency swaps by 0.516%. This finding is consistent with the hypothesis that firms use foreign currency debt to hedge their exchange rate exposure as foreign cash flows provide a natural hedge. Our results are in line with previous studies (see, for example, Keloharju and Niskanen (2001), Allayannis et al. (2003), Brown et al. (2011), Mora et al. (2013)), which show that other measures of foreign operations are positively related to foreign debt levels as suggested by the risk management theory.

Firm size is also an important determinant of foreign currency debt use, as shown by the significant positive coefficient on the log of book assets. In untabulated results, we replace log of assets with log of sales and obtain a similar result. These results support the effect of information barriers on the choice of currency for the denomination of debt. As suggested by Mora et al. (2013), when information is asymmetric, size is a factor that can facilitate increased transparency and thus access to finance. Large firms generally have a better international reputation. Foreign investors are therefore likely to face a lower informational disadvantage if they invest in these firms (Keloharju and Niskanen, 2001, Kedia and Mozumdar, 2003). This finding is also consistent with the market depth hypothesis. As shown by Keloharju and Niskanen (2001) and Allayannis et al. (2003), large firms generally have a wider access to

international capital markets. If local debt markets are not deep enough to satisfy their demands, these firms will seek out foreign funds.

Although not reported here, the results in Table 10 do not change qualitatively if we use quick ratio instead of current ratio or the ratio of R&D to assets instead of R&D to sales. As a robustness test, we run regressions on the percentage of foreign currency debt before incorporating the effect of foreign currency swaps. The results are presented in Table A1 in the appendices. These results suggest that the effect of foreign operations on foreign debt use is stronger after incorporating the effect of swaps. A 1% increase in the percentage of foreign sales increases the level of foreign debt before accounting for the effect of foreign currency swaps by only 0.432%. As discussed previously, it is the combination of the initial foreign exchange exposure of the debt and the firm's currency swap activities that determines the firm's overall foreign exchange exposure. We, however, still note that asset tangibility and profitability are positively related to foreign debt levels before incorporating the effect of foreign currency swaps, whereas the coefficient on market-to-book ratio is negative. The significance of the coefficient on asset tangibility and market-to-book provide additional support for the effect of information barriers. Kedia and Mozumdar (2003) argue that firms with high asset tangibility are likely to have lower information asymmetries and, for this reason, are likely to raise more foreign debt. Allayannis et al. (2003) suggest that foreign lenders in East Asia prefer loans collateralized by tangible assets due to the high costs of monitoring borrowers. They also argue that if firms with more growth opportunities, as proxied by higher market-to-book, have greater information asymmetries, such firms will borrow more locally. The positive coefficient on profitability, proxied by the return on assets, is consistent with the signalling hypothesis proposed by Mora et al. (2013). They argue that more profitable firms incur dollar debt to signal their quality to creditors. This finding also supports the notion that more profitable firms have a better reputation and thus an easier access to international capital markets (Keloharju and Niskanen, 2001). None of these studies, however, obtain expected results.

We also estimate the model using the subsample of firms that have available data on foreign debt levels both before and after accounting for the effect of foreign currency swaps. The results, reported in Table A2 in the appendices, are qualitatively similar, except that the coefficient on market-to-book ratio is not significant.

As discussed by Allayannis et al. (2003), the specification of tests for the choice of currency for the denomination of debt are complicated by two factors. The first relates

to the fact that not all firms use foreign debt, which results in a point mass at zero. The second and more important issue is the problem of endogenous variables related to both local and foreign currency debt. To address these problems, we follow Allayannis et al. (2003) and estimate two sets of regressions. The first consists of variables assumed to be exogenous. The second is a simultaneous-equation Tobit model, similar to that of Nelson and Olson (1978). It is a two-stage analysis. Fitted value of local currency debt from the first stage estimation is included in the second stage estimation. Further details of these specifications are discussed in the appendices. The results from the simpler one-step specification are similar to those from the simultaneous-equation model.

Overall, our results suggest that foreign exchange exposure and firm size are the key drivers of foreign currency debt use in our sample. This finding is in line with the study of Keloharju and Niskanen (2001), who find that the variables that are associated with the firm's hedging policies in general but not directly linked to currency exposure have less to do with the likelihood of issuing foreign debt than those that have a direct link to hedging currency exposure or to the firm's access to foreign currency lending (size).

5.1.2. Individual currency exposure

In this section, we examine the relation between foreign operations and foreign debt at the currency level. We also control for firm incentives to lower interest costs by including the interest rate differential between the local and foreign currency.

The results, presented in Table 11 and Table 12, provide additional support for the effect of foreign operations on the use of foreign currency debt. The coefficients on US sales and EU sales are positive and highly significant. As discussed above, this finding suggests that firms raise foreign debt to hedge their currency exposure at the currency level, consistent with the hedging hypothesis. There is strong evidence to support the information barriers and market depth hypothesis as the coefficient on firm size is also positive and highly significant.

As in the previous section, we do a number of robustness tests. We run the regressions on the percentage of US and EU debt before incorporating the effect of foreign currency swaps. The results are presented in Table A4 and Table A7 in the appendices. We note that the differential between the UK and US short-term interest rates is negatively related to US debt level before accounting for the effect of swaps. This evidence is in contrast to the speculation hypothesis. It is instead consistent with the tax hypothesis as proposed by Keloharju and Niskanen (2001) that the greater the interest rate differential between the local and foreign currency, the smaller the tax

shields from borrowing in foreign currency and thus the smaller firms' incentives to issue foreign currency debt. We also estimate the model using the subsample of firms that have available data on US/EU debt levels both before and after accounting for the effect of foreign currency swaps. The results, reported in Table A5 and Table A8 in the appendices, are qualitatively similar, except that the coefficient on the differential between the UK and EU short-term interest rates is negative and significant.

To check for the results' robustness across time, we also estimate the model for subperiods 2001-2006 and 2007-2015. The results are reported in Table A6 and Table A9 in the appendices. There is no evidence in support of speculative motives having an effect on US debt use decision. In contrast, the interest rate differential is significantly positively related to EU debt levels in the pre-crisis period. The impact of interest rate differential on EU debt is strong, in comparison to that of EU sales or firm size. A 1% increase in the differential between the UK and EU interest rates increases the share of EU debt before and after incorporating the effect of swaps by 1.716% and 1.108%, respectively. This result is in line with previous studies (see, for example, Keloharju and Niskanen (2001), Allayannis et al. (2003), Brown et al. (2011)), which suggest that the costs of issuing debt are an important determinant of the decision to use foreign debt. Before the financial crisis, firms may have believed that they could lower these costs by borrowing in euros, which on average have a lower interest rate than sterling.

5.2. Foreign currency swap usage by UK firms

As mentioned above, using data on the firm's initial and final currency debt mix, we calculate the net foreign currency swap percentage as the final foreign currency debt percentage minus the initial foreign currency debt percentage. It is the net share of the firm's total debt that is swapped to foreign currency. In this section, we discuss the determinants of the decision to swap into foreign currency.

As shown in Table 13, firms with a greater level of exposure, proxied by greater foreign sales, have a higher share of their debt that is swapped to foreign currency, consistent with hedging theory and the results from the previous section. A 1% increase in the percentage of foreign sales increases the net foreign currency swap percentage by 0.185%. The results do not provide support for the signalling hypothesis, in line with Mora et al. (2013). In fact, more profitable firms have a lower share of their debt that is swapped to foreign currency. Their explanation to this finding is that insufficient foreign funds might be misallocated to less profitable firms if, for example, firms cannot guarantee high returns to secure loans. Gonzalez et al. (2010) argue that more

profitable firms generally have less debt according to the pecking order theory as firms prefer to fund their investment with internal resources. As suggested by Allayannis et al. (2003), foreign debt is a complement of local debt. Firms will use foreign debt after exhausting the local funding market. Consequently, more profitable firms will use a correspondingly lower level of foreign debt.

In Table 14 and Table 15, we present the results at the currency level. Consistent with previous results, US sales and EU sales are highly significant in explaining the decision of swapping into the US dollar and the euro, respectively. A 1% increase in the percentage of US sales increases the net US dollar swap percentage by 0.429%. The corresponding figure is 0.352% for the euro. Direct costs of debt are an important determinant of foreign currency swap use, as suggested by the highly significant and positive coefficient on the interest rate differential. Firms may have believed that they could lower these costs by swapping into the US dollar or the euro, which on average have a lower interest rate than sterling. These results provide support for the speculation hypothesis and are in line with previous studies (see, for example, Allayannis et al. (2003) and Brown et al. (2011)). The economic relevance of interest rate differential for foreign currency swap usage is strong, compared to the impact of foreign sales. Table 14, for example, suggests that a 1% increase in the differential between the UK and US interest rates increases the net US dollar swap percentage by 1.612%.

As a robustness test, we estimate the model for subperiods 2001-2006 and 2007-2015. The results are reported in Table A10 in the appendices. There is no evidence in support of the financial crisis having an effect on the decision to swap into the US dollar or the euro. In untabulated results, we repeat all these regressions on a subsample of swap users defined as firms that use foreign currency swaps at least once in the sample period. The results do not change qualitatively.

5.3. Foreign currency debt and swap direction

Firms use foreign currency swaps to modify the initial foreign exchange exposure of their debts. The final exposure of the firm's debt, after accounting for the effect of swaps, best reflects the implementation of its foreign exchange risk management programme. As stated in the data description section, if a firm used any foreign currency swaps during a fiscal year, we attempt to determine the directions of swaps. In Table 16, we repeat the OLS analysis conducted previously using the swap direction variables as one of the explanatory variables. The results show that firms that swap into sterling initially have more foreign currency debt compared to those that do not use swaps. After

incorporating the effect of swaps, firms that swap into sterling are no more likely to have foreign currency debt than swap non-users. We also note that the coefficients for the swap direction variables now become somewhat similar. These results suggest that regardless of the direction of swaps that firms undertake, there is a convergence in the currency profiles of firms' debt.

As a robustness check, we compare firms that swap into sterling and those that swap into foreign currency or both directions. The results show that firms that swap into foreign currency initially have less foreign currency debt compared to those that swap into sterling. After accounting for the effect of swaps, firms that swap into foreign currency are no less likely to have foreign currency debt than those that swap into sterling. Again, these results show that firms are getting closer to their desired foreign exchange exposure, regardless of the direction of swaps.

A similar pattern can be observed from Table 17 when we estimate the model using US debt as the dependent variable. The results show that firms that swap into sterling initially have more US debt compared to those that do not use swaps and firms that swap into foreign currency initially have less US debt compared to those that swap into sterling. In Table 18, we use EU debt as the dependent variable and find that after incorporating the effect of swaps, firms that swap into foreign currency have more EU debt compared to swap non-users.

5.4. Foreign currency swap usage and default probability

In this section, we examine the relationship between foreign currency swap use and the probability of default. We use the fundamental probability of default (PD) values sourced from S&P CIQ. S&P Global Market Intelligence has developed PD Model Fundamentals, a PD model that incorporates both financial and business risk and provides a comprehensive overview of a company's creditworthiness. To check for the results' robustness, we also use the Expected Default Frequency (EDF) values sourced from Moody's Analytics. EDF metrics are forward-looking probabilities of default. Our control variables come from the hedging literature (see, for example, Smith and Stulz (1985) and Nance et al. (1993)) and the literature on firm default (see, for example, Shumway (2001), Chava and Jarrow (2004) (2004) and Campbell et al. (2008)).

Table 19 provides summary statistics for measures of default probability as well as control variables. The mean and median PDs are quite low (1.9% and 0.7%, respectively). Our sample period is 2002-2015 due to the lack of coverage of PD data in CIQ before 2002. In robustness checks, we use EDF and extend our sample period

to include the years 1999-2001. Panel B of Table 19 shows that firms that use foreign currency swaps have lower default probabilities than those that do not. Consistent with previous studies (see, for example, Guay (1999), Hentschel and Kothari (2001), Campello et al. (2011) and Bartram et al. (2011)), we find that foreign currency swap users are significantly larger and have higher leverage ratios, lower price volatility and fewer liquid assets compared to non-users.

Our pooled OLS results are presented in Table 20. In contrast to univariate tests in Table 19, we find evidence that firms that use foreign currency swaps have statistically higher probabilities of default, controlling for other firm characteristics that may drive firm default. The results show that swap use increases default probability by 0.36%. We further examine the effects of swap directions and find a higher likelihood of bankruptcy for firms that swap into foreign currency compared to those that do not use foreign currency swaps.

All of the coefficients on control variables have the expected signs and are highly significant. Firms with higher leverage ratios have higher expected costs of financial distress and hence higher probabilities of default, in line with Campello et al. (2011), Magee (2013) and Marin (2013). Larger and more profitable firms are exposed to lower default risk. A potential explanation is that larger firms are more likely to diversify products and markets, while more profitable firms are better able to service their debts or finance themselves instead of raising costly external funds from the capital market. Liquidity has a negative impact on the default probability. Firms with more cash or liquid assets do not necessarily rely on external financing to make investment or interest payments. We also find that lower price volatility and better equity market performance indicate lower probability of default.

As robustness checks, we run the regressions using the lagged values of explanatory variables and use the quantile regression model. The results, presented in Table A11 and Table A12 in the appendices, are qualitatively similar to our previous results, except that firms that swap into sterling also have higher likelihood of bankruptcy than those that do not use foreign currency swaps. We also use the EDF values sourced from Moody's Analytics as the dependent variables and repeat the OLS analysis conducted previously. The results are provided in Table A13 in the appendices. We find that firms that use foreign currency derivatives have statistically lower probabilities of default and a higher likelihood of bankruptcy for firms that swap into foreign currency compared to those that swap into sterling.

The effects of swap use on default probability may vary over time, which is potentially consistent with the prevailing macroeconomic and financial conditions. To examine the time-varying effects of foreign currency swaps, we interact the swap dummy with year dummies. It could be argued that derivative users will hedge more during periods of economic downturn. If it is the case, we expect a greater impact of swap use on the probability of default during these periods, and hence higher values for the interaction terms' coefficients. Conversely, firms may reduce the level of hedging activities during favourable macroeconomic conditions, in which case there will be smaller differences in the default risk between swap users and non-users. Thus, the coefficients on the interaction terms may fall in value. We use the annual GDP growth rate to control for time effects that may be associated with the probability of default. The results are presented in Table A14 in the appendices.

As can be seen from Table A14, the interaction terms' coefficients decrease from 0.008 in 2004 to 0.004 in 2007. This seems to closely follow the performance of the UK economy. During the 2004-2006 period, the real GDP growth rate averaged 3%, household consumption went up and corporate profits increased. High profitability and liquidity might have led to fewer hedging activities during this period, which, in turn, could explain lower absolute values of the interaction terms' coefficients. In 2010, the crisis in the eurozone, the UK's biggest trading partner, deepened as Greece and Ireland received bailouts. After a spell of growth in the UK, GDP declined in the final quarter of the year. One year later, there was growth in the first three quarters, but the economy contracted again at the end of the year. Unemployment peaked at 2.6 million, the highest since 1996. The squeeze on household spending intensified as inflation topped 5%. The Bank of England predicted a slow and uncertain path to growth, zig-zagging between small rises and falls. In 2013, the UK lost its AAA credit rating. The increase in the interaction terms' coefficients from 2011 to 2014 is consistent with the economic downturn in the UK during this period.

6. Conclusion

In this study, we examine the determinants of the choice of foreign currency debt. We first control for firm characteristics that affect foreign debt use at the aggregate level and then include proxies for currency differences. We find that foreign currency exposure, proxied by foreign sales, is highly significant in explaining the firm's use of foreign currency debt. The results support the view that firms use foreign currency debt to hedge their exchange rate exposure as foreign cash flows provide a natural hedge.

The firm's use of foreign currency debt is positively related to its size. This is not surprising given that larger firms are more likely to have international operations and for that matter larger operations and relatively more direct access to international capital markets than small companies. This is further evidence in support of the market depth theory.

The results at the currency level provide additional support for the effect of foreign operations and firm size on the use of foreign currency debt. As a robustness check, we estimate the model for subperiods 2001-2006 and 2007-2015 and find that before the financial crisis, firms tended to borrow more in euros when the differential between the UK and EU interest rates increased in an attempt to lower interest costs. We then examine the determinants of the decision to swap into foreign currency and again find that direct costs of debt are an important determinant of foreign currency swap use. Firms may have believed that they could lower these costs by swapping into US dollars or euros, which on average have a lower interest rate than sterling, consistent with the speculation hypothesis.

We further examine the direction of swaps. The results show that firms that swap into sterling initially have more foreign currency debt compared to those that do not use swaps, and firms that swap into foreign currency initially have less foreign currency debt compared to those that swap into sterling. After incorporating the effect of swaps, firms are getting closer to their desired foreign exchange exposure. These results suggest that regardless of the direction of swaps that firms undertake, there is a convergence in the currency profiles of firms' debt.

Finally, we examine the relationship between foreign currency swap use and the probability of default and find evidence that firms that use foreign currency swaps have higher probabilities of default, controlling for other firm characteristics that may drive firm default. We also find a higher likelihood of bankruptcy for firms that swap into foreign currency compared to those that do not use foreign currency swaps. The effects of swap use on default probability vary over time, consistent with the prevailing macroeconomic and financial conditions. Our results suggest that these effects are stronger during periods of heightened macroeconomic uncertainty and weaker during favourable macroeconomic conditions.

Taken as a whole, our results on foreign currency debt use provide a mixed picture as to whether UK firms are taking a firm-wide risk management approach or investment management approach. Hedging foreign exchange exposure is clearly very important,

but pricing considerations also matter a lot. Before the financial crisis, relative interest rates are also important when firms consider borrowing in a foreign currency. These results mimic the findings for the fixed/floating mix of debt. Again, it is possible that managers are evaluated on their current performance or approaching retirement age. In that case, the firm may choose to borrow in currencies where interest rates are low in an attempt to lower the total interest paid in the short run. Our findings that foreign currency swap users have higher probabilities of default also suggest that local and international financial institutions should develop emergency plans for stabilizing the foreign currency swap market in times of financial crisis. Policy makers should concentrate on structural economic issues rather than purely financial remedies.

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Table 1: Summary of Previous Studies on Foreign Currency Debt Use (in chronological order)

Author(s) of study	Date	Source of data	Types of firms	Sample period	Sample size	Country
Allayannis G., Ihrig J. & Weston J.P.	2001	COMPUSTAT, CRSP & annual reports	multinational, non-financial	1996-1998	265 firms	US
Allayannis G. & Ofek E.	2001	annual reports & DISCLOSURE	non-financial S&P 500	1993	378 firms	US
Keloharju M. & Niskanen M.	2001	private survey	non-financial	1985-1991	44 companies 337 long-term loans	Finland
Allayannis G., Brown G.W. & Klaper L.F.	2003	SBC Warburg Dillon Read equity reports	non-financial	1996-1998	327 firms	8 East Asian countries
Kedia S. & Mozumdar A.	2003	Moody's Investor Services	sales greater than $1.6 billion	1996	523 firms	US
Bancel F. & Mittoo U.R.	2004	survey		2001	87 firms	16 European countries
Aabo T.	2006	questionnaires	non-financial	2001	47 firms	Denmark
Servaes H. & Tufano P.	2006	survey	Deutsche Bank's corporate clients	2005	334 companies	39 countries
McBrady M.R. & Schill M.J.	2007	Thomson Financial Securities Data Company Platinum Global New Issues	public sector entities	1991-2003	2,080 international bond offerings	31 countries
Clark E. & Judge A.	2008	annual reports	non-financial top 500	1995	366 firms	UK
Habib M.M. & Joy M.	2008	Bondware	all issuer types	1999-2008	172,352 bond offerings	116 countries
Arena M.P. & Roper A.H.	2010	Compustat Global Thomson Financial's Security Data Corporation Global New Issues Database	non-US, non-financial	1995-2004	8,287 debt issues 2,437 firms	23 countries
González L.O., Búa M.V., López S.F. & Durán P.	2010	annual accounts & SABI database survey	non-financial	2004	96 companies	Spain
Nandy, D.K.	2010	Loan Pricing Corporation's Dealscan database	large corporate & middle market	1987-1995	99 loan deals	UK & Canada
Brown M., Ongena S. & Yesin P.	2011	Business Environment and Enterprise Performance Survey	small	2002-2005	3,101 firms	25 transition countries
Mora N., Neaime S. & Aintablian S.	2013	survey	small	2005-2006	201 companies	Lebanon

Table 2: Summary of Dependent Variables and Econometric Methodology in Previous Studies

Author(s) of study	Date	Dependent variable	Econometric methodology
Allayannis G., Ihrig J. & Weston J.P.	2001	an indicator variable set equal to 1 if the firm has foreign-currency derivatives or uses foreign debt	logistic regression
Allayannis G. & Ofek E.	2001	a binary variable equal to 1 if a firm uses foreign debt and 0 otherwise; the amount of foreign debt issue	binominal probit, truncated regression
Keloharju M. & Niskanen M.	2001	a dummy variable which takes the value of 1 if a loan is denominated in any foreign currency and 0 if the loan is Finnish markka denominated	probit
Allayannis G., Brown G.W. & Klaper L.F.	2003	debt divided by firm value	Tobit
Kedia S. & Mozumdar A.	2003	a dummy variable which takes a value of 1 when the firm has any foreign debt and 0 otherwise	probit
Aabo T.	2006	an ordered variable with the values of 1 (currency derivatives are more important), 2 (currency derivatives and foreign debt are equally important), and 3 (foreign debt is more important)	ordered probit regression
McBrady M.R. & Schill M.J.	2007	the abnormal share of total non-convertible, non-domestic currency bond offerings denominated in a particular currency	fixed-effects panel regressions
Clark E. & Judge A.	2008	The likelihood that a firm chooses one of three categories of FC hedging strategy: 1) FC derivatives and FC debt; 2) FC debt only; and 3) FC derivatives only	multinomial logit
Habib M.M. & Joy M.	2008	the number of bonds issued in a currency as a share of the total number of bonds issued in all currencies	fixed effects
Arena M.P. & Roper A.H.	2010	a dummy variable which takes the value 1 if the debt is issued by either the parent or a domestic subsidiary and 1 if it is issued by a foreign subsidiary, the ratio of the amount of debt issued by all foreign subsidiaries of a company located in a specific country to the total amount of debt issued by the multinational firm in a fiscal year	logit & Tobit
González L.O., Búa M.V., López S.F. & Durán P.	2010	the likelihood of using foreign debt, the percentage of debt in foreign currency	binomial probit, multinomial logistic & Tobit
Nandy, D.K.	2010	a dummy which equals 1 if the loan is denominated in US dollars and 0 if the loan is in Canadian dollars/UK pounds	probit
Brown M., Ongena S. & Yesin P.	2011	a dummy variable which takes the value 1 if the most recent loan was denominated in a foreign currency and 1 otherwise	probit
Mora N., Neaime S. & Aintablian S.	2013	whether a firm takes on dollar debt conditional on reporting that it borrows	probit

Table 3: Frequency Distribution of Foreign Currency Derivative Use

This table provides the frequency distribution of derivative use by UK firms over the sample period 1999-2015.

Derivative Categories	Frequency	Percentage
Panel A: Derivative Users and Non-users		
Derivative Users	5,306	82.44
Non-users	1,130	17.56
Total	6,436	100.00
Panel B: Types of Derivatives (As a % of Derivative Users)		
FC Derivatives	4,154	78.29
IR Derivatives	4,299	81.02
CP Derivatives	728	13.72
Panel C: FC Derivative Users		
Disclose Types of Derivatives	3,900	93.89
Do not Disclose Types of Derivatives	254	6.11
Total	4,154	100.00
Panel D: Types of FC Derivatives (As a % of FC Derivative Users that Disclose)		
FC Forwards	3,483	89.31
FC Swaps	1,696	43.49
FC Options	452	11.59
Panel E: FC Swap Direction (As a % of FC Swap Users that Disclose)		
Swap into Sterling	327	37.07
Swap into foreign currency	426	48.30
Swap into both	129	14.63

Table 4: Descriptive Statistics of Foreign Currency Debt Use

This table provides summary statistics of initial and final foreign currency debt for the full sample and subsample. Swapped to foreign currency is the net percentage of debt that is swapped into foreign currencies. Absolute swapped to foreign currency is the amount of foreign currency swaps outstanding at the fiscal year end as a percentage of the total debt. Swap users are defined as firms that use foreign currency swaps at least once during the sample period.

Variable	Obs	Mean	Median	Std. Dev.	Min	Max
Panel A: Full Sample						
Foreign currency debt (pre-swap) (%)	4,574	39.66	16.68	42.87	0.00	100.00
Foreign currency debt (net of swap) (%)	4,646	46.06	45.04	39.93	0.00	100.00
Panel B: Subsample of Firms with Available Data on Foreign Currency Debt both Pre- and Net of Swap						
Foreign currency debt (pre-swap) (%)	3,545	40.30	22.31	42.48	0.00	100.00
Swapped to foreign currency (%)	3,545	7.31	0.00	39.33	-100.00	100.00
|Swapped to foreign currency (%) |	3,545	24.41	7.69	31.69	0.00	100.00
Foreign currency debt (net of swap) (%)	3,545	47.60	48.52	39.88	0.00	100.00
Panel C: Subsample of Swap Users						
Foreign currency debt (pre-swap) (%)	1,790	45.47	43.89	40.12	0.00	100.00
Swapped to foreign currency (%)	1,790	8.29	0.22	40.66	-100.00	100.00
|Swapped to foreign currency (%) |	1,790	27.91	14.90	30.70	0.00	100.00
Foreign currency debt (net of swap) (%)	1,790	53.76	59.82	36.99	0.00	100.00

Table 5: Proportion of Foreign Currency Debt Users in Samples of Empirical Studies

This table provides details of the frequency of foreign currency debt use reported in previous studies.

Author(s) of study	Date	Country	Sample period	Sample size	% of FC Debt users	FC Debt as a % of total debt
Allayannis G. & Ofek E.	2001	US	1993	378 firms	22.0	NA
Keloharju M. & Niskanen M.	2001	Finland	1985-1991	337 long-term loans	54.9	NA
Allayannis G., Brown G.W. & Klaper L.F.	2003	8 East Asian countries	1996-1998	327 firms	61.8	61.7
Kedia S. & Mozumdar A.	2003	US	1996	523 firms	22.0	20.0
Clark E. & Judge A.	2008	UK	1995	192 firms	51.6	NA
Arena M.P. & Roper A.H.	2010	23 countries	1995-2004	8287 debt issues	18.7	NA
González L.O., Búa M.V., López S.F. & Durán P.	2010	Spain	2004	96 companies	42.0	5.0
Nandy, D.K.	2010	UK & Canada	1987-1995	99 loan deals	68.7	47.4
Brown M., Ongena S. & Yesin P.	2011	25 transition countries	2002-2005	3,101 firms	25.0	NA
Mora N., Neaime S. & Aintablian S.	2013	Lebanon	2005-2006	77 companies	82.0	73.4

Table 6: Descriptive Statistics of Sales, Assets and Debt by Currency

This table displays how total sales, assets and debt (pre- and net of swap) are distributed across 3 main currencies, i.e. Sterling, US dollar and Euro.

Variable	Obs	Mean	Median	Std. Dev.	Min	Max
Panel A: Sales						
UK sales	5,831	53.87	52.00	37.68	0.00	100.00
US sales	5,831	15.17	0.00	20.68	0.00	100.00
EU sales	5,831	16.64	7.92	20.81	0.00	100.00
Other sales	5,831	14.31	4.00	21.93	0.00	100.00
Panel B: Assets						
UK assets	4,969	55.74	59.30	38.30	0.00	100.00
US assets	4,969	15.77	1.18	23.57	0.00	100.00
EU assets	4,969	13.19	0.07	21.34	0.00	100.00
Other assets	4,969	14.99	3.02	23.99	0.00	100.00
Panel C: Debt (Pre-swap)						
UK debt	4,574	60.34	83.32	42.87	0.00	100.00
US debt	4,574	20.26	0.00	33.35	0.00	100.00
EU debt	4,574	6.85	0.00	18.81	0.00	100.00
Other debt	4,574	12.55	0.00	28.67	0.00	100.00
Panel D: Debt (Net of Swap)						
UK debt	4,646	53.89	54.81	39.94	0.00	100.00
US debt	4,646	24.97	4.28	32.45	0.00	100.00
EU debt	4,646	13.49	0.00	23.06	0.00	100.00
Other debt	4,646	7.60	7.09	15.98	0.00	100.00

Table 7: Determinants of the Choice of Foreign Currency Debt

This table presents hypotheses on the use of foreign currency debt based on related theory and evidence.

Variable	Hedging	Speculation	Agency cost	Market depth
Foreign sales	+			
Natural log of assets			+	+
Asset tangibility	-		+	
Current ratio	-			
R&D/sales	+		-	
Market-to-book/assets	+		-	
ROA			+	
Dividend yield	+			
Credit rating			+	
Interest rate differentials		+		

Table 8: Descriptive Statistics of Explanatory Variables

This table provides summary statistics for variables that are used to explain foreign currency debt use by UK firms during the sample period 1999-2015. Asset tangibility is the ratio of fixed assets to total assets. Current ratio and quick ratio are current assets and quick assets divided by current liabilities, respectively. Dividend yield is dividend per share as a percentage of year-end stock price.

Variable	Obs	Mean	Median	Std.Dev.	Min	Max
Foreign sales (%)	5831	46.13	48.00	37.68	0.00	100.00
Foreign assets (%)	4969	44.16	40.58	38.29	0.00	100.00
Natural log of assets	6369	6.50	6.42	1.83	-0.77	12.35
Natural log of sales	6304	6.08	6.17	2.07	-5.81	12.66
Asset tangibility	6366	0.58	0.60	0.24	0.00	1.00
Current ratio	6333	2.07	1.30	10.62	0.00	797.84
Quick ratio	6276	1.48	0.86	10.45	0.00	797.84
R&D/sales	6298	25.02	0.00	701.81	0.00	43636.84
R&D/assets	6363	2.14	0.00	7.01	0.00	166.67
Market-to-book	5158	1.53	1.08	2.42	0.00	73.69
Return on assets	6183	4.71	4.93	8.90	-110.16	186.76
Dividend yield (%)	4899	3.25	2.74	3.81	0.00	100.00
Credit rating	6876	0.13	0.00	0.34	0.00	1.00

Table 9: Test of Difference in Means and Medians between Foreign Debt Users and Non-users

This table presents the results of t test on the equality of means and Wilcoxon rank-sum test on the equality of medians between foreign debt users and non-users. Foreign debt users are defined as firms that use foreign debt during the fiscal year. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

Variable	Foreign Debt Non-users			Foreign Debt Users			Difference	
	Mean	Median	Obs	Mean	Median	Obs	Mean	Median
Foreign sales	12.79	0.00	1200	57.07	63.00	3242	-44.28***	-36.80***
Foreign assets	8.26	0.00	974	55.83	61.34	2986	-47.57***	-36.41***
Natural log of assets	6.11	6.13	1220	6.94	6.86	3306	-0.83***	-14.32***
Natural log of sales	5.63	5.77	1215	6.62	6.58	3296	-0.99***	-16.42***
Asset tangibility	0.59	0.64	1220	0.59	0.61	3306	-0.01	2.04**
Current ratio	1.78	1.12	1213	1.57	1.28	3292	0.22***	-3.53***
Quick ratio	1.11	0.67	1211	1.08	0.86	3284	0.03	-10.89***
R&D/sales	8.83	0.00	1215	5.02	0.00	3293	3.80**	-11.17***
R&D/assets	1.59	0.00	1220	1.76	0.00	3303	-0.17	-11.06***
Market-to-book/assets	1.62	1.04	1059	1.38	1.07	3008	0.24***	-0.03
Return on assets	5.04	5.18	1192	4.87	4.95	3255	0.17	1.87*
Dividend yield	3.11	2.54	970	3.42	2.89	2763	-0.31**	-4.70***
Credit rating	0.07	0.00	1249	0.19	0.00	3390	-0.11***	-9.47***

Table 10: Regressions of Final Foreign Currency Debt (Net of Swap) 1999-2015

This table presents the results of regressions on final foreign currency debt defined as the percentage of outstanding debt that is denominated in foreign currency after accounting for the effect of foreign currency swaps. The sample period is 1999-2015. Standard errors in parentheses are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	OLS	Lag	Tobit	Fixed effects	Beta
Foreign sales	0.619***	0.603***	0.868***	0.270***	0.025***
	(0.032)	(0.034)	(0.048)	(0.071)	(0.001)
Natural log of assets	4.551***	4.650***	6.848***	7.761***	0.168***
	(0.863)	(0.929)	(1.240)	(2.466)	(0.033)
Asset tangibility	0.849	1.504	-1.410	-6.736	0.097
	(5.252)	(5.586)	(8.629)	(11.788)	(0.200)
Current ratio	0.361	-0.042	-0.349	-0.351	0.011
	(0.970)	(1.047)	(1.646)	(1.098)	(0.037)
R&D/sales	-0.525	-0.705	-0.774	-0.969	-0.023
	(0.433)	(0.442)	(0.597)	(0.634)	(0.017)
Market-to-book	0.010	-0.283	0.011	-0.548	-0.012
	(0.525)	(0.468)	(0.707)	(0.597)	(0.018)
Return on assets	0.131	0.304	0.149	-0.225	0.009
	(0.202)	(0.217)	(0.298)	(0.225)	(0.009)
Dividend yield	0.327	0.374**	0.619*	-0.040	0.012
	(0.208)	(0.184)	(0.361)	(0.096)	(0.010)
Credit rating	-4.093	-4.185	-5.880	3.868	-0.161
	(2.774)	(2.916)	(3.875)	(4.561)	(0.101)
Constant	-25.977***	-35.979***	-65.132***	-18.991	-3.062***
	(9.772)	(9.208)	(14.001)	(18.846)	(0.363)
Industry FE	Yes	Yes	Yes	No	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	3370	3011	3370	3370	3370
Adjusted R_2	0.479	0.465		0.050	

Table 11: Regressions of Final US Debt (Net of Swap) 1999-2015

This table presents the results of regressions on final US debt defined as the percentage of outstanding debt that is denominated in US dollar after accounting for the effect of foreign currency swaps. The sample period is 1999-2015. Standard errors in parentheses are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	OLS	Lag	Tobit	Fixed effects	Beta
US sales	0.839***	0.831***	1.275***	0.332***	0.037***
	(0.053)	(0.055)	(0.078)	(0.122)	(0.003)
3-month Interest rate differentials	-0.340	-0.237	-0.183	-0.391	-0.005
	(0.418)	(0.449)	(0.707)	(0.398)	(0.017)
Natural log of assets	2.924***	3.129***	5.441***	3.999**	0.143***
	(0.791)	(0.850)	(1.226)	(1.655)	(0.032)
Asset tangibility	14.720***	13.491**	17.906*	1.467	0.434*
	(5.673)	(5.876)	(10.094)	(9.927)	(0.222)
Current ratio	2.868*	2.527	3.373	0.345	0.069
	(1.519)	(1.578)	(2.628)	(0.718)	(0.056)
R&D/sales	0.187	0.043	0.074	-0.156	0.009
	(0.292)	(0.310)	(0.402)	(0.453)	(0.012)
Market-to-book	-0.008	0.124	-0.021	-0.757*	-0.003
	(0.413)	(0.381)	(0.698)	(0.424)	(0.013)
Return on assets	0.280	0.459**	0.196	-0.005	0.016
	(0.225)	(0.233)	(0.352)	(0.187)	(0.010)
Dividend yield	0.029	0.051	0.079	-0.088	0.005
	(0.183)	(0.151)	(0.320)	(0.090)	(0.010)
Credit rating	-1.178	-2.086	-1.107	7.204	0.021
	(2.635)	(2.712)	(4.013)	(4.488)	(0.103)
Constant	-31.174***	-29.436***	-78.370***	-8.395	-3.594***
	(8.894)	(9.486)	(14.708)	(11.912)	(0.352)
Industry FE	Yes	Yes	Yes	No	Yes
Year FE	No	No	No	No	No
Observations	3370	3011	3370	3370	3370
Adjusted $R2$	0.429	0.418		0.040	

Table 12: Regressions of Final EU Debt (Net of Swap) 1999-2015

This table presents the results of regressions on final EU debt defined as the percentage of outstanding debt that is denominated in Euro after accounting for the effect of foreign currency swaps. The sample period is 1999-2015. Standard errors in parentheses are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	OLS	Lag	Tobit	Fixed effects	Beta
EU sales	0.597***	0.578***	0.977***	0.262***	0.028***
	(0.052)	(0.052)	(0.076)	(0.055)	(0.003)
3-month Interest rate differentials	-0.417	0.198	-0.261	-0.037	-0.003
	(0.525)	(0.542)	(0.948)	(0.509)	(0.024)
Natural log of assets	1.521**	1.512**	4.926***	4.348***	0.151***
	(0.589)	(0.617)	(1.012)	(1.106)	(0.027)
Asset tangibility	-4.550	-5.170	-10.049	-2.521	-0.152
	(3.560)	(3.616)	(6.817)	(6.731)	(0.151)
Current ratio	-0.795	-1.163	-1.629	-0.603	-0.037
	(0.761)	(0.792)	(1.658)	(0.664)	(0.037)
R&D/sales	-0.309*	-0.445**	-0.427	-0.068	-0.016
	(0.170)	(0.218)	(0.370)	(0.297)	(0.010)
Market-to-book	-0.615***	-0.679***	-1.581**	-0.159	-0.031**
	(0.217)	(0.247)	(0.780)	(0.218)	(0.012)
Return on assets	0.210	0.190	0.437	-0.117	0.007
	(0.156)	(0.176)	(0.291)	(0.148)	(0.007)
Dividend yield	0.066	0.056	0.134	-0.004	0.005
	(0.085)	(0.100)	(0.179)	(0.060)	(0.004)
Credit rating	-1.882	-2.140	-4.643	1.980	-0.188*
	(2.044)	(2.237)	(3.727)	(2.233)	(0.096)
Constant	-13.438**	-14.813**	-40.951***	-17.563**	-3.108***
	(6.835)	(6.846)	(11.539)	(8.604)	(0.310)
Industry FE	Yes	Yes	Yes	No	Yes
Year FE	No	No	No	No	No
Observations	3370	3011	3370	3370	3370
Adjusted R_2	0.282	0.266		0.043	

Table 13: Regressions of Swapped to Foreign Currency (%) 2001-2015

This table presents the results of regressions on the net share of the firm's total debt that is swapped to foreign currency. The sample period is 2001-2015. Standard errors in parentheses are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	OLS	Lag	Tobit	Fixed effects
Foreign sales	0.185***	0.180***	0.188***	0.156*
	(0.040)	(0.042)	(0.041)	(0.081)
Natural log of assets	0.618	0.688	0.594	-2.288
	(1.054)	(1.127)	(1.075)	(4.424)
Asset tangibility	-10.553	-11.115	-10.447	-12.561
	(6.499)	(6.890)	(6.603)	(17.557)
Current ratio	-1.465	-1.662	-1.407	0.412
	(1.107)	(1.299)	(1.125)	(1.500)
R&D/sales	-0.213	-0.478	-0.230	-1.193**
	(0.331)	(0.356)	(0.338)	(0.554)
Market-to-book	1.784	1.985	1.941	0.175
	(1.759)	(1.615)	(1.804)	(2.405)
Return on assets	-0.856***	-0.923***	-0.887***	-0.541*
	(0.283)	(0.304)	(0.289)	(0.288)
Dividend yield	0.149	0.159	0.150	0.074
	(0.152)	(0.166)	(0.153)	(0.134)
Credit rating	-3.397	-2.554	-3.493	-5.746
	(3.867)	(3.929)	(3.901)	(6.394)
Constant	-43.751***	-6.383	-6.659	24.242
	(13.968)	(11.885)	(12.220)	(34.791)
Industry FE	Yes	Yes	Yes	No
Year FE	Yes	Yes	Yes	Yes
Observations	2817	2676	2817	2817
Adjusted R_2	0.052	0.051		0.022

Table 14: Regressions of Swapped to US dollar (%) 2001-2015

This table presents the results of regressions on the net share of the firm's total debt that is swapped to US dollar. The sample period is 2001-2015. Standard errors in parentheses are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	OLS	Lag	Tobit	Fixed effects
US sales	0.429***	0.437***	0.429***	0.284*
	(0.062)	(0.065)	(0.063)	(0.162)
3-month Interest rate differentials	1.612***	1.785***	1.619***	0.486
	(0.566)	(0.523)	(0.567)	(0.567)
Natural log of assets	-2.188***	-2.334**	-2.190***	-2.772
	(0.812)	(0.904)	(0.820)	(2.366)
Asset tangibility	5.050	4.938	5.116	-4.445
	(4.567)	(4.836)	(4.585)	(11.178)
Current ratio	-0.454	-0.456	-0.460	-0.141
	(0.860)	(1.074)	(0.873)	(0.824)
R&D/sales	-0.287	-0.536*	-0.283	-0.318
	(0.277)	(0.290)	(0.279)	(0.316)
Market-to-book	0.853	0.494	0.889	1.091
	(1.362)	(1.324)	(1.381)	(1.527)
Return on assets	-0.497**	-0.417**	-0.502**	-0.295
	(0.200)	(0.198)	(0.201)	(0.222)
Dividend yield	-0.148	-0.105	-0.148	-0.082
	(0.103)	(0.093)	(0.103)	(0.122)
Credit rating	-0.849	0.612	-0.837	-1.996
	(3.019)	(3.083)	(3.017)	(4.032)
Constant	5.946	9.285	20.295**	26.245
	(7.344)	(8.397)	(8.032)	(16.764)
Industry FE	Yes	Yes	Yes	No
Year FE	No	No	No	No
Observations	2817	2676	2817	2817
Adjusted R_2	0.113	0.115		0.009

Table 15: Regressions of Swapped to Euro (%) 2001-2015

This table presents the results of regressions on the net share of the firm's total debt that is swapped to Euro. The sample period is 2001-2015. Standard errors in parentheses are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	OLS	Lag	Tobit	Fixed effects
EU sales	0.352***	0.349***	0.353***	0.119*
	(0.046)	(0.045)	(0.046)	(0.064)
3-month Interest rate differentials	1.742***	1.559**	1.747***	0.955
	(0.594)	(0.605)	(0.593)	(0.648)
Natural log of assets	0.175	-0.192	0.176	-2.189
	(0.554)	(0.575)	(0.553)	(1.708)
Asset tangibility	-8.663**	-8.576**	-8.641***	4.650
	(3.358)	(3.507)	(3.350)	(7.948)
Current ratio	-1.506***	-1.782***	-1.497***	-0.164
	(0.554)	(0.605)	(0.554)	(0.752)
R&D/sales	-0.255	-0.292	-0.259	-0.103
	(0.174)	(0.194)	(0.176)	(0.378)
Market-to-book	-0.945	-1.588*	-0.936	-1.102
	(0.930)	(0.883)	(0.931)	(1.275)
Return on assets	0.104	0.175	0.103	-0.139
	(0.166)	(0.179)	(0.166)	(0.188)
Dividend yield	0.021	0.076	0.022	-0.028
	(0.083)	(0.104)	(0.083)	(0.079)
Credit rating	-6.546***	-6.198***	-6.552***	-1.812
	(2.032)	(2.162)	(2.026)	(4.181)
Constant	3.699	6.707	8.214	21.069
	(5.487)	(5.935)	(5.972)	(12.819)
Industry FE	Yes	Yes	Yes	No
Year FE	No	No	No	No
Observations	2817	2676	2817	2817
Adjusted $R2$	0.140	0.138		0.008

Table 16: OLS Regressions of Foreign Currency Debt and Swap Direction

This table presents the results of the direction of swaps in comparison with firms that that swap into Sterling and those that do not use foreign currency swaps. The dependent variables are initial and final foreign currency debt and the corresponding sample period is 2001-2015 and 1999-2015, respectively. Standard errors in parentheses are adjusted for clustering by firm. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

	Compared to firms that swap into Sterling		Compared to firms that do not use swaps	
	Initial foreign currency debt (Pre-swap)	Final foreign currency debt (Net of Swap)	Initial foreign currency debt (Pre-swap)	Final foreign currency debt (Net of Swap)
Swap into Sterling			10.525**	1.076
			(4.214)	(3.243)
Swap into foreign currency	-9.015**	5.561	-1.676	3.511
	(4.393)	(3.948)	(3.597)	(3.189)
Swap into both	-4.136	3.788	3.144	3.765
	(6.867)	(5.010)	(7.297)	(4.530)
Cannot determine swap direction	-10.753***	1.061	-4.357	0.491
	(4.110)	(3.385)	(3.396)	(2.815)
Foreign sales	0.249***	0.512***	0.446***	0.609***
	(0.069)	(0.044)	(0.042)	(0.033)
Natural log of assets	4.186***	5.170***	3.970***	4.347***
	(1.598)	(1.437)	(1.145)	(0.973)
Asset tangibility	21.811*	-0.093	14.112**	-2.236
	(12.846)	(9.362)	(7.109)	(5.429)
Current ratio	8.759***	3.219	1.122	-0.258
	(3.214)	(2.180)	(1.297)	(0.951)
R&D/sales	-0.057	-1.299*	0.174	-0.468
	(0.604)	(0.668)	(0.433)	(0.447)
Market-to-book	2.994	1.712*	-3.286	0.150
	(3.327)	(0.955)	(2.001)	(0.543)
Return on assets	0.096	-0.558	1.101***	0.081
	(0.565)	(0.350)	(0.304)	(0.205)
Dividend yield	0.276	0.557*	0.212	0.335
	(0.397)	(0.324)	(0.175)	(0.208)
Credit rating	1.698	-3.293	0.777	-4.172
	(4.817)	(3.469)	(3.509)	(2.791)
Constant	-44.276**	3.003	4.293	-25.291**
	(18.027)	(18.841)	(15.260)	(9.922)
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	1208	1182	3328	3269
Adjusted R_2	0.299	0.467	0.319	0.478

Table 17: OLS Regressions of US Debt and Swap Direction

This table presents the results of the direction of swaps in comparison with firms that that swap into Sterling and those that do not use foreign currency swaps. The dependent variables are initial and final US debt and the corresponding sample period is 2001-2015 and 1999-2015, respectively. Standard errors in parentheses are adjusted for clustering by firm. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

	Compared to firms that swap into Sterling		Compared to firms that do not use swaps	
	Initial US debt (Pre-swap)	Final US debt (Net of Swap)	Initial US debt (Pre-swap)	Final US debt (Net of Swap)
Swap into Sterling			11.907***	2.394
			(3.434)	(3.226)
Swap into foreign currency	-11.439***	-1.732	-0.584	-0.871
	(4.227)	(3.859)	(3.691)	(2.911)
Swap into both	-8.454	-9.426**	2.376	-8.488***
	(6.558)	(4.200)	(6.606)	(3.095)
Cannot determine swap direction	-15.804***	-6.356*	-5.447**	-5.418**
	(3.494)	(3.273)	(2.620)	(2.123)
US sales	0.187*	0.714***	0.403***	0.848***
	(0.109)	(0.075)	(0.069)	(0.054)
3-month Interest rate differentials	-2.607***	-0.265	-1.928***	-0.030
	(0.965)	(0.755)	(0.551)	(0.413)
Natural log of assets	6.948***	4.612***	6.096***	3.590***
	(1.530)	(1.237)	(0.969)	(0.841)
Asset tangibility	14.077	18.831**	9.646	9.578*
	(11.403)	(7.756)	(6.162)	(5.245)
Current ratio	12.058***	9.192***	2.660**	1.854
	(2.793)	(2.743)	(1.305)	(1.346)
R&D/sales	0.315	0.210	0.439	0.208
	(0.705)	(0.587)	(0.351)	(0.274)
Market-to-book	2.789	3.016***	-1.378	0.247
	(2.756)	(0.997)	(1.550)	(0.429)
Return on assets	-0.307	-0.612	0.732**	0.197
	(0.438)	(0.380)	(0.290)	(0.230)
Dividend yield	0.155	0.376	0.111	0.053
	(0.382)	(0.299)	(0.175)	(0.185)
Credit rating	-1.669	-1.029	-0.996	-1.133
	(4.765)	(3.165)	(3.630)	(2.585)
Constant	-42.236***	-31.475**	-39.659***	-27.074***
	(14.327)	(14.539)	(11.743)	(10.164)
Industry FE	Yes	Yes	Yes	Yes
Year FE	No	No	No	No
Observations	1208	1182	3328	3269
Adjusted R_2	0.338	0.450	0.337	0.447

Table 18: OLS Regressions of EU Debt and Swap Direction

This table presents the results of the direction of swaps in comparison with firms that that swap into Sterling and those that do not use foreign currency swaps. The dependent variables are initial and final EU debt and the corresponding sample period is 2001-2015 and 1999-2015, respectively. Standard errors in parentheses are adjusted for clustering by firm. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

	Compared to firms that swap into Sterling		Compared to firms that do not use swaps	
	Initial EU debt (Pre-swap)	Final EU debt (Net of Swap)	Initial EU debt (Pre-swap)	Final EU debt (Net of Swap)
Swap into Sterling			0.990	2.708
			(1.899)	(2.279)
Swap into foreign currency	-0.934	1.522	0.467	4.785*
	(2.556)	(2.990)	(2.055)	(2.858)
Swap into both	-1.211	4.726	1.110	9.549***
	(3.716)	(3.437)	(3.651)	(2.946)
Cannot determine swap direction	-0.493	-1.423	0.639	2.443
	(2.176)	(2.308)	(1.629)	(1.871)
EU sales	0.255***	0.598***	0.238***	0.581***
	(0.078)	(0.071)	(0.044)	(0.053)
3-month Interest rate differentials	-1.418	-0.587	-0.750	-0.358
	(0.884)	(0.907)	(0.486)	(0.532)
Natural log of assets	2.493***	1.597	1.171**	0.855
	(0.901)	(1.185)	(0.529)	(0.660)
Asset tangibility	-3.305	-20.291**	-0.440	-6.543*
	(6.998)	(8.202)	(2.583)	(3.517)
Current ratio	-1.184	-4.557**	-0.417	-1.367*
	(1.629)	(2.115)	(0.551)	(0.739)
R&D/sales	-0.054	-1.172***	0.057	-0.334**
	(0.300)	(0.344)	(0.166)	(0.168)
Market-to-book	0.846	-1.006**	0.466	-0.628***
	(1.140)	(0.454)	(0.604)	(0.219)
Return on assets	0.331	0.167	0.072	0.203
	(0.248)	(0.355)	(0.108)	(0.153)
Dividend yield	0.566*	0.243	0.089	0.043
	(0.311)	(0.231)	(0.079)	(0.080)
Credit rating	4.944*	-1.358	4.887***	-2.190
	(2.878)	(2.860)	(1.813)	(2.015)
Constant	-14.054	19.627	-13.695**	1.274
	(11.617)	(13.608)	(6.052)	(6.565)
Industry FE	Yes	Yes	Yes	Yes
Year FE	No	No	No	No
Observations	1208	1182	3328	3269
Adjusted R_2	0.174	0.350	0.127	0.295

Table 19: Summary Statistics of Default Probability and Explanatory Variables

This table presents summary statistics of default probability and explanatory variables. Book leverage is total debt divided by total assets. Price volatility is the standard deviation of weekly log-normal price returns annualized with a factor of 52 for the 52 trading weeks in a year. Excess return is annual share price return minus the value-weighted FTSE all shares index annual return. The sample period is 2002-2015.

Panel A: Probability of Default

Variable	*Obs.*	*Mean*	*Median*	*Std. Dev.*	*Min.*	*Max.*
S&P CIQ PD	4,313	0.019	0.007	0.038	0.000	1.000
Moody EDF	4,543	1.373	0.703	2.197	0.012	49.600

Panel B: Test of Difference in Means and Medians between Foreign Currency Swap Users and Non-users

Variable	*Foreign currency swap non-users*			*Foreign currency swap users*			*Difference*	
	Mean	*Median*	*N*	*Mean*	*Median*	*N*	*Mean*	*Median*
S&P CIQ PD	0.022	0.008	2697	0.010	0.004	1201	0.012***	16.387***
Moody EDF	1.483	0.730	2192	0.904	0.471	772	0.579***	9.997***
Book leverage	0.230	0.204	2486	0.283	0.368	1178	-0.053***	-11.002***
Natural log of assets	6.196	6.180	2692	8.192	9.198	1201	-1.996***	-32.668***
ROA	5.034	4.939	2661	6.114	7.757	1192	-1.080***	-4.145***
Current ratio	1.606	1.325	2692	1.315	1.513	1201	0.290***	7.141***
5-year price volatility	42.348	37.835	2447	36.118	42.131	1126	6.230***	11.528***
1-year price volatility	36.917	30.575	2570	31.859	36.608	1158	5.058***	9.579***
Excess return	9.707	5.010	2683	5.895	20.720	1199	3.812**	2.096**

Table 20: OLS Regressions of Default Probability 2002-2015

This table presents the results of OLS regressions on the probability of default, proxied by the fundamental probability of default (PD) sourced from S&P CIQ. The sample period is 2002-2015. Standard errors in parentheses are adjusted for clustering by firm. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

	(1)	(2)	(3)	(4)
Foreign currency derivatives (dummy)	-0.00039			
	(0.00156)			
Foreign currency swaps (dummy)		0.00360**		
		(0.00150)		
Swap into Sterling				0.00176
				(0.00223)
Swap into foreign currency			0.00071	0.00514***
			(0.00198)	(0.00197)
Swap into both			-0.00294	0.00086
			(0.00218)	(0.00310)
Cannot determine swap direction			0.00297	0.00415**
			(0.00222)	(0.00195)
Book leverage	0.03328***	0.03284***	0.03942***	0.03297***
	(0.00612)	(0.00599)	(0.00941)	(0.00599)
Natural log of assets	-0.00498***	-0.00554***	-0.00375***	-0.00557***
	(0.00052)	(0.00059)	(0.00058)	(0.00058)
Return on assets	-0.00235***	-0.00235***	-0.00068*	-0.00236***
	(0.00023)	(0.00023)	(0.00038)	(0.00023)
Current ratio	-0.00199***	-0.00194***	-0.00311***	-0.00194***
	(0.00062)	(0.00063)	(0.00111)	(0.00063)
1-year price volatility	0.00040***	0.00040***	0.00021***	0.00040***
	(0.00006)	(0.00006)	(0.00006)	(0.00006)
Excess return	-0.00006***	-0.00006***	-0.00003**	-0.00006***
	(0.00001)	(0.00001)	(0.00001)	(0.00001)
Constant	0.04722***	0.05438***	0.02346**	0.05481***
	(0.00692)	(0.00676)	(0.00901)	(0.00672)
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	3499	3499	1130	3499
Adjusted R_2	0.525	0.527	0.339	0.527

Internet Appendix to "The Determinants of Corporate Foreign Currency Debt Use by UK"

This internet appendix contains additional information on the data and more robustness checks. Appendix 1 provides examples of corporate risk management disclosures sourced from annual reports. Appendix 2 presents additional robustness checks for our analysis.

Internet Appendix 1: Qualitative disclosures by UK firms (Annual report and accounts 1999)

1. Firms using foreign currency debt for hedging

Geest Plc writes, "Balance sheet translation hedging is carried out in order to preserve the sterling value of shareholders funds by funding foreign currency assets with matching borrowings in the same currency." (pg. 33)

Yorkshire Chemical writes, "Overseas debt partially funds the working capital requirements of the Group's subsidiary operations. Being denominated in the currency of the subsidiary, it acts as a partial hedge against currency translation differences on the Group's net investment in these subsidiaries." (pg. 46)

Rugby Plc writes, "The Group seeks to mitigate the impact of extreme movements in foreign exchange rates on shareholders' funds by holding foreign currency borrowings to hedge certain of its assets overseas. As a consequence the Group incurs interest costs in the same currencies as those in which it generates operating profit, thereby also reducing the impact of foreign exchange movements on reported earnings." (pg. 19)

2. Foreign currency debt increases exposure

Yorkshire Water writes, "Debt denominated in foreign currency is swapped into sterling where this achieves a lower cost of financing, and is otherwise only utilised to finance overseas assets." (pg. 28)

Lloyds Chemist writes, "The Group raised a further $30 million from the private placement of a fixed rate loan note, eliminating the foreign exchange exposure by the use of a forward foreign currency swap." (pg. 23)

Anglian Water writes, "The Group borrowed US dollars, some of this was swapped to eliminate the risk of currency fluctuations." … "Borrowings include £182.6 million denominated in foreign currencies. Of this amount £177.5 million has been swapped to eliminate the risk of currency fluctuations." (pg. 19)

HP Bulmer writes, “The Group issued $45m fixed coupon senior notes… The Group entered into foreign currency and interest rate swaps which removes all US dollar exposure, resulting in a sterling obligation.” (pg. 15)

Daily Mail writes, “$113m of the loan notes have been converted effectively into sterling liabilities using cross currency swaps and forward contracts.” (pg. 23)

McKechnie writes, “The $15m loan note has been swapped into sterling and fixed at £10.1m.” (pg. 28)

British Aerospace Plc writes, “The Group has entered into currency swaps to manage the foreign currency exposure associated with borrowings denominated in foreign currency. Borrowings have been swapped on a fully hedged basis into sterling.” (pg. 39)

Asda writes, “The group has entered into foreign currency swaps which have the effect of converting US dollar borrowings to sterling denominated interest.” (pg. 26)

BT writes, “The group’s foreign currency borrowings which totalled £7,304 million at 31 March 2000 are used to finance its operations. Of these borrowings, approximately £6.2 billion was swapped into sterling.” (pg. 36)

Internet Appendix 2: Additional robustness checks

To address the problem of endogeneity, we follow a Journal of Finance paper by Allayannis et al. (2003) and choose to a simultaneous-equation Tobit model suggested by Nelson and Olson (1978). This essay examines a firm’s choice between natural local, synthetic local (hedged foreign) and foreign currency debt. Using a two-stage estimation procedure, Allayannis et al. (2003) include other debt types as determinants and assume that all other non-debt variables are exogenous. They argue that “While this is probably not the case…, it is unwieldy to treat more of the variables examined as endogenous. Similarly, if we extend the analysis to some nondebt variables, it is not obvious which ones should be included in this set” (p.2704). They also indicate an additional problem related to the limited dependent variables and show that the primary alternative to a Tobit specification is a two-stage estimation procedure with separate equations for the decision to use a type of debt and the extent of usage for users only (e.g. Probit and OLS). The log-likelihood specification test favours the Tobit model. However, relatively strong assumptions are needed to produce consistent estimates. Given the above limitations of a simultaneous-equation Tobit model, we are cautious about the estimation results and choose to discuss them only where they are different from the one-step regression estimates or provide additional insights.

Results correcting for endogeneity are reported in Table A3. Although there are minor differences, the evidence shows similar relations. First, note that, although not reported here, the first stage estimation produces consistent results with those from the above one-stage specifications. Smaller firms and those with lower levels of foreign sales have more local currency debt. As local currency debt appears to be influenced by similar factors as foreign currency debt, we include fitted value of UK debt in the second stage estimation as a robustness check for our results reported in Table 10. The results show that foreign operations, proxied by foreign sales, and firm size remain statistically significant in explaining foreign debt levels.

Table A1: Regressions of Initial Foreign Currency Debt (Pre-swap) 2001-2015

This table presents the results of regressions on initial foreign currency debt defined as the percentage of outstanding debt that is denominated in foreign currency before accounting for the effect of foreign currency swaps. The sample period is 2001-2015. Standard errors in parentheses are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	OLS	Lag	Tobit	Fixed effects	Beta
Foreign sales	0.432***	0.430***	0.919***	0.029	0.013***
	(0.042)	(0.043)	(0.094)	(0.073)	(0.001)
Natural log of assets	4.190***	4.136***	10.518***	9.218***	0.136***
	(1.007)	(1.037)	(2.162)	(3.213)	(0.031)
Asset tangibility	18.221***	16.855**	38.364**	1.565	0.601***
	(6.779)	(6.994)	(16.013)	(13.533)	(0.191)
Current ratio	1.616	1.402	3.966	-1.340	0.064*
	(1.213)	(1.231)	(3.213)	(1.153)	(0.038)
R&D/sales	0.106	0.022	-0.192	0.491	-0.001
	(0.423)	(0.456)	(0.818)	(0.746)	(0.013)
Market-to-book	-3.312*	-3.715**	-8.572**	0.344	-0.106**
	(1.723)	(1.669)	(4.194)	(1.754)	(0.051)
Return on assets	1.131***	1.335***	2.508***	0.079	0.032***
	(0.295)	(0.295)	(0.724)	(0.263)	(0.009)
Dividend yield	0.216	0.248	0.569	-0.013	0.007
	(0.178)	(0.186)	(0.444)	(0.111)	(0.005)
Credit rating	0.164	-0.730	-3.903	11.405*	-0.040
	(3.587)	(3.617)	(7.269)	(5.905)	(0.102)
Constant	-0.922	0.828	-139.419***	-31.871	-2.641***
	(15.063)	(15.654)	(26.353)	(24.689)	(0.356)
Industry FE	Yes	Yes	Yes	No	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	3482	3303	3482	3482	3482
Adjusted $R2$	0.318	0.316		0.033	

Table A2: Regressions of Initial and Final Foreign Currency Debt 2001-2015 (Subsample of firms with available data both pre- and net of swap)

	Final Foreign Currency Debt (Net of swap)					Initial Foreign Currency Debt (Pre-swap)				
	OLS	Lag	Tobit	Fixed effects	Beta	OLS	Lag	Tobit	Fixed effects	Beta
Foreign sales	0.612***	0.611***	0.872***	0.207**	0.025***	0.427***	0.431***	0.867***	0.051	0.013***
	(0.035)	(0.036)	(0.052)	(0.085)	(0.002)	(0.045)	(0.047)	(0.097)	(0.080)	(0.001)
Natural log of assets	4.647***	4.570***	6.922***	6.457*	0.171***	4.030***	3.882***	9.830***	8.745**	0.130***
	(0.936)	(0.992)	(1.347)	(3.481)	(0.035)	(1.093)	(1.116)	(2.225)	(3.711)	(0.034)
Asset tangibility	4.065	3.098	2.911	-9.524	0.182	14.618*	14.213*	27.012	3.038	0.508**
	(5.714)	(5.874)	(9.470)	(13.809)	(0.221)	(7.460)	(7.663)	(16.805)	(15.845)	(0.211)
Current ratio	0.477	0.127	-0.184	-0.612	0.014	1.942	1.788	3.989	-1.024	0.072**
	(1.029)	(1.109)	(1.715)	(1.006)	(0.038)	(1.217)	(1.257)	(3.108)	(1.294)	(0.036)
R&D/sales	-0.401	-0.679	-0.617	-0.870	-0.020	-0.188	-0.201	-0.657	0.323	-0.010
	(0.426)	(0.447)	(0.597)	(0.651)	(0.017)	(0.440)	(0.468)	(0.825)	(0.705)	(0.012)
Market-to-book	0.004	-0.357	-0.259	0.003	-0.008	-1.781	-2.342	-4.027	-0.173	-0.061
	(1.613)	(1.478)	(2.618)	(1.816)	(0.066)	(1.949)	(1.833)	(4.344)	(2.249)	(0.057)
Return on assets	0.227	0.378	0.359	-0.310	0.013	1.083***	1.301***	2.274***	0.231	0.032***
	(0.260)	(0.264)	(0.412)	(0.252)	(0.012)	(0.306)	(0.310)	(0.723)	(0.313)	(0.010)
Dividend yield	0.325	0.397**	0.613	-0.006	0.012	0.176	0.238	0.536	-0.080	0.006
	(0.206)	(0.190)	(0.374)	(0.097)	(0.010)	(0.181)	(0.192)	(0.441)	(0.120)	(0.006)
Credit rating	-4.075	-4.094	-5.730	4.537	-0.174	-0.679	-1.540	-4.878	10.282	-0.066
	(2.919)	(3.080)	(4.146)	(5.430)	(0.107)	(3.809)	(3.862)	(7.112)	(6.533)	(0.106)
Constant	-37.862***	-27.858***	-72.247***	-4.886	-3.172***	5.888	-21.475*	-119.181***	-29.128	-2.417***
	(9.516)	(9.738)	(14.797)	(27.065)	(0.386)	(13.793)	(11.653)	(26.152)	(27.620)	(0.379)
Observations	2817	2676	2817	2817	2817	2817	2676	2817	2817	2817
Adjusted R_2	0.475	0.468		0.027		0.300	0.303		0.032	

Table A3: Determinants of Foreign Currency Debt (Simultaneous Equation Estimation)

This table presents results from a two-stage simultaneous equations specification. The dependent variable is the percentage of foreign debt to total debt. Fitted value of UK debt from the first stage regression is included in the second stage regression. The sample period is 1999-2015. Standard errors in parentheses are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Foreign debt (Net of Swap)
UK debt (Net of Swap)	0.553
	(1.285)
Foreign sales	1.116*
	(0.582)
Natural log of assets	8.512**
	(4.168)
Asset tangibility	4.617
	(15.983)
Current ratio	2.000
	(5.583)
R&D/sales	-0.745
	(0.605)
Market-to-book	0.104
	(0.738)
Return on assets	0.401
	(0.657)
Dividend yield	0.835
	(0.623)
Credit rating	-8.414
	(7.685)
Constant	-131.702
	(149.631)
Observations	3370
N_lc	834
N_rc	326

Table A4: Regressions of Initial US Debt (Pre-swap) 2001-2015

This table presents the results of regressions on initial US debt defined as the percentage of outstanding debt that is denominated in US dollar before accounting for the effect of foreign currency swaps. The sample period is 2001-2015. Standard errors in parentheses are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	OLS	Lag	Tobit	Fixed effects	Beta
US sales	0.373***	0.366***	1.027***	0.082	0.012***
	(0.067)	(0.069)	(0.136)	(0.110)	(0.002)
3-month Interest rate differentials	-2.569***	-2.154***	-7.246***	-1.283***	-0.091***
	(0.581)	(0.523)	(1.645)	(0.474)	(0.019)
Natural log of assets	5.909***	6.138***	18.286***	6.180***	0.242***
	(0.910)	(0.943)	(2.183)	(2.012)	(0.031)
Asset tangibility	13.900**	11.802*	35.493**	7.074	0.520**
	(6.238)	(6.396)	(17.819)	(10.481)	(0.209)
Current ratio	3.383**	3.199**	8.647**	0.223	0.113**
	(1.358)	(1.415)	(3.433)	(0.721)	(0.047)
R&D/sales	0.495	0.470	0.589	0.232	0.016
	(0.347)	(0.360)	(0.725)	(0.450)	(0.013)
Market-to-book	-1.891	-1.397	-6.422	-0.853	-0.095**
	(1.344)	(1.314)	(4.197)	(1.043)	(0.047)
Return on assets	0.837***	0.954***	1.783**	0.081	0.036***
	(0.280)	(0.272)	(0.750)	(0.186)	(0.011)
Dividend yield	0.097	0.093	0.297	0.070	0.005
	(0.173)	(0.138)	(0.458)	(0.060)	(0.007)
Credit rating	-1.113	-3.135	-12.020	11.669*	-0.024
	(3.674)	(3.671)	(7.960)	(5.985)	(0.125)
Constant	-41.128***	-43.030***	-245.532***	-30.621*	-4.366***
	(10.980)	(11.777)	(27.085)	(15.583)	(0.346)
Industry FE	Yes	Yes	Yes	No	Yes
Year FE	No	No	No	No	No
Observations	3482	3303	3482	3482	3482
Adjusted $R2$	0.318	0.313		0.047	

Table A5: Regressions of Initial and Final US Debt 2001-2015 (Subsample of firms with available data both pre- and net of swap)

	Final US debt (Net of swap)					Initial US debt (Pre-swap)				
	OLS	Lag	Tobit	Fixed effects	Beta	OLS	Lag	Tobit	Fixed effects	Beta
US sales	0.837***	0.847***	1.266***	0.328**	0.036***	0.409***	0.411***	1.039***	0.043	0.014***
	(0.055)	(0.056)	(0.081)	(0.152)	(0.003)	(0.071)	(0.072)	(0.135)	(0.132)	(0.002)
3-month Interest rate differentials	-0.746	0.033	-0.940	-0.641	-0.017	-2.359***	-1.752***	-6.569***	-1.127**	-0.093***
	(0.531)	(0.510)	(0.887)	(0.508)	(0.022)	(0.595)	(0.537)	(1.596)	(0.493)	(0.021)
Natural log of assets	3.228***	3.354***	5.701***	2.855	0.155***	5.416***	5.688***	17.076***	5.627**	0.245***
	(0.864)	(0.922)	(1.335)	(2.096)	(0.036)	(0.940)	(0.977)	(2.240)	(2.445)	(0.035)
Asset tangibility	15.544***	14.046**	20.941**	0.779	0.466**	10.494	9.108	24.884	5.224	0.398*
	(5.880)	(6.031)	(10.612)	(11.673)	(0.231)	(6.521)	(6.720)	(18.203)	(12.690)	(0.221)
Current ratio	2.658*	2.414	3.061	0.456	0.061	3.112**	2.870*	7.220**	0.598	0.099**
	(1.490)	(1.558)	(2.556)	(0.690)	(0.053)	(1.442)	(1.476)	(3.532)	(0.828)	(0.050)
R&D/sales	0.170	-0.030	0.032	-0.123	0.008	0.457	0.506	0.460	0.195	0.015
	(0.297)	(0.310)	(0.420)	(0.518)	(0.012)	(0.342)	(0.352)	(0.640)	(0.493)	(0.012)
Market-to-book	0.210	0.261	-0.087	0.282	-0.004	-0.644	-0.233	-3.093	-0.809	-0.048
	(1.445)	(1.359)	(2.500)	(1.149)	(0.060)	(1.532)	(1.456)	(4.522)	(1.329)	(0.054)
Return on assets	0.330	0.549*	0.356	-0.196	0.021	0.827***	0.966***	1.783**	0.100	0.037***
	(0.307)	(0.302)	(0.481)	(0.223)	(0.014)	(0.305)	(0.295)	(0.801)	(0.220)	(0.013)
Dividend yield	0.080	0.092	0.137	-0.040	0.007	0.228	0.196	0.595	0.043	0.011
	(0.189)	(0.160)	(0.328)	(0.099)	(0.010)	(0.190)	(0.153)	(0.465)	(0.060)	(0.008)
Credit rating	-1.910	-2.906	-1.737	7.354	-0.012	-1.061	-3.518	-10.818	9.350*	-0.038
	(2.811)	(2.880)	(4.334)	(4.968)	(0.112)	(3.599)	(3.626)	(7.613)	(5.620)	(0.127)
Constant	-29.871***	-27.192**	-86.552***	0.235	-3.745***	-35.818***	-36.477***	-223.881***	-26.010	-4.388***
	(9.835)	(11.182)	(15.973)	(16.485)	(0.390)	(11.281)	(11.770)	(27.217)	(18.672)	(0.372)
Observations	2817	2676	2817	2817	2817	2817	2676	2817	2817	2817
Adjusted R_2	0.434	0.430		0.023		0.311	0.312		0.030	

Table A6: OLS Regressions of US Debt Pre- and Post-crisis

This table presents the results of OLS regressions on initial and final US debt defined as the percentage of outstanding debt that is denominated in US dollar before and after accounting for the effect of foreign currency swaps, respectively. The sample periods are 2001-2006 (pre-crisis) and 2007-2015 (crisis and post-crisis). Standard errors in parentheses are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Final US debt (Net of swap)		Initial US debt (Pre-swap)	
	2001-2006	2007-2015	2001-2006	2007-2015
US sales	0.827***	0.850***	0.273***	0.464***
	(0.063)	(0.067)	(0.075)	(0.081)
3-month Interest rate differentials	0.275	-1.824*	0.040	-3.626***
	(0.452)	(1.031)	(0.494)	(0.926)
Natural log of assets	2.539***	3.130***	4.600***	6.624***
	(0.871)	(1.067)	(1.090)	(1.058)
Asset tangibility	7.980	19.896**	3.494	16.119**
	(5.501)	(8.177)	(6.490)	(7.409)
Current ratio	1.111	4.264**	1.914	3.875**
	(1.141)	(2.066)	(1.365)	(1.615)
R&D/sales	0.146	0.241	-0.111	0.672*
	(0.406)	(0.353)	(0.505)	(0.376)
Market-to-book	-0.009	-1.615	1.879	-3.346**
	(0.405)	(2.053)	(1.898)	(1.698)
Return on assets	0.256	0.518	0.635*	1.024***
	(0.232)	(0.417)	(0.324)	(0.376)
Dividend yield	-0.380	0.115	0.058	0.080
	(0.298)	(0.205)	(0.285)	(0.177)
Credit rating	0.072	-2.689	3.015	-3.817
	(2.946)	(3.564)	(4.095)	(4.207)
Constant	-20.950**	-46.229***	-35.394***	-35.876***
	(9.509)	(12.076)	(10.824)	(10.864)
Industry FE	Yes	Yes	Yes	Yes
Year FE	No	No	No	No
Observations	1713	1657	1258	2224
Adjusted R_2	0.424	0.446	0.249	0.357

Table A7: Regressions of Initial EU Debt (Pre-swap) 2001-2015

This table presents the results of regressions on initial EU debt defined as the percentage of outstanding debt that is denominated in Euro before accounting for the effect of foreign currency swaps. The sample period is 2001-2015. Standard errors in parentheses are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	OLS	Lag	Tobit	Fixed effects	Beta
EU sales	0.247***	0.231***	0.926***	0.021	0.009***
	(0.043)	(0.041)	(0.127)	(0.032)	(0.002)
3-month Interest rate differentials	-0.754	-0.078	-2.865	-0.179	-0.040**
	(0.474)	(0.466)	(1.806)	(0.408)	(0.018)
Natural log of assets	1.392***	1.505***	9.390***	3.627***	0.098***
	(0.454)	(0.443)	(1.592)	(0.970)	(0.019)
Asset tangibility	0.796	0.706	13.412	-11.060**	0.055
	(2.605)	(2.467)	(11.539)	(5.286)	(0.097)
Current ratio	-0.007	0.057	2.558	-0.888*	0.012
	(0.578)	(0.584)	(2.569)	(0.495)	(0.024)
R&D/sales	0.080	-0.032	0.238	-0.114	0.003
	(0.164)	(0.147)	(0.601)	(0.145)	(0.005)
Market-to-book	0.343	0.369	2.337	0.185	0.010
	(0.506)	(0.493)	(2.315)	(0.565)	(0.019)
Return on assets	0.053	0.043	-0.073	0.128	-0.003
	(0.106)	(0.103)	(0.491)	(0.114)	(0.004)
Dividend yield	0.096	0.019	0.524*	0.036	0.005*
	(0.080)	(0.062)	(0.294)	(0.073)	(0.003)
Credit rating	4.679***	4.481**	11.473**	1.542	0.176**
	(1.795)	(1.852)	(5.602)	(2.762)	(0.074)
Constant	-16.601***	-17.370***	-126.460***	-12.359	-3.052***
	(5.974)	(5.728)	(18.978)	(7.517)	(0.290)
Industry FE	Yes	Yes	Yes	No	Yes
Year FE	No	No	No	No	No
Observations	3482	3303	3482	3482	3482
Adjusted $R2$	0.127	0.125		0.010	

Table A8: Regressions of Initial and Final EU Debt 2001-2015 (Subsample of firms with available data both pre- and net of swap)

	Final EU debt (Net of swap)					Initial EU debt (Pre-swap)				
	OLS	Lag	Tobit	Fixed effects	Beta	OLS	Lag	Tobit	Fixed effects	Beta
EU sales	0.616***	0.597***	0.982***	0.176***	0.029***	0.264***	0.248***	0.923***	0.057	0.010***
	(0.054)	(0.054)	(0.078)	(0.057)	(0.003)	(0.048)	(0.046)	(0.135)	(0.037)	(0.002)
3-month Interest rate differentials	0.498	0.916	1.727*	0.617	0.039	-1.244**	-0.642	-5.113**	-0.338	-0.061***
	(0.610)	(0.612)	(1.018)	(0.581)	(0.027)	(0.557)	(0.552)	(2.009)	(0.459)	(0.020)
Natural log of assets	1.691**	1.427**	5.008***	3.108**	0.155***	1.517***	1.619***	9.138***	5.297***	0.103***
	(0.657)	(0.670)	(1.082)	(1.395)	(0.029)	(0.481)	(0.471)	(1.625)	(1.182)	(0.020)
Asset tangibility	-6.084	-5.976	-12.896*	-5.905	-0.213	2.580	2.600	16.148	-10.555*	0.107
	(4.074)	(3.965)	(7.434)	(7.536)	(0.170)	(2.937)	(2.773)	(12.075)	(6.005)	(0.109)
Current ratio	-1.096	-1.318	-2.048	-0.954	-0.050	0.410	0.465	3.839	-0.790	0.032
	(0.839)	(0.859)	(1.742)	(0.633)	(0.041)	(0.614)	(0.616)	(2.347)	(0.599)	(0.026)
R&D/sales	-0.296*	-0.418*	-0.466	-0.184	-0.016*	-0.041	-0.126	-0.125	-0.081	-0.001
	(0.169)	(0.221)	(0.367)	(0.350)	(0.009)	(0.159)	(0.156)	(0.614)	(0.162)	(0.005)
Market-to-book	0.032	-0.738	0.488	-0.891	-0.005	0.977	0.850	5.190*	0.211	0.033
	(1.118)	(0.996)	(2.151)	(1.252)	(0.047)	(0.689)	(0.669)	(2.670)	(0.670)	(0.024)
Return on assets	0.148	0.211	0.247	0.023	0.004	0.044	0.036	-0.170	0.163	-0.004
	(0.192)	(0.205)	(0.342)	(0.166)	(0.008)	(0.112)	(0.110)	(0.512)	(0.134)	(0.004)
Dividend yield	0.072	0.068	0.159	-0.016	0.006	0.051	-0.009	0.300	0.013	0.003
	(0.091)	(0.104)	(0.192)	(0.056)	(0.004)	(0.075)	(0.061)	(0.277)	(0.073)	(0.002)
Credit rating	-2.347	-2.080	-5.410	-0.221	-0.207**	4.198**	4.118**	10.681*	1.591	0.158**
	(2.250)	(2.357)	(3.962)	(2.808)	(0.105)	(1.965)	(2.054)	(5.958)	(3.435)	(0.080)
Constant	-16.532**	-4.032	-39.382***	-3.702	-3.011***	-20.230***	-10.739**	-124.090***	-24.772***	-3.052***
	(7.420)	(6.471)	(12.172)	(11.646)	(0.330)	(6.359)	(4.974)	(19.484)	(8.834)	(0.305)
Observations	2817	2676	2817	2817	2817	2817	2676	2817	2817	2817
Adjusted R_2	0.283	0.274		0.014		0.131	0.127		0.019	

Table A9: OLS Regressions of EU Debt Pre- and Post-crisis

This table presents the results of OLS regressions on initial and final EU debt defined as the percentage of outstanding debt that is denominated in Euro before and after accounting for the effect of foreign currency swaps, respectively. The sample periods are 2001-2006 (pre-crisis) and 2007-2015 (crisis and post-crisis). Standard errors in parentheses are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Final EU debt (Net of swap)		Initial EU debt (Pre-swap)	
	2001-2006	2007-2015	2001-2006	2007-2015
EU sales	0.560***	0.648***	0.121***	0.324***
	(0.058)	(0.066)	(0.037)	(0.057)
3-month Interest rate differentials	1.716***	0.501	1.108**	-0.617
	(0.619)	(0.837)	(0.557)	(0.721)
Natural log of assets	1.116	1.831**	0.934*	1.514***
	(0.771)	(0.714)	(0.554)	(0.547)
Asset tangibility	-6.388*	-5.881	-0.615	-0.235
	(3.699)	(5.450)	(2.725)	(3.743)
Current ratio	-1.318**	-0.814	-0.141	-0.258
	(0.662)	(1.194)	(0.430)	(0.871)
R&D/sales	-0.779***	-0.174	-0.230	0.177
	(0.248)	(0.182)	(0.194)	(0.194)
Market-to-book	-0.526***	-0.049	2.371**	-0.024
	(0.185)	(1.205)	(1.092)	(0.551)
Return on assets	0.214	0.097	0.002	0.009
	(0.163)	(0.235)	(0.118)	(0.143)
Dividend yield	0.647**	-0.053	0.529*	0.063
	(0.270)	(0.075)	(0.276)	(0.080)
Credit rating	-0.950	-1.235	6.065**	4.652**
	(2.413)	(2.628)	(2.653)	(2.223)
Constant	0.558	-0.789	-14.540***	-25.653***
	(9.506)	(10.529)	(4.673)	(6.064)
Industry FE	Yes	Yes	Yes	Yes
Year FE	No	No	No	No
Observations	1713	1657	1258	2224
Adjusted R_2	0.268	0.323	0.101	0.160

Table A10: OLS Regressions of Swapped to US dollar and Euro (%) Pre- and Post-crisis

This table presents the results of regressions on the net share of the firm's total debt that is swapped to US dollar and Euro. The sample periods are 2001-2006 (pre-crisis) and 2007-2015 (crisis and post-crisis). Standard errors in parentheses are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Swapped to US dollar (%)		Swapped to Euro (%)	
	2001-2006	2007-2015	2001-2006	2007-2015
US sales	0.490***	0.349***		
	(0.088)	(0.070)		
EU sales			0.469***	0.280***
			(0.059)	(0.055)
3-month Interest rate differentials (UK-US)	0.177	1.472		
	(0.786)	(0.951)		
3-month Interest rate differentials (UK-EU)			1.942**	1.619*
			(0.986)	(0.917)
Natural log of assets	-0.996	-2.909***	0.278	0.209
	(1.222)	(0.898)	(0.903)	(0.544)
Asset tangibility	9.395	6.294	-10.865***	-6.871
	(6.195)	(5.460)	(4.134)	(4.291)
Current ratio	-0.452	0.201	-1.962**	-1.093
	(1.370)	(0.869)	(0.764)	(0.730)
R&D/sales	0.243	-0.419	-0.506*	-0.213
	(0.625)	(0.284)	(0.279)	(0.205)
Market-to-book	1.991	0.102	-1.900	-0.567
	(2.207)	(1.566)	(1.599)	(0.992)
Return on assets	-0.510**	-0.540**	0.146	0.138
	(0.244)	(0.269)	(0.227)	(0.217)
Dividend yield	-0.096	-0.133	0.720*	-0.101
	(0.429)	(0.100)	(0.371)	(0.068)
Credit rating	-6.199	2.161	-7.958**	-5.484***
	(3.777)	(3.515)	(3.650)	(1.884)
Constant	-3.657	25.245***	1.266	8.589
	(12.748)	(9.674)	(9.837)	(6.646)
Industry FE	Yes	Yes	Yes	Yes
Year FE	No	No	No	No
Observations	1163	1654	1163	1654
Adjusted $R2$	0.140	0.100	0.185	0.107

Table A11: OLS Regressions of Default Probability 2002-2015 (With lagged explanatory variables)

This table presents the results of OLS regressions on the probability of default, proxied by the fundamental probability of default (PD) sourced from S&P CIQ. The sample period is 2002-2015. Standard errors in parentheses are adjusted for clustering by firm. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

	(1)	(2)	(3)	(4)
L.Foreign currency derivatives (dummy)	-0.00135			
	(0.00157)			
L.Foreign currency swaps (dummy)		0.00284*		
		(0.00145)		
L.Swap into Sterling				0.00212
				(0.00216)
L.Swap into foreign currency			0.00091	0.00406**
			(0.00212)	(0.00188)
L.Swap into both			-0.00347	-0.00075
			(0.00225)	(0.00263)
L.Cannot determine swap direction			0.00185	0.00316*
			(0.00250)	(0.00187)
L.Book leverage	0.02499***	0.02480***	0.02700***	0.02488***
	(0.00532)	(0.00520)	(0.00763)	(0.00518)
L.Natural log of assets	-0.00445***	-0.00498***	-0.00349***	-0.00500***
	(0.00051)	(0.00058)	(0.00058)	(0.00058)
L.Return on assets	-0.00158***	-0.00159***	-0.00022	-0.00159***
	(0.00021)	(0.00021)	(0.00029)	(0.00021)
L.Current ratio	-0.00119*	-0.00114*	-0.00356***	-0.00114*
	(0.00063)	(0.00062)	(0.00114)	(0.00062)
L.1-year price volatility	0.00037***	0.00037***	0.00029***	0.00037***
	(0.00005)	(0.00005)	(0.00008)	(0.00005)
L.Excess return	-0.00010***	-0.00010***	-0.00005**	-0.00010***
	(0.00002)	(0.00002)	(0.00002)	(0.00002)
Constant	0.04159***	0.04383***	0.02063**	0.04407***
	(0.00736)	(0.00756)	(0.01043)	(0.00756)
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	3376	3376	1105	3376
Adjusted R_2	0.370	0.371	0.276	0.371

Table A12: Quantile Regressions of Default Probability 2002-2015

This table presents the results of quantile regressions on the probability of default, proxied by the fundamental probability of default (PD) sourced from S&P CIQ. The sample period is 2002-2015. Standard errors in parentheses are adjusted for clustering by firm. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

	(1)	(2)	(3)	(4)
Foreign currency derivatives (dummy)	-0.00068**			
	(0.00031)			
Foreign currency swaps (dummy)		0.00145***		
		(0.00024)		
Swap into Sterling				0.00093***
				(0.00027)
Swap into foreign currency			-0.00042	0.00151***
			(0.00036)	(0.00026)
Swap into both			-0.00103**	0.00057
			(0.00040)	(0.00055)
Cannot determine swap direction			0.00026	0.00167***
			(0.00033)	(0.00032)
Book leverage	0.01549***	0.01497***	0.01366***	0.01461***
	(0.00083)	(0.00081)	(0.00149)	(0.00074)
Natural log of assets	-0.00273***	-0.00297***	-0.00251***	-0.00299***
	(0.00009)	(0.00009)	(0.00012)	(0.00009)
Return on assets	-0.00086***	-0.00085***	-0.00029***	-0.00086***
	(0.00003)	(0.00003)	(0.00003)	(0.00002)
Current ratio	-0.00111***	-0.00108***	-0.00181***	-0.00110***
	(0.00012)	(0.00012)	(0.00017)	(0.00010)
1-year price volatility	0.00020***	0.00020***	0.00007***	0.00019***
	(0.00002)	(0.00002)	(0.00002)	(0.00002)
Excess return	-0.00002***	-0.00002***	-0.00000	-0.00002***
	(0.00000)	(0.00000)	(0.00000)	(0.00000)
Constant	0.02410***	0.02445***	0.02218***	0.02533***
	(0.00114)	(0.00112)	(0.00142)	(0.00108)
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	3499	3499	1130	3499
Pseudo R_2	0.238	0.239	0.258	0.239

Table A13: OLS Regressions of Default Probability 1999-2015 (Moody EDF)

This table presents the results of OLS regressions on the probability of default, proxied by the Expected Default Frequency (EDF) sourced from Moody's Analytics. The sample period is 1999-2015. Standard errors in parentheses are adjusted for clustering by firm. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

	(1)	(2)	(3)	(4)
Foreign currency derivatives (dummy)	-0.23810**			
	(0.09353)			
Foreign currency swaps (dummy)		-0.05002		
		(0.07532)		
Swap into Sterling				-0.09830
				(0.10093)
Swap into foreign currency			0.26956**	0.18011
			(0.12754)	(0.13549)
Swap into both			0.20006	0.03375
			(0.16307)	(0.18554)
Cannot determine swap direction			0.00268	-0.17266*
			(0.09805)	(0.09040)
Book leverage	1.88676***	1.92582***	1.03889**	1.92631***
	(0.44013)	(0.44533)	(0.42323)	(0.44411)
Natural log of assets	-0.34096***	-0.35815***	-0.18550***	-0.36011***
	(0.04435)	(0.04955)	(0.04907)	(0.04948)
Return on assets	-0.06987***	-0.07141***	-0.05617***	-0.07146***
	(0.01164)	(0.01157)	(0.01374)	(0.01154)
Current ratio	-0.22034***	-0.21797***	0.08659	-0.21989***
	(0.04420)	(0.04429)	(0.06467)	(0.04421)
1-year price volatility	0.04972***	0.04964***	0.04245***	0.04956***
	(0.00438)	(0.00439)	(0.00583)	(0.00440)
Excess return	-0.00757***	-0.00757***	-0.00670***	-0.00755***
	(0.00097)	(0.00097)	(0.00124)	(0.00097)
Constant	2.07324***	2.03175***	1.83615**	2.07336***
	(0.45260)	(0.46958)	(0.78285)	(0.46816)
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	3662	3662	980	3662
Adjusted R_2	0.467	0.465	0.458	0.466

Table A14: Time-varying Effects of Foreign Currency Swap Use on Default Probability

This table presents the time-varying effects of foreign currency swap use on the probability of default, proxied by the fundamental probability of default (PD) sourced from S&P CIQ. Annual GDP growth rate is included to control for macroeconomic conditions. The sample period is 2002-2015. Standard errors in parentheses are adjusted for clustering by firm. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

	(1)
Foreign currency swaps (dummy)	-0.00088
	(0.00199)
Foreign currency swaps # year 2002	0.00365
	(0.00239)
Foreign currency swaps # year 2003	0.00000
	(.)
Foreign currency swaps # year 2004	0.00797***
	(0.00179)
Foreign currency swaps # year 2005	0.00651***
	(0.00216)
Foreign currency swaps # year 2006	0.00783***
	(0.00225)
Foreign currency swaps # year 2007	0.00441*
	(0.00246)
Foreign currency swaps # year 2008	-0.00223
	(0.00327)
Foreign currency swaps # year 2009	0.00680*
	(0.00392)
Foreign currency swaps # year 2010	0.00328
	(0.00222)
Foreign currency swaps # year 2011	0.00367*
	(0.00219)
Foreign currency swaps # year 2012	0.00815***
	(0.00247)
Foreign currency swaps # year 2013	0.00693***
	(0.00253)
Foreign currency swaps # year 2014	0.00577*
	(0.00333)
Foreign currency swaps # year 2015	0.00142
	(0.00230)
(Control variables included)	
Constant	0.05534***
	(0.00687)
Industry FE	Yes
Year FE	No
Observations	3499
Adjusted R^2	0.517

Chapter 4: The Effects of Interest Rate Swap Usage on the Probability of Default

Abstract

This essay examines the effects of interest rate swap usage on the probability of default. We do so by constructing a large hand-collected dataset of UK non-financial firms over the sample period 1999-2015. Our results show that the use of interest rate swaps is associated with a reduction in the default probability for our sample firms, consistent with firms using swaps for hedging. The impact of interest rate swaps is stronger during periods of heightened macroeconomic uncertainty. We also find that firms that use interest rate swaps have lower levels of price volatility and return sensitivity. Our results are robust to the use of alternative measures of swap usage and probability of default.

Keywords: Derivatives, interest rate swaps, hedging, speculation, default probabilities.

JEL CODES: G3, G32.

1. Introduction

The question of whether firms are hedging or speculating when using derivatives is important for several reasons. According to the Bank of England Systemic Risk Survey (October 2009), corporate default is ranked second in a list of five risks that market participants believed would have the strongest effects on the UK financial system. Since the 2008 financial crisis, regulators have attempted to curb the use of over-the-counter derivatives. The derivative market is also predicted to bear a huge burden of the financial transaction tax if it is introduced. All of these reasons provide the motivation for our study.

Using a large hand-collected dataset of UK non-financial firms during the period from 1999 to 2015, we examine the relationship between the corporate use of interest rate swaps and the probability of default. We believe that this question is more relevant in a UK setting than a US setting for several reasons. First, the bankruptcy code in the UK is creditor-friendly, as opposed to shareholder-friendly in the US. Therefore, UK firms are more likely to fall into administration and liquidation. Also, the use of derivatives in general and interest rate swaps in particular is more intense among UK firms compared to their US counterparts. According to the Bank of England Financial Stability Report (December 2010), the aggregate level of capital gearing of the UK corporate sector was higher than the corresponding figures for US and EU firms, indicating greater exposure to interest rate changes.

Our sample period covers the 2000-2001 global recession and the 2007-2009 financial crisis. The significant variation in macroeconomic conditions and more importantly credit risk during this period provides an unique opportunity to examine the effects of swap usage on firm default since such activity is expected to be most beneficial in times of economic downturn. The lack of studies on this topic as well as the limited number of hedging studies in the UK make our essay an interesting and important contribution to research.

We find evidence that interest rate swap users have lower probabilities of default, controlling for other firm characteristics that may affect default risk. We then examine the effects of swap directions and find the lower likelihood of bankruptcy for firms that swap toward fixed compared to those that swap toward floating or do not use interest rate swaps. Our results are robust to the use of Moody EDF values as measure of default probability or the construction of new swap variables using data from S&P. Also, we show that the effects of swap usage on default probability vary over time with the

prevailing macroeconomic and financial conditions. We further examine the impact of interest rate swaps on firm risk by looking at the volatility of stock prices and the sensitivity of stock returns to market returns and find that swap usage is associated with lower levels of price volatility and return sensitivity.

Our essay is organized as follows. Section 2 reviews the relevant literature. Section 3 describes our data and discusses our methodology. Section 4 presents our empirical results. Section 5 concludes.

2. Literature Review

When examining the rationale for corporate hedging, most studies incorporate derivative usage into their definition of hedging, assuming that derivatives are used for hedging purposes, rather than speculation. However, the use of derivatives may be motivated by other reasons, which may or may not reduce risk. For example, firms may attempt to take speculative positions to earn profit or match their competitors' risk management strategies, or managers may want to increase their portfolio value. The correlation between derivative usage and firm risk, therefore, is not straightforward. Generally, when firms use derivatives for hedging, they should end up with lower risk. However, if managers attempt to maximize their compensation, there may be incentives to increase firm risk. It is also possible that managers incorporate their views of future price movements into derivative transactions and partially hedge the underlying exposure. If this is the case, financial risk may be increased.

Despite the wide empirical work on the determinants of firms' use of derivatives, there are only a few studies looking at the correlation between derivative usage and firm risk. Table 1 provides a list of previous empirical studies that examine whether firms are using derivatives for hedging or speculation. As defined by Hentschel and Kothari (2001), the difference between hedging and speculation with derivatives is that a hedger uses derivatives to offset its inherent exposures, while a speculator uses derivatives to increase its inherent exposures. Derivatives are regarded as attractive tools for speculative purposes because of their liquidity and no requirement of advance payment (Niehaus and Harrington, 2003).

Guay (1999) examines the impact of derivatives in firms that begin using derivatives. The results show that firm risk reduces following the use of derivatives, consistent with firms hedging with derivatives. Risk reduction averages 5% of stock return volatility for all sample firms, ranging from 11% to 22% of exposure for exchange rate and interest rate derivative users, respectively. The decisions to begin

using derivatives and the realized risk reductions vary across firms with the expected hedging benefits.

Hentschel and Kothari (2001) investigate whether firms' riskiness increases or decreases with derivatives using data from financial reports of 425 large US firms. Of these, many firms take large positions in derivatives to manage their exposures. However, compared to those that do not use derivatives, derivative users show few measurable differences in risk. Their results are also inconsistent with firms speculating with derivatives on a large scale.

Faulkender (2005) focuses on the use of interest rate swaps to modify the interest rate exposure of newly issued debt and examines whether firms are hedging or timing the market. The final interest rate exposure, combining the initial exposure and swap usage, is found to be largely driven by the term spread at the time the firm issues debt, suggesting that firms' interest rate risk management is primarily driven by speculative purposes rather than hedging. In a later study, Chernenko and Faulkender (2011) argue that examining panel data can help distinguish between the use of derivatives that endure over time and are more consistent with hedging, and those that are transient and more likely to result from speculation. Their decomposition results show that the time-series variation in swap usage is associated with the term spread, consistent with Faulkender (2005). This suggests that firms are using derivatives not only to hedge but also to speculate. Specifically, firms tend to use interest rate swaps to speculate and manage earnings when their executive compensation arrangements are more sensitive to performance.

Nguyen and Faff (2010) suggest a nonlinear relationship between derivatives usage and firm risk. Specifically, using a sample of Australian firms, they find that firm risk reduces with the use of derivatives for moderate derivative users, but increases for extensive derivative users. However, compared to those that do not use derivatives, they find no evidence that extensive users incur higher risk. Overall, their results are consistent with firms using derivatives to hedge.

Bartram et al. (2011) construct a large sample of non-financial firms from 47 countries and study the impact of derivative usage on firm value and risk. They find that total risk and systematic risk both decline with the use of derivatives. The average cash flow and stock return volatility of derivative users is 50% and 18% lower than that of non-users, respectively. Firms that use derivatives also have lower market betas. However, firms appear to be hedging downside risk as derivative usage is associated

with higher abnormal returns and larger profits during the 2001-2002 global economic downturn. In a later study, Bartram (2017) reaffirms the finding that firms use derivatives for hedging purposes. Derivative users have a lower or similar level of exposure, except for slightly higher net commodity price exposure for firms using commodity price derivatives. There are few differences among countries in the effect of derivative usage on firm risk. This effect is also independent of corporate governance at the country level or access to derivatives.

Beber and Fabbri (2012) show that managers' characteristics and personal beliefs explain the time-variation of foreign currency derivatives use beyond firm, industry and market fundamentals. The notional amounts of derivatives respond to past foreign exchange returns, as if managers were taking active views on future currency prices. Overconfident managers who are younger, hold an MBA degree and have less previous working experience speculate more.

Júnior (2013) studies the use of foreign exchange derivatives by Brazilian non-financial firms during the global financial crisis of 2007-2009. The results show that in 2008, out of the 98 firms that used derivatives, 61.2% were classified as hedgers, 22.5% as selective hedgers and 16.3% as speculators. After the crisis, the number of firms classified as selective hedgers and speculators reduced (6.6% and 14.5%, respectively). Magee (2013) examines the effect of foreign currency hedging with derivatives on the probability of financial distress. There is no evidence that the decision to hedge foreign currency risk affects a firm's probability of financial distress, but the extent of hedging is associated with a lower probability. By contrast, Marin (2013) finds that the probability of bankruptcy is 89.5% lower for firms that hedge foreign currency risk compared to ones that do not. This result suggests that foreign currency risk management instruments are used for reducing risk.

Adam et al. (2015) observe managers' responses to their gains and losses from timing the market when they use derivatives and find that managers increase the level of speculative activities following speculative gains but do not reduce speculative activities following speculative losses. This result is consistent with the selective self-attribution associated with managerial overconfidence. In a recent study, Adam et al. (2017) examine the widespread practice of "selective hedging", which is defined as "managers speculating by incorporating their market views into firms' hedging programs" (p.269). In contrast to passive hedging, managers hedge selectively by actively varying the timing and size of their derivative transactions based on their views

of future market movements. Using a sample of gold mining firms in North America, Adam et al. (2017) find a positive correlation between the extent of selective hedging and future stock return volatility, suggesting that selective hedging increases firm risk.

Taken as a whole, a review of the literature provides a mixed picture as to whether the use of derivatives reduces or increases risk. Generally, firms use derivatives for hedging, which should reduce risk. However, derivatives may be used for other purposes, which may increase firm risk.

3. Data and Methodology

3.1. Data Collection

Our sample consists of large UK non-financial firms over the 1999-2015 period. We focus on non-financial firms because financial firms, e.g. banks and insurance companies, may have different motives for employing derivatives which could potentially bias our results. Earlier research on the corporate use of derivatives relies on surveys due to the limited availability of data on derivative usage. After the successive enactment of international financial reporting standards, the disclosure of firms' risk management practices and derivatives use in annual reports have been improved. This allows us to hand-collect data for each firm in our sample. Using annual reports, we search the entire footnotes to financial statements for any mention of the following keywords: "risk management", "hedg", or "derivative". If a reference is found, we read the surrounding text and record whether a firm used any derivative instruments during a fiscal year and, if any, the notional amounts of derivatives outstanding at the fiscal year end. Firms are classified as non-users if the use of derivatives is not mentioned. Table 2 provides the frequency distribution of derivative usage by UK firms during the period 1999-2015.

Panel A of Table 2 shows that 82.4% of our sample are derivative users. This figure is greater than the 64% of UK firms using derivatives as reported by Bartram et al. (2011) for their sample of UK firms, and the 50% and 48% for US firms found by Campello et al. (2011) and Chen and King (2014), respectively. In Panel B of Table 2, we provide a breakdown of our sample into firms that use interest rate derivatives and those that do not. Of our sample, 66.8% are interest rate derivative users. Again, this is nearly double the corresponding figure of 36.5% in Bartram et al. (2011) and greater than the 35.6% and 39% of US firms as indicated by Campello et al. (2011) and Chen and King (2014), respectively. Given that the sample size of these above studies is possibly not comparable to ours, these comparisons suggest that UK firms employ

derivatives more extensively than US firms. The figure of derivative users in our sample is also higher than the 66% and 44% reported by Bartram et al. (2011) for their sample of French and German firms, respectively. It follows from this that derivatives use is more prevalent among UK firms and a study into the effect of derivative usage on the probability of default is very relevant within a UK context.

While firms may use forward or option contracts, e.g. collars and caps, to manage their interest rate risk, Panel D of Table 2 shows that swaps are considered the predominant tool. Of the 94.7% interest rate derivative users that disclose types of interest rate derivatives, 95.5% use interest rate swaps. This corresponds to 60.4% of our sample. Again, this is greater than the 26.6% of US firms using interest rate swaps as reported by Chernenko and Faulkender (2011). In an earlier study, Faulkender (2005) finds that only 10.9% of the debt issuances from US firms in the chemistry industry are swapped. Bretscher et al. (2018) report that only 63% of their sample of US firms are swap users, defined as firms that use interest rate swaps at least once during the sample period. The corresponding figure for UK firms in our sample is 88.5%. This shows that there are more swap activities in the UK than in the US and reaffirms our earlier suggestion.

If a firm discloses that it uses interest rate swaps, we attempt to determine the swap directions, i.e. whether the firm pays floating or fixed rate in its swap transactions. Panel E of Table 2 shows that while most firms explicitly disclose if swaps were used to manage interest rate risk, only 56.1% of swap users report swap positions. Of these, more than half, corresponding to 32.9% of swap users in the sample, swap toward fixed, while 12.9% swap toward floating and the rest swap toward both directions. To the best of our knowledge, we are the first to collect data on the directions of swaps, thus providing additional insight into the effect of swap usage on firms' default probability.

Due to the lack of disclosure in annual reports, we create a continuous measure of swap usage by using data on floating-rate debt. Firms can use interest rate swaps to modify the interest rate exposure of their debt. It is the combination of the initial interest rate exposure of the debt and a firm's interest rate swap activities that determines its overall interest rate exposure. We collect data on the share of firms' debt that is floating before the effect of interest rate swaps from S&P Capital IQ (CIQ). The CIQ database provides detailed information on debt and capital structure from annual reports. We also use annual reports to record the amount of floating-rate debt after accounting for the effect of swaps and divide this by the firm's total debt. Using these data on the initial

and final debt mix of the firm, we calculate the net floating swap percentage as the final floating-rate debt percentage minus the initial floating-rate debt percentage. It is the net share of the firm's total debt that is swapped to floating. Its absolute value represents the amount of interest rate swaps outstanding at the fiscal year end as a percentage of the firm's debt.

If a firm does not use interest rate swaps, its initial floating-rate debt percentage (pre-swap) should be equal to its final floating-rate debt percentage (net of swap). We test the difference in means between these two measures for a subsample of swap non-users and find that they are not significantly different. The results are presented in Table 3. In untabulated statistics, we also repeat this test for firms that do not use interest rate derivatives as a robustness check. Given that we use data from two sources, the proportions of floating-rate debt prove to be measured with precision and serve as good approximations of the firm's interest rate exposure that can be used to measure swap usage.

Panel A of Table 4 provides summary statistics for swap usage for the full sample. Prior to the effect of swaps, the mean (median) percentage of floating-rate debt is 57.7% (70.6%). After some firms swap toward floating and others swap toward fixed, 57.1% (56.7%) of the outstanding debt is floating. The average amount of interest rate swaps is equivalent to 24.2% of the firm's total debt, and a net share of 0.7% is swapped toward fixed. Although the mean floating swap percentage is relatively small, the standard deviation is 39.3%, indicating considerable variation in swap usage across firms and over time. This suggests that considering swaps in the analysis is important as the use of swaps can 'redistribute' firms across different levels of debt mix and thus affect the probability of default. Summary statistics for the swap users subsample are reported in Panel B of Table 4. This sample includes firms that use interest rate swaps at least once during the sample period. The number of observations reduces by nearly 20%, and average swap size increases to 26.4% of the outstanding debt.

Compared with previous studies, these statistics suggest that not only are there more swap activities in the UK but also the magnitude of swap usage by UK firms is larger. Chernenko and Faulkender (2011), for example, show that the average amount of interest rate swaps is equivalent to only 6.8% of the firm's total debt for their sample of US firms. In a later US study, Bretscher et al. (2018) report that for the average firm-year, swap size corresponds to 6.9% of the outstanding debt. These studies are,

however, consistent with our finding that a net average of the firm-year's debt is swapped toward fixed or, in other words, firms tend to be fixed-rate payers.

3.2. Variable Construction

3.2.1. Probability of Default

Most existing default probability models developed by external vendors or internal risk management functions in companies are neither able to adequately capture the noticeable increase in default rates nor clearly distinguish between distressed and creditworthy companies. This aggravated the credit crisis, and thus the default risk. In such a risky environment, it would be not enough to merely rely on company financial fundamentals, because business risk has now become as important as financial risk. This risk contains relevant information about the business environment in which the company operates, and specific elements of its management quality and competitiveness. Given that available quantitative models do not explicitly include business risk, we use the fundamental probability of default (PD) values sourced from S&P CIQ. S&P Global Market Intelligence has developed PD Model Fundamentals, a PD model that incorporates both financial and business risk and provides a comprehensive overview of a company's creditworthiness.

Proxies for probability of default can be calculated using both accounting- and market-based structural models. Accounting-based measures of default probability use information from financial reports which, by definition, is backward-looking and may not be informative about a firm's financial prospects. Market-based structural models, in contrast, use the market value of equity, which reflects the market's expectations about a firm's financial performance and thus contain forward-looking information. As robustness checks, we use the Expected Default Frequency (EDF) values sourced from Moody's Analytics. EDF metrics are forward-looking probabilities of default. The EDF model is an option-pricing based model, utilizing Vasicek's formulation of option contracts. All credit risk-related information is summarized into one metric, called Distance-to-Default (DD), which is then mapped to the probability space to obtain the EDF credit metric.

3.2.2. Control Variables

Our control variables come from the hedging literature (see, for example, Smith and Stulz (1985) and Nance et al. (1993)) and the literature on firm default (see, for example, Shumway (2001), Chava and Jarrow (2004) and Campbell et al. (2008)). Table 5 summarizes the definitions of control variables and the predicted signs on the

estimated coefficients of each variable. Except share price return, which is downloaded from Datastream, data on all other variables are collected from S&P CIQ.

a. Leverage

Smith and Stulz (1985) show that leverage creates incentives for firms to hedge in at least two ways. If the firm borrows frequently, it benefits from a reputation for hedging because such a reputation could increase the price for its new debt. Also, bond covenants can impose constraints on shareholders and cause them to take actions that they would otherwise avoid. In that case, a firm can hedge to reduce the costs of financial distress. Several studies find a positive relationship between firm leverage and default. Campbell et al. (2008) differentiate bankrupt firms from the rest of their sample in months preceding a bankruptcy filing and find that their leverage is extremely high (mean and median leverage is almost 80% and exceeds 87%, respectively). For a firm that initially has sample mean value of leverage, a one-standard deviation increase in leverage increases the failure probability by 156%. Marin (2013) compares the bankrupt versus non-bankrupt firms in the fiscal year prior to the filing by contrast and shows that the former has much higher leverage than the latter (44% versus 31%). Magee (2013) shows that firms with greater leverage have a lower distance to default. A one-standard deviation increase in leverage decreases the distance to default by 3.991. In this study, we calculate leverage as the ratio of total debt to total assets and expect a positive correlation between leverage and the probability of default.

b. Size

Shumway (2001) develops a hazard model for forecasting bankruptcy and suggests that firm size is a strong predictor. Larger firms are relatively safe. Chava and Jarrow (2004) investigate the forecasting accuracy of bankruptcy hazard rate models and find that increasing size indicates a smaller chance of bankruptcy. Campbell et al. (2008) start with a basic specification used by Shumway (2001) and show a negative relationship between the market capitalization of each firm and the probability of bankruptcy or failure. When they increase the horizon at which they attempt to predict failure, the effect of market capitalization become stronger. Consistent with Shumway (2001) and Campbell et al. (2008), Magee (2013) finds that firm size is positively related to the distance to default. We use the natural logarithm of assets as a measure of firm size and expect a negative coefficient on this variable.

c. Profitability

There is evidence of a link between profitability and default risk. Campbell et al. (2008) find that profitability is a good predictor of bankruptcy. A one-standard deviation increase in profitability reduces the failure probability by 44% of its initial value for a firm that has sample mean value of profitability. Marin (2013) indicates that the more profitable a firm is, the lower the odds of filing for bankruptcy. We control for profitability with the ratio of EBITDA to total assets and expect a negative association between firm profitability and default.

d. Liquidity

Nance et al. (1993) suggest that firms could reduce default probability by investing in more liquid assets since this helps to assure bondholders that fixed claims are covered. The more funds available to pay these fixed claims, the lower the expected costs of financial distress. Copeland and Joshi (1996) argue that cash flow volatility can lead to business disruption. When cash flow decreases unexpectedly, the cost of doing business will increase because suppliers, customers and workers may believe that the firm may not remain in business. Campbell et al. (2008) indicate that a firm with a high liquidity ratio may postpone bankruptcy or even avoid it altogether if circumstances improve because it has more liquid assets to pay interest. They also find evidence of a 21% reduction in the failure probability resulting from a one-standard deviation increase in cash holdings for a firm that initially has sample mean value of cash holdings. Consistent with these findings, Magee (2013) shows that more liquid firms have a greater distance to default. Marin (2013) finds that there is a strong negative relationship between liquidity and the likelihood of bankruptcy. In this study, we use current ratio, defined as current assets divided by current liabilities, as a measure of liquidity. We expect a negative coefficient on this variable.

e. Price volatility

Shumway (2001) finds that the standard deviation of each firm's stock returns is strongly related to its bankruptcy probability both statistically and logically. A firm that has more variable cash flows ought to have more variable stock returns, and hence a higher probability of bankruptcy. Chava and Jarrow (2004) show that decreasing the stock's volatility indicates a lower likelihood of bankruptcy. Campbell et al. (2008) compute the proportional impact of a one-standard deviation increase in each predictor on the failure probability and report a 64% increase for volatility. At long horizons of the forecast, the coefficient on volatility is almost unchanged as the horizon increases. Magee (2013) finds that a one-standard deviation increase in stock return volatility

reduces the distance to default by 2.799. In our study, price volatility is computed as the standard deviation of weekly log-normal price returns over the past one and five years, annualized with a factor of 52 for the 52 trading weeks in a year. We expect that price volatility is positively related to the probability of default.

f. Excess return

Shumway (2001) suggests that if traders discount the equity of a firm that is almost bankrupt, then its past excess returns could predict bankruptcy. Chava and Jarrow (2004) find that increasing excess return reduces the likelihood of bankruptcy. Campbell et al. (2008) report that for a firm that initially has sample mean value of past excess return, a one-standard deviation increase in excess return decreases the failure probability by 28%. Magee (2013) also finds that excess return is positively related to the distance to default. We calculate excess return as annual share price return minus the value-weighted FTSE all shares index annual return. The return index from Datastream includes the re-investment of dividends. We expect a negative association between excess return and default probability.

3.2.3. Summary Statistics

Table 6 provides summary statistics for measures of pre-derivative exposure and probability of default as well as control variables. In Panel A of Table 6, we present measures of financial price exposure that do not account for the effect of derivatives. On average, about a half of firms' sales (50.1%) are generated outside the UK and nearly a half of firms' assets (46.9%) are located in foreign countries. Firms in our sample have high levels of foreign debt which is close to 50%. These figures are much higher than the corresponding figures in other studies. Bartram et al. (2011), for example, show that the average level of foreign sales in their sample is 23%. However, their sample firms originate from various countries, so this mean value may reflect great differences across countries. A more appropriate comparison would be against the US counterparts. Allayannis and Ofek (2001) report that US non-financial firms in the S&P 500 have around 20% foreign sales on average. Purnanandam (2008) finds a median value of foreign sales of 14.6% for a sample of US firms with foreign currency exposure. It follows that our sample firms have higher levels of foreign trading activities than US firms, which lead to a higher level of foreign currency exposure and cash flow volatility. These statistics support our suggestion that the UK is a better setting for examining the effect of derivatives and swaps, in particular, on firms' default probability.

Panel B of Table 6 displays summary statistics for our sample firms' probability of default (PD) and EDF. The mean and median PDs are quite low (1.9% and 0.7%, respectively). These values for EDF are 1.4 and 0.7, respectively. Our main analyses use the period from 2002 to 2015 due to the lack of wide coverage of PD data in CIQ before 2002. In robustness checks in Section 4.3, we study EDF separately and extend our sample period to include the years 1999 to 2001. We examine the time-series variation in the default probability by plotting the mean values of PD and EDF for interest rate swap users and non-users during the period 2002-2015 and 1999-2015, respectively.

Figure 1 shows that interest rate swap users have lower probability of default across all years in the sample period and default risk declines over time for both groups. During the financial crisis of 2007-2008, the average default probability of non-users increases while the average default probability of users remains relatively stable.

Figure 2 shows that interest rate swap users and non-users are at the same level of default risk at the beginning of the sample period. However, moving toward 2002, the average EDF of users falls behind while the default probability of non-users goes up at a faster rate. After reaching a peak in 2002-2003, the probability of default for both groups reduces until 2007 when it starts to increase. In 2007, interest rate swap users and non-users have similar levels of default risk. The difference between two groups reaches its maximum during the economic slowdown and increased credit risk of 2002. This suggests that economic uncertainty may affect firms that do not use interest rate swaps more than firms that use interest rate swaps. Overall, Figure 2 also shows that swap users, on average, have lower probability of default than non-users.

Panel C of Table 6 shows summary statistics for our control variables. The average leverage ratio across firms in our sample is 24.2%, which is quite close to the 25.5% found by Bartram et al. (2011). Return on assets ranges from -25.4% to 23.1%, indicating the existence of both loss-making and profitable firms. The average level of liquidity, measured by current ratio, is 1.6. On average, our sample firms earn higher returns than the market as a whole. These statistics suggest that there is a wide cross-section of firms in our sample, some of which have financial price exposure and may need to use derivatives for hedging.

Earlier research indicates that there are significant differences in the characteristics of firms that use interest rate swaps and those that do not. We use univariate tests for difference in means and medians between interest rate swap users and non-users to

examine the existence of such differences in our sample. Specifically, we use both parametric (t test) and non-parametric (Wilcoxon rank-sum (Mann-Whitney) test) tests. The results are reported in Table 7. The number of observations for the purposes of comparison are different due to data availability.

As can be seen from Table 7, interest rate swap users have higher levels of pre-derivative interest rate exposure. We find statistically lower Z-score and interest coverage for interest rate swap users than non-users. The results also show that firms that use interest rate swaps have lower default probabilities than those that do not, based on both mean and median tests. Consistent with many previous studies (see, for example, Guay (1999), Hentschel and Kothari (2001), Campello et al. (2011) and Bartram et al. (2011)), we find that interest rate swap users are significantly larger, have higher leverage ratios and lower price volatility compared to non-users. The size finding supports the hypothesis that larger firms can benefit from the scale of economies in derivative transaction costs and hence are more likely to use derivatives. Interest rate swap users also keep fewer liquid assets, which is in line with the notion that liquidity is the hedging substitute.

3.3. Methodology

We use regression analysis to examine the effect of swap usage on default probability. We start with a basic model that includes several potential drivers of firm default following Shumway (2001), Chava and Jarrow (2004) and Campbell et al. (2008), and then add our swap usage variables. Specifically, our regression model takes the general form as follows:

$$PD_{it}\ (or\ EDF_{it}) = \beta_0 + \beta_1 Swaps_{it} + \beta_2 Leverage_{it} + \beta_3 Size_{it} + \beta_4 Profitability_{it} + \beta_5 Liquidity_{it} + \beta_6 Price\ volatility_{it} + \beta_7 Excess\ return_{it} + \varepsilon_{it}. \qquad (1).$$

We include year dummies to control for common shocks to the default probability of all firms and industry dummies to control for industry effects. Standard errors are adjusted for within-firm correlation (i.e. clustering by firm) and heteroskedasticity using the White-Huber estimator.

4. Empirical Results

4.1.Multivariate Tests

In this section, we use multivariate tests to control for the correlation between different firm characteristics while holding other firm-level attributes constant. We first

estimate our models using data on interest rate derivatives and the directions of swaps collected from annual reports. Binary measures of swap usage are used in these tests and are the main variables of interest. The results are presented in Table 8. We find evidence that firms that use interest rate derivatives or interest rate swaps have statistically lower probabilities of default, controlling for other firm characteristics that may drive firm default. Our pooled OLS results indicate that the use of swaps reduces default probability by approximately 0.004%. We then examine the effect of swap directions and find the lower likelihood of bankruptcy for firms that swap toward fixed compared to those that swap toward floating or do not use interest rate swaps.

All of the coefficients on control variables have the expected signs and are highly significant. Firms with higher leverage ratios have higher expected costs of financial distress and hence higher probabilities of default, consistent with Campello et al. (2011), Magee (2013) and Marin (2013). Larger and more profitable firms are exposed to lower default risk. A potential explanation is that larger firms are more likely to diversify products and markets, while more profitable firms are better able to service their debts or finance themselves instead of raising costly external funds from the capital market. Liquidity has a negative impact on the default probability. Firms with more cash or liquid assets do not necessarily rely on external financing to make investment or interest payments. We also find that lower price volatility and better equity market performance indicate lower probability of default.

In Table 9, we run the regressions using the lagged values of explanatory variables. Chen and King (2014) argue that these values may not correlate with the contemporaneous unobservable factors that drive firm default. The results in Table 9 confirm our previous results. We also employ a quantile regression model in Table 10 and show that the results are robust. Note that in these tests, firms that swap toward floating have higher likelihood of bankruptcy than those that do not use interest rate swaps.

The use of interest rate swaps is a corporate decision that is endogenous. There is a problem of selection bias in studies that use observational data. In our study, the problem of endogeneity might also arise due to simultaneous causality. In other words, if interest rate swaps are used for hedging, they could reduce firm default risk, but it can be the case that firms that have high probabilities of default are more likely to use interest rate swaps for hedging purposes. Thus, the use of interest rate swaps could affect the probability of default, but the probability of default could also affect the

decision to use interest rate swaps. We control for endogeneity using a treatment effects model which includes two equations, i.e. the selection and regression equation. It is possible that firms decide to use interest rate swaps to achieve their expected benefits such as to reduce the costs of financial distress and therefore the sample of interest rate swap users could be non-random. In the selection equation, we model the decision to use interest rate swaps as a function of firm characteristics that have been shown to be important determinants of interest rate swap usage in the literature, including two instrumental variables. The first instrument is the market-to-book ratio. Wall and Pringle (1989) and Samant (1996) argue that interest rate swaps may be used to reduce agency costs associated with the underinvestment problem and that these costs are higher for firms in growing industries. The ratio of market value to book value of equity is used to proxy for growth opportunities. For the second instrument, we use the ratio of fixed asset to total assets (asset tangibility). Wall and Pringle (1989) argue that the use of interest rate swap reduces equity holders' incentives to shift risk onto debt holders and that these incentives are greater for firms with low asset tangibility. Samant (1996) finds that fixed-rate payers have lower ratios of fixed assets to total assets compared to swap non-users.

We present the results of OLS regressions with endogenous treatment effects in Table 11. As can be seen from the regression equations, the coefficients on interest rate swaps are negative and highly significant, which suggests that firms that use interest rate swaps have statistically lower probabilities of default, consistent with the previous OLS results. The coefficient values are about -0.022, indicating that other things being equal, interest rate swap users have a mean default probability that is 0.022% lower than swap non-users.

4.2.Robustness Checks

As robustness checks, we use the EDF values sourced from Moody's Analytics as the dependent variables and repeat the OLS analysis conducted previously. EDF metrics are forward-looking probabilities of default. The results are provided in Table 12 and remain qualitatively similar.

As mentioned above, we use data on the initial floating-rate debt percentage from S&P CIQ and the final floating-rate debt percentage from annual reports to calculate the net floating swap percentage and its absolute value. In this section, we use the net floating swap percentage to create dummy variables indicating whether the firm swaps toward floating or fixed or does not use interest rate swaps. We also use its absolute

value to construct new measures of interest rate swaps outstanding at the fiscal year end as a percentage of the firm's debt if the firm does the following: i/ swaps toward floating, ii/ swaps toward fixed, iii/ swaps toward floating or does not use interest rate swaps, and iv/ swaps toward fixed or does not use interest rate swaps. The results are presented in Table 13. Consistent with the previous results, the greater the average swap size is, the lower probability of default the firm has. When we split the sample into firms that swap toward floating and those that swap toward fixed, the results show that swapping from floating to fixed could reduce default probability. These results are robust even if we include swap non-users in both subsamples. Also, there is evidence that the higher the net floating swap percentage, the greater the probability of default. When creating dummy variables for the directions of swaps, we see that firms that swap toward fixed have significantly lower default probability compared to those that do not use swaps.

We also find that larger and more profitable firms, those with less debt, high liquidity and more excess return, are less likely to default on their debts. The coefficients of the price volatility variables are positive and significant at better than 1%, indicating that changes in stock price over a 1-year or 5-year period increase the firm's probability of default.

4.3.Time-varying Effects of Interest Rate Swap Usage on Default Probability

The effects of swap usage on default probability may vary over time, which is potentially consistent with the prevailing macroeconomic and financial conditions. To examine the time-varying effects of interest rate swaps, we interact the swap dummy with year dummies. This allows the coefficients on the swap dummy to vary by year. It could be argued that derivative users will hedge more during periods of economic downturn. If this is the case, we expect a greater impact of swap usage on the probability of default during these periods, and hence higher negative values for the interaction terms' coefficients. Conversely, firms may reduce the level of hedging activities or even speculate during favourable macroeconomic conditions, in which case there will be smaller differences in the default risk between swap users and non-users. Thus, the coefficients on the interaction terms may fall in absolute value or even be positive. We use the annual gross domestic product (GDP) growth rate to control for time effects that may be associated with the probability of default and estimate the following model:

$$PD_{it}\ (or\ EDF_{it}) = \beta_0 + \beta_1 Swaps_{it} + \beta_2 Leverage_{it} + \beta_3 Size_{it} + \beta_4 Profitability_{it} + \beta_5 Liquidity_{it} + \beta_6 Price\ volatility_{it} + \beta_7 Excess\ return_{it} + + \beta_8 GDP_t + \sum_{t=9}^{25} \beta_t\ Swaps_{it} * Year_t + \varepsilon_{it}. (2)$$

The results are presented in Table 14. In Figure 3, we plot the coefficients on the interaction terms using the results of S&P CIQ PD. As a robustness check, in untabulated statistics, we replace interest rate swaps with interest rate derivatives and find similar results.

As can be seen from Figure 3, the interaction terms' coefficients vary from -0.106 in 2004 to -0.121 in 2008. This seems to closely follow the performance of the UK economy. During the 2004-2006 period, the real GDP growth rate averaged 3%, household consumption went up and corporate profits increased. In addition, according to the Bank of England Financial Stability Report, the balance sheets of UK firms did not look stretched in aggregate. Instead, because of higher profits and lower investment, the UK corporate sector held large balances of liquid assets and was a net saver. UK corporate insolvencies also remained close at their lowest point. High profitability and liquidity might have led to fewer hedging activities during this period, which, in turn, could explain lower absolute values of the interaction terms' coefficients. In 2008, the UK economy experienced a sharp decline in GDP as a result of the global financial crisis. Interest rate spreads went up due to concerns about future corporate distress. The Bank of England reported that the first quarter of 2009 witnessed an over 50% increase in corporate insolvencies compared with the previous year.[1] The highest and negative coefficients in 2008 are consistent with the deterioration in the UK credit risk conditions. Overall, our results suggest that the effects of interest rate swap usage on the probability of default are stronger during periods of heightened macroeconomic uncertainty.

4.4. The Effects of Interest Rate Swap Usage on the Price Volatility and Beta

We further examine the effects of swap usage on firm risk by looking at price volatility and the sensitivity of stock returns against the market. The results are provided in Table 15-Table 18. As can be seen from Table 15, firms that use interest rate swaps have fewer volatile stocks. Regarding the directions of swaps, there are lower levels of price volatility for firms that swap toward fixed compared with those that do not use interest rate swaps. Table 16 also shows evidence that swapping toward floating

[1] Financial Stability Report, June 2009, Bank of England.

increases the volatility of stock prices, and the greater the average swap size, the lower levels of price volatility. Apart from the effects of swap usage, we find that smaller and less profitable firms, and those with high leverage tend to see more changes in their stock prices.

We use beta sourced from S&P CIQ as the dependent variable in Table 17 and Table 18. 1-year beta is defined as the slope of the 52-week regression line of the percentage price change of the stock relative to the percentage price change of its benchmark. The benchmarks are the S&P 500 for all US stocks, the S&P/TSX Composite for all Canadian stocks and the MSCI EAFE (Developed Markets) and MSCI Emerging Markets for all other international stocks. We find that the larger amount of interest rate swaps the firm uses, particularly if it swaps into a fixed rate exposure, the less sensitive its stock returns to the overall fluctuation of the market index. Larger and less profitable firms, those with high leverage and liquidity ratios, show higher sensitivity of stock returns. In untabulated statistics, we replace 5-year price volatility with 1-year price volatility and 1-year beta with 5-year beta and find similar results.

5. Conclusion

This study examines the effects of interest rate swap usage on the probability of default. Our results suggest that firms that use interest rate swaps have lower default probabilities, controlling for other firm characteristics that may be associated with default risk. We find that the likelihood of bankruptcy is lower for firms that swap toward fixed compared to those that swap toward floating or do not use interest rate swaps. These results are robust when we use EDF values sourced from Moody's Analytics to measure the probability of default or construct new measures of interest rate swaps using data from annual reports.

The effects of swap usage on default probability may vary over time, which is potentially consistent with the prevailing macroeconomic and financial conditions. We further examine the time-varying effects of interest rate swap usage on firm default and find stronger effects during periods of heightened macroeconomic uncertainty. Finally, we examine the impact of swap usage on firm risk by looking at price changes and the volatility of stock prices against the market. The results show that firms that use interest rate swaps have lower levels of price volatility and the greater the average swap size, the lower the sensitivity of stock prices.

Our findings have important implications. Despite public concern over the relationship between the use of derivatives and firm risk, the evidence shows that

interest rate swaps are used for hedging. The use of interest rate swaps is associated with a reduction in firm risk. From a policy making perspective, the lack of evidence on the use of financial derivatives for speculation suggests that further regulations on derivatives reporting in the UK may not be necessary. However, current derivative financial instrument disclosure requirements need to be strictly enforced to protect shareholders' wealth.

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Table 1: Summary of previous empirical studies on derivative usage and firm risk

This table provides a list of previous empirical studies that examine whether firms are using derivatives for hedging or speculation.

Author(s)	Year	Area of study	Country	Sample size
Guay	1999	All derivatives	US	254 firms
Hentschel and Kothari	2001	All derivatives	US	425 firms
Faulkender	2005	Interest rate derivatives	US	133 firms
Nguyen and Faff	2010	Foreign currency and interest rate derivatives	Australia	469 firms
Bartram, Brown and Conrad	2011	All derivatives	47 countries	6,888 firms
Chernenko and Faulkender	2011	Interest rate derivatives	US	11,261 firm-years
Beber and Fabbri	2012	Foreign currency derivatives	US	231 firms
Júnior	2013	Foreign currency derivatives	Brazil	200 firms
Magee	2013	Foreign currency derivatives	US	401 firms
Marin	2013	Foreign currency derivatives	US	344 firms
Adam, Fernando and Golubeva	2015	All derivatives	North America	92 firms
Adam, Fernando and Salas	2017	All derivatives	North America	92 firms
Bartram	2017	All derivatives	47 countries	6,896 firms

Table 2: Frequency Distribution of Derivative Usage

This table provides the frequency distribution of derivative usage by UK firms during the period 1999-2015.

Derivative Categories	Frequency	Percentage
Panel A: Derivative Users and Non-users		
Derivative Users	5,306	82.44
Non-users	1,130	17.56
Total	6,436	100.00
Panel B: Types of Derivatives		
IR Derivatives	4,299	66.80
FC Derivatives Only	877	13.63
FC & CP Derivatives	88	1.37
CP Derivatives Only	42	0.65
Non-users of Derivatives	1,130	17.56
Total	6,436	100.00
Panel C: IR Derivative Users		
Disclose Types of IR Derivatives	4,071	94.70
Do not Disclose Types of IR Derivatives	228	5.30
Total	4,299	100.00
Panel D: Types of IR Derivatives[2]		
IR Swaps	3,887	95.48
IR Forwards Only	119	2.92
IR Forwards & Options	10	0.25
IR Options Only	55	1.35
Total	4,071	100.00
Panel E: IR Swap Direction		
Swap into floating	503	12.94
Swap into fixed	1,277	32.85
Swap into both	402	10.34
Cannot determine direction	1,705	43.86
Total	3,887	100.00

[2] As a % of interest rate derivative users that disclose types of interest rate derivatives

Table 3: Test of Difference in Means between Initial and Final Floating-rate Debt Percentages

This table provides the results of the test of the difference in means between initial floating-rate debt percentage (pre-swap) and final floating-rate debt percentage (net of swap) for a subsample of swap non-users.

	Initial floating-rate debt (%)	N	Final floating-rate debt (%)	N	Mean difference
IR swap non-users	65.48	847	63.84	847	1.64

Table 4: Swap Usage Summary Statistics

This table provides summary statistics of swap usage for the full sample and the swap users subsample. Swap users are defined as firms that use interest rate swaps at least once during the sample period.

Panel A: Full Sample						
Variable	**Obs.**	**Mean**	**Median**	**Std. Dev.**	**Min**	**Max**
Floating-rate debt (pre-swap) (%)	2,427	57.74	70.62	41.31	0.00	100.00
Swapped to floating (%)	2,427	-0.67	0.00	39.28	-100.00	100.00
|Swapped to floating (%)|	2,427	24.19	7.86	30.96	0.00	100.00
Floating-rate debt (net of swap) (%)	2,427	57.07	56.74	38.01	0.00	100.00
Panel B: Subsample of Swap Users						
Variable	**Obs.**	**Mean**	**Median**	**Std. Dev.**	**Min**	**Max**
Floating-rate debt (pre-swap) (%)	2,147	55.95	62.45	40.91	0.00	100.00
Swapped to floating (%)	2,147	-0.50	0.00	40.87	-100.00	100.00
|Swapped to floating (%)|	2,147	26.35	11.67	31.24	0.00	100.00
Floating-rate debt (net of swap) (%)	2,147	55.45	53.31	36.95	0.00	100.00

Table 5: Variable Definitions and Summary of Hypotheses

This table summarizes the definitions of control variables and the predicted signs on the estimated coefficients of each variable.

Explanatory variable	Variable description	Hypothesis
Book leverage	Total debt divided by total assets	+
Firm size	Natural logarithm of assets	-
Return on assets	EBITDA divided by total assets	-
Current ratio	Current assets divided by current liabilities	-
Price volatility	The standard deviation of weekly log-normal price returns annualized with a factor of 52 for the 52 trading weeks in a year	+
Excess return	Annual share price return minus the value-weighted FTSE all shares index annual return	-

Table 6: Summary Statistics

This table provides summary statistics for measures of pre-derivative exposure and probability of default as well as control variables.

Variable	Obs.	Mean	Median	Std. Dev.	Min.	Max.
Panel A: Pre-derivative Exposure						
Foreign sales (%)	3,911	50.134	55.592	37.825	0.000	100.000
Foreign assets (%)	3,448	46.941	47.674	38.329	0.000	100.000
Foreign debt (%)	3,094	48.219	49.531	39.974	0.000	100.000
Z-score	3,875	3.189	2.605	3.090	-4.690	26.402
Interest coverage	4,002	66.196	10.750	236.506	0.511	1837.000
Panel B: Probability of Default						
S&P CIQ PD	4,313	0.019	0.007	0.038	0.000	1.000
Moody EDF	4,543	1.373	0.703	2.197	0.012	49.600
Panel C: Control Variables						
Book leverage	3,982	0.242	0.223	0.170	0.001	0.845
Natural log of assets	4,304	6.695	6.559	1.754	0.577	12.349
ROA	4,251	5.310	5.103	5.871	-25.366	23.109
Current ratio	4,304	1.593	1.282	1.310	0.251	13.140
5-year price volatility	3,883	40.745	36.267	18.104	15.877	111.259
1-year price volatility	4,084	35.574	29.536	20.599	9.686	139.829
Excess return	4,285	9.090	4.010	45.027	-82.780	258.060

Table 7: Test of Difference in Means and Medians between Interest Rate Swap Users and Non-users

This table provides the results of parametric (t test) and non-parametric (Wilcoxon rank-sum (Mann-Whitney) test) tests between interest rate swap users and non-users.

	Interest rate swap non-users			Interest rate swap users			Difference	
Variable	**Mean**	**Median**	**N**	**Mean**	**Median**	**N**	**Mean**	**Median**
Foreign sales (%)	54.210	62.410	1,307	46.941	49.584	2,320	7.268***	5.928***
Foreign assets (%)	48.484	50.082	1,169	46.255	47.674	2,036	2.229	1.913*
Foreign debt (%)	48.795	49.354	984	47.681	49.420	1,967	1.114	1.383
Z-score	3.697	3.217	1,375	2.536	2.331	2,151	1.162***	14.266***
Interest coverage	106.468	17.956	1,326	23.214	8.387	2,361	83.254***	20.083***
S&P CIQ PD	0.023	0.008	1,461	0.015	0.006	2,432	0.008***	5.319***
Moody EDF	1.588	0.718	1,135	1.173	0.626	1,829	0.415***	4.545***
Book leverage	0.180	0.145	1,273	0.282	0.265	2,387	-0.102***	-20.025***
Natural log of assets	6.012	5.978	1,457	7.291	7.213	2,432	-1.279***	-21.968***
ROA	5.634	5.821	1,429	5.226	4.797	2,421	0.408**	5.171***
Current ratio	1.764	1.442	1,457	1.369	1.167	2,432	0.395***	12.887***
5-year price volatility	42.939	38.592	1,292	38.938	34.179	2,281	4.001***	8.648***
1-year price volatility	38.264	31.904	1,368	33.655	27.824	2,360	4.610***	9.838***
Excess return	9.578	3.740	1,449	8.114	4.415	2,428	1.464	-0.084

Table 8: OLS Regressions of Default Probability (Annual Reports)

This table provides the results of OLS regressions of default probability, proxied by the fundamental probability of default (PD) sourced from S&P CIQ. Data on interest rate derivatives and the directions of swaps are collected from annual reports. The sample period is 2002-2015. Standard errors in parentheses are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Interest rate derivatives	-0.00382**	-0.00390***						
	(0.00148)	(0.00139)						
Interest rate swaps			-0.00362**	-0.00402***				
			(0.00148)	(0.00141)				
Swap into floating							0.00220	0.00233
							(0.00208)	(0.00205)
Swap into fixed					-0.00583***	-0.00627***	-0.00611***	-0.00673***
					(0.00180)	(0.00176)	(0.00162)	(0.00152)
Swap into both					-0.00345*	-0.00314*	-0.00242	-0.00212
					(0.00192)	(0.00189)	(0.00235)	(0.00229)
Cannot determine swap direction					-0.00160	-0.00129	-0.00198	-0.00217
					(0.00189)	(0.00192)	(0.00202)	(0.00199)
Book leverage	0.03656***	0.03583***	0.03633***	0.03573***	0.03949***	0.03696***	0.03797***	0.03743***
	(0.00621)	(0.00616)	(0.00617)	(0.00615)	(0.00690)	(0.00682)	(0.00607)	(0.00601)
Natural log of assets	-0.00466***	-0.00470***	-0.00466***	-0.00465***	-0.00443***	-0.00431***	-0.00534***	-0.00540***
	(0.00052)	(0.00051)	(0.00052)	(0.00051)	(0.00053)	(0.00052)	(0.00057)	(0.00056)

ROA	-0.00227***	-0.00238***	-0.00227***	-0.00238***	-0.00197***	-0.00199***	-0.00229***	-0.00240***
	(0.00025)	(0.00023)	(0.00025)	(0.00023)	(0.00032)	(0.00030)	(0.00024)	(0.00023)
Current ratio	-0.00209***	-0.00210***	-0.00210***	-0.00212***	-0.00164***	-0.00160***	-0.00202***	-0.00203***
	(0.00069)	(0.00063)	(0.00069)	(0.00063)	(0.00060)	(0.00057)	(0.00070)	(0.00065)
5-year price volatility	0.00037***		0.00037***		0.00030***		0.00036***	
	(0.00007)		(0.00007)		(0.00006)		(0.00007)	
1-year price volatility		0.00039***		0.00039***		0.00033***		0.00038***
		(0.00006)		(0.00006)		(0.00007)		(0.00006)
Excess return	-0.00007***	-0.00006***	-0.00007***	-0.00006***	-0.00007***	-0.00006***	-0.00007***	-0.00006***
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
Constant	0.04576***	0.05105***	0.04561***	0.05065***	0.04812***	0.04287***	0.05444***	0.05670***
	(0.00770)	(0.00679)	(0.00768)	(0.00673)	(0.00769)	(0.00559)	(0.00808)	(0.00693)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3361	3499	3361	3499	2238	2312	3361	3499
Adjusted $R2$	0.488	0.528	0.487	0.528	0.422	0.456	0.493	0.534

Table 9: OLS Regressions of Default Probability (Lag) (Annual Reports)

This table provides the results of OLS regressions of default probability, proxied by the fundamental probability of default (PD) sourced from S&P CIQ, using the lagged values of independent variables. Data on interest rate derivatives and the directions of swaps are collected from annual reports. The sample period is 2002-2015. Standard errors in parentheses are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
L.Interest rate derivatives	-0.00287*	-0.00140						
	(0.00155)	(0.00153)						
L.Interest rate swaps			-0.00307*	-0.00179				
			(0.00159)	(0.00158)				
L.Swap into floating							0.00158	0.00292
							(0.00200)	(0.00204)
L.Swap into fixed					-0.00465***	-0.00521***	-0.00538***	-0.00467***
					(0.00176)	(0.00184)	(0.00169)	(0.00161)
L.Swap into both					-0.00134	-0.00107	-0.00104	0.00072
					(0.00220)	(0.00223)	(0.00247)	(0.00242)
L.Cannot determine swap direction					-0.00060	0.00000	-0.00173	0.00065
					(0.00180)	(0.00189)	(0.00222)	(0.00228)
L.Book leverage	0.02781***	0.02600***	0.02785***	0.02618***	0.03053***	0.02779***	0.02912***	0.02779***
	(0.00548)	(0.00526)	(0.00547)	(0.00533)	(0.00592)	(0.00590)	(0.00540)	(0.00517)
L.Natural log of assets	-0.00432***	-0.00445***	-0.00428***	-0.00440***	-0.00406***	-0.00409***	-0.00484***	-0.00500***
	(0.00051)	(0.00052)	(0.00050)	(0.00051)	(0.00050)	(0.00051)	(0.00056)	(0.00055)
L.ROA	-0.00158***	-0.00160***	-0.00158***	-0.00160***	-0.00125***	-0.00122***	-0.00160***	-0.00162***
	(0.00023)	(0.00022)	(0.00023)	(0.00022)	(0.00027)	(0.00029)	(0.00023)	(0.00022)

L.Current ratio	-0.00171***	-0.00121*	-0.00173***	-0.00122*	-0.00123**	-0.00112**	-0.00167**	-0.00114*
	(0.00065)	(0.00063)	(0.00065)	(0.00063)	(0.00060)	(0.00056)	(0.00066)	(0.00064)
L.5-year price volatility	0.00036***		0.00036***		0.00029***		0.00035***	
	(0.00007)		(0.00007)		(0.00006)		(0.00007)	
L.1-year price volatility		0.00037***		0.00037***		0.00036***		0.00036***
		(0.00005)		(0.00005)		(0.00006)		(0.00005)
L.Excess return	-0.00011***	-0.00010***	-0.00011***	-0.00010***	-0.00009***	-0.00010***	-0.00011***	-0.00010***
	(0.00002)	(0.00002)	(0.00002)	(0.00002)	(0.00002)	(0.00002)	(0.00002)	(0.00002)
Constant	0.04063***	0.04124***	0.04046***	0.04109***	0.04566***	0.02510***	0.04630***	0.05515***
	(0.00800)	(0.00741)	(0.00802)	(0.00739)	(0.00813)	(0.00698)	(0.00843)	(0.00699)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3218	3376	3218	3376	2212	2306	3218	3376
Adjusted R_2	0.348	0.370	0.349	0.370	0.312	0.343	0.352	0.374

Table 10: Quantile regressions of Default Probability (Annual Reports)

This table provides the results of quantile regressions of default probability, proxied by the fundamental probability of default (PD) sourced from S&P CIQ. Data on interest rate derivatives and the directions of swaps are collected from annual reports. The sample period is 2002-2015. Standard errors in parentheses are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Interest rate derivatives	-0.00038	-0.00055*						
	(0.00027)	(0.00029)						
Interest rate swaps			-0.00055*	-0.00078***				
			(0.00030)	(0.00029)				
Swap into floating							0.00063**	0.00063*
							(0.00030)	(0.00034)
Swap into fixed					-0.00144***	-0.00130***	-0.00111***	-0.00135***
					(0.00030)	(0.00027)	(0.00027)	(0.00032)
Swap into both					-0.00125***	-0.00083***	-0.00060*	-0.00038
					(0.00026)	(0.00029)	(0.00036)	(0.00029)
Cannot determine swap direction					-0.00074***	-0.00054	-0.00090**	-0.00087**
					(0.00027)	(0.00036)	(0.00041)	(0.00036)
Book leverage	0.01668***	0.01582***	0.01666***	0.01612***	0.01766***	0.01501***	0.01690***	0.01631***
	(0.00104)	(0.00092)	(0.00106)	(0.00092)	(0.00094)	(0.00098)	(0.00099)	(0.00089)
Natural log of assets	-0.00282***	-0.00279***	-0.00278***	-0.00275***	-0.00283***	-0.00267***	-0.00294***	-0.00297***
	(0.00009)	(0.00009)	(0.00008)	(0.00009)	(0.00009)	(0.00010)	(0.00009)	(0.00010)
ROA	-0.00083***	-0.00088***	-0.00084***	-0.00087***	-0.00062***	-0.00062***	-0.00083***	-0.00088***
	(0.00003)	(0.00003)	(0.00002)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)

Current ratio	-0.00110***	-0.00113***	-0.00112***	-0.00111***	-0.00102***	-0.00096***	-0.00114***	-0.00110***
	(0.00013)	(0.00013)	(0.00014)	(0.00013)	(0.00008)	(0.00012)	(0.00011)	(0.00012)
5-year price volatility	0.00014***		0.00015***		0.00012***		0.00014***	
	(0.00002)		(0.00002)		(0.00002)		(0.00002)	
1-year price volatility		0.00020***		0.00020***		0.00015***		0.00020***
		(0.00002)		(0.00002)		(0.00002)		(0.00002)
Excess return	-0.00002***	-0.00002***	-0.00002***	-0.00002***	-0.00001**	-0.00001***	-0.00002***	-0.00002***
	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)
Constant	0.02448***	0.02434***	0.02426***	0.02404***	0.02382***	0.02301***	0.02586***	0.02577***
	(0.00109)	(0.00115)	(0.00119)	(0.00103)	(0.00117)	(0.00121)	(0.00115)	(0.00114)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3361	3499	3361	3499	2238	2312	3361	3499
Pseudo R_2	0.227	0.238	0.227	0.238	0.232	0.241	0.229	0.240

Table 11: Controlling for Endogeneity

This table presents the results of OLS regressions with endogenous treatment effects. The variables for the treatment equation include the market-to-book ratio and the ratio of fixed assets to total assets (asset tangibility). Standard errors in parentheses are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Interest rate swaps		Default probability	
	(1)	(2)	(3)	(4)
Market-to-book	-0.40641***	-0.37119***		
	(0.06838)	(0.07127)		
Asset tangibility	1.05248***	0.99655***		
	(0.27809)	(0.27133)		
Interest rate swaps			-0.02255***	-0.02187***
			(0.00389)	(0.00408)
Book leverage	1.81826***	1.80503***	0.04830***	0.04696***
	(0.36097)	(0.37522)	(0.00727)	(0.00717)
Natural log of assets	0.29402***	0.30185***	-0.00291***	-0.00299***
	(0.04031)	(0.03892)	(0.00065)	(0.00065)
ROA	0.00978	0.01096	-0.00240***	-0.00250***
	(0.01130)	(0.01092)	(0.00026)	(0.00024)
Current ratio	0.02829	0.01354	-0.00271***	-0.00270***
	(0.05223)	(0.04819)	(0.00074)	(0.00070)
5-year price volatility	-0.00748***		0.00034***	
	(0.00286)		(0.00007)	
1-year price volatility		-0.00772***		0.00035***
		(0.00218)		(0.00006)
Excess return	0.00162**	0.00095	-0.00007***	-0.00006***
	(0.00073)	(0.00068)	(0.00001)	(0.00001)
Constant	-2.73944***	-2.74391***	0.03415***	0.03468***
	(0.56464)	(0.56129)	(0.00781)	(0.00751)
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations			3339	3475

Table 12: OLS Regressions of Default Probability (Moody EDF) (Annual Reports)

This table provides the results of OLS regressions of default probability, proxied by the Expected Default Frequency (EDF) sourced from Moody's Analytics. Data on interest rate derivatives and the directions of swaps are collected from annual reports. The sample period is 1999-2015. Standard errors in parentheses are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Interest rate derivatives	-0.26483**	-0.29155***						
	(0.11209)	(0.10765)						
Interest rate swaps			-0.23676**	-0.26145***				
			(0.10625)	(0.09997)				
Swap into floating							-0.09098	-0.07674
							(0.13522)	(0.12473)
Swap into fixed					-0.09852	-0.18811*	-0.25793*	-0.33524***
					(0.12271)	(0.10870)	(0.13359)	(0.12418)
Swap into both					-0.29387**	-0.28732***	-0.43169***	-0.37841***
					(0.13646)	(0.10885)	(0.14050)	(0.12063)
Cannot determine swap direction					-0.05520	-0.04176	-0.22394**	-0.18790*
					(0.13222)	(0.11423)	(0.11146)	(0.10864)
Book leverage	2.09858***	2.08353***	2.07430***	2.05922***	1.74524***	1.55048***	2.12167***	2.12718***
	(0.49099)	(0.46600)	(0.48632)	(0.46149)	(0.38294)	(0.34775)	(0.49170)	(0.46655)
Natural log of assets	-0.32200***	-0.34462***	-0.32172***	-0.34336***	-0.28914***	-0.28945***	-0.32418***	-0.35219***
	(0.04726)	(0.04370)	(0.04750)	(0.04373)	(0.04444)	(0.03756)	(0.05019)	(0.04634)
ROA	-0.06839***	-0.07232***	-0.06869***	-0.07259***	-0.06596***	-0.06170***	-0.06887***	-0.07286***
	(0.01361)	(0.01168)	(0.01362)	(0.01169)	(0.01315)	(0.01071)	(0.01369)	(0.01169)

Current ratio	-0.20202***	-0.22154***	-0.20308***	-0.22245***	-0.13031**	-0.15470***	-0.20440***	-0.22293***
	(0.05379)	(0.04491)	(0.05403)	(0.04491)	(0.05173)	(0.04111)	(0.05395)	(0.04494)
5-year price volatility	0.05433***		0.05426***		0.04865***		0.05422***	
	(0.00539)		(0.00539)		(0.00576)		(0.00538)	
1-year price volatility		0.04949***		0.04949***		0.05073***		0.04931***
		(0.00439)		(0.00440)		(0.00589)		(0.00443)
Excess return	-0.00928***	-0.00743***	-0.00927***	-0.00743***	-0.00870***	-0.00688***	-0.00929***	-0.00746***
	(0.00116)	(0.00097)	(0.00116)	(0.00097)	(0.00152)	(0.00108)	(0.00116)	(0.00097)
Constant	2.77444***	2.07261***	2.75785***	2.03382***	1.48894***	1.66656***	2.78137***	2.19721***
	(0.47170)	(0.45413)	(0.46941)	(0.45188)	(0.50340)	(0.37947)	(0.50495)	(0.43037)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3456	3662	3456	3662	2371	2503	3456	3662
Adjusted R_2	0.440	0.468	0.440	0.468	0.374	0.452	0.440	0.468

Table 13: OLS Regressions of Default Probability (Annual Reports & CAPIQ)

This table provides the results of OLS regressions of default probability, proxied by the fundamental probability of default (PD) sourced from S&P CIQ. The net floating swap percentage is the net share of the firm's total debt that is swapped to floating. Its absolute value represents the amount of interest rate swaps outstanding at the fiscal year end as a percentage of the firm's debt. Data on these variables are collected from annual reports & S&P CIQ. The sample period is 2002-2015. Standard errors in parentheses are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
|Swapped to floating (%)|	-0.00005**	-0.00004**								
	(0.00002)	(0.00002)								
|Swapped to floating (%)| (Swapped to floating)			-0.00003	-0.00003						
			(0.00003)	(0.00003)						
|Swapped to floating (%)| (Swapped to fixed)					-0.00008**	-0.00008**				
					(0.00003)	(0.00003)				
Swapped to floating (%)							0.00003*	0.00002*		
							(0.00001)	(0.00001)		
Swap into floating (dummy)									-0.00203	-0.00173
									(0.00169)	(0.00175)
Swap into fixed (dummy)									-0.00480**	-0.00434**
									(0.00206)	(0.00212)
Book leverage	0.03580***	0.03257***	0.03753***	0.03398***	0.03200***	0.02524**	0.03622***	0.03289***	0.03804***	0.03457***
	(0.00709)	(0.00706)	(0.00778)	(0.00776)	(0.01125)	(0.01065)	(0.00705)	(0.00705)	(0.00727)	(0.00729)
Natural log of assets	-0.00563***	-0.00558***	-0.00504***	-0.00479***	-0.00830***	-0.00815***	-0.00580***	-0.00573***	-0.00560***	-0.00556***
	(0.00067)	(0.00068)	(0.00074)	(0.00072)	(0.00129)	(0.00123)	(0.00069)	(0.00069)	(0.00068)	(0.00068)

ROA	-0.00209***	-0.00223***	-0.00141***	-0.00141***	-0.00242***	-0.00253***	-0.00209***	-0.00222***	-0.00210***	-0.00223***
	(0.00028)	(0.00028)	(0.00034)	(0.00030)	(0.00047)	(0.00042)	(0.00028)	(0.00028)	(0.00028)	(0.00028)
Current ratio	-0.00074	-0.00033	-0.00206**	-0.00181**	-0.00122	-0.00114	-0.00072	-0.00031	-0.00086	-0.00044
	(0.00077)	(0.00088)	(0.00081)	(0.00077)	(0.00085)	(0.00090)	(0.00077)	(0.00088)	(0.00078)	(0.00088)
5-year price volatility	0.00036***		0.00039***		0.00033***		0.00036***		0.00036***	
	(0.00007)		(0.00011)		(0.00009)		(0.00008)		(0.00007)	
1-year price volatility		0.00032***		0.00038***		0.00034***		0.00032***		0.00032***
		(0.00007)		(0.00010)		(0.00011)		(0.00007)		(0.00007)
Excess return	-0.00006***	-0.00005***	-0.00008***	-0.00007***	-0.00007***	-0.00004**	-0.00006***	-0.00005***	-0.00006***	-0.00005***
	(0.00001)	(0.00001)	(0.00002)	(0.00002)	(0.00003)	(0.00002)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
Constant	0.05610***	0.05850***	0.04362***	0.03790***	0.08888***	0.08953***	0.05716***	0.05953***	0.05782***	0.06011***
	(0.00796)	(0.00735)	(0.00890)	(0.01163)	(0.01275)	(0.01217)	(0.00808)	(0.00747)	(0.00808)	(0.00751)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2010	2093	1019	1048	643	675	2010	2093	2010	2093
Adjusted R_2	0.485	0.494	0.427	0.435	0.465	0.487	0.483	0.493	0.485	0.495

Table 14: Time-varying Effects of Interest Rate Swap Usage on Default Probability

This table presents the time-varying effects of interest rate swap usage on the probability of default. Annual GDP growth rate is included to control for macroeconomic conditions. The sample period is 2002-2015. Standard errors in parentheses are adjusted for clustering by firm. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

	S&P CIQ PD		MOODY EDF	
	(1)	(2)	(3)	(4)
Interest rate swaps	-0.00440	0.10852***	-0.56561*	0.00071
	(0.00403)	(0.00469)	(0.30427)	(0.11649)
Interest rate swaps # year 1999			0.49551	-0.87149***
			(0.31641)	(0.11492)
Interest rate swaps # year 2000			0.28362	-1.15747***
			(0.33156)	(0.14043)
Interest rate swaps # year 2001			0.18275	-0.86203***
			(0.28741)	(0.14872)
Interest rate swaps # year 2002	0.00503	-0.10919***	0.62974**	-0.12604
	(0.00432)	(0.00493)	(0.29173)	(0.16037)
Interest rate swaps # year 2003	0.00290	-0.11243***	0.21181	-0.49818***
	(0.00462)	(0.00480)	(0.30763)	(0.11023)
Interest rate swaps # year 2004	0.00497	-0.10579***	0.34699	0.18315
	(0.00484)	(0.00543)	(0.29145)	(0.11532)
Interest rate swaps # year 2005	0.00325	-0.10909***	0.43569	0.00000
	(0.00451)	(0.00501)	(0.32427)	(.)
Interest rate swaps # year 2006	0.00388	-0.11022***	0.50488*	-0.17710*
	(0.00441)	(0.00475)	(0.30395)	(0.09596)
Interest rate swaps # year 2007	0.00211	-0.11422***	0.57477*	-0.47407***
	(0.00419)	(0.00446)	(0.29268)	(0.09657)
Interest rate swaps # year 2008	-0.00088	-0.12089***	0.97273***	-0.57937**
	(0.00245)	(0.00413)	(0.27050)	(0.27995)
Interest rate swaps # year 2009	0.00000	-0.11040***	0.00000	-0.51775
	(.)	(0.00529)	(.)	(0.32513)
Interest rate swaps # year 2010	-0.00235	-0.11279***	-0.00364	-0.10191
	(0.00340)	(0.00458)	(0.26722)	(0.12318)
Interest rate swaps # year 2011	-0.00171	-0.11204***	0.02528	-0.05993
	(0.00339)	(0.00465)	(0.33945)	(0.30406)
Interest rate swaps # year 2012	-0.00141	-0.11032***	-0.27950	-0.18341
	(0.00343)	(0.00467)	(0.25896)	(0.11435)

Interest rate swaps # year 2013	-0.00050	-0.11194***	0.07826	-0.24044**
	(0.00392)	(0.00473)	(0.27824)	(0.10419)
Interest rate swaps # year 2014	0.00330	-0.11320***	0.46485	-0.43977***
	(0.00473)	(0.00482)	(0.31304)	(0.10804)
Interest rate swaps # year 2015	0.00093	-0.11472***	0.93283***	0.06624
	(0.00428)	(0.00460)	(0.33117)	(0.18857)
Book leverage	0.03693***	0.03661***	2.11971***	2.12352***
	(0.00623)	(0.00622)	(0.48170)	(0.47238)
Natural log of assets	-0.00474***	-0.00477***	-0.33325***	-0.34748***
	(0.00052)	(0.00051)	(0.04697)	(0.04423)
ROA	-0.00230***	-0.00243***	-0.06881***	-0.07673***
	(0.00025)	(0.00024)	(0.01341)	(0.01196)
Current ratio	-0.00209***	-0.00207***	-0.20513***	-0.22334***
	(0.00069)	(0.00063)	(0.05501)	(0.04616)
5-year price volatility	0.00037***		0.05399***	
	(0.00007)		(0.00529)	
1-year price volatility		0.00038***	-0.05086	0.07987**
		(0.00006)	(0.03904)	(0.03998)
Excess return	-0.00007***	-0.00005***		0.04713***
	(0.00001)	(0.00001)		(0.00426)
GDP growth	-0.00007	0.00139***	-0.00960***	-0.00734***
	(0.00052)	(0.00047)	(0.00113)	(0.00091)
Constant	0.04586***	0.05070***	2.25419***	2.63974***
	(0.00742)	(0.00683)	(0.43789)	(0.43681)
Industry FE	Yes	Yes	Yes	Yes
Year FE	No	No	No	No
Observations	3361	3499	3456	3662
Adjusted R_2	0.485	0.523	0.436	0.457

Table 15: OLS Regressions of 5-year Price Volatility (Annual Reports)

This table provides the results of OLS regressions of 5-year price volatility. Data on interest rate derivatives and the directions of swaps are collected from annual reports. The sample period is 1999-2015. Standard errors in parentheses are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)
Interest rate derivatives	-3.00285**			
	(1.45304)			
Interest rate swaps		-3.03923**		
		(1.31883)		
Swap into floating				-2.52561
				(1.72501)
Swap into fixed			-1.56331	-4.98566***
			(1.61515)	(1.67496)
Swap into both			0.50275	-2.22681
			(1.92054)	(1.96311)
Cannot determine swap direction			2.60496*	-0.21985
			(1.54439)	(1.19749)
Book leverage	21.37652***	21.29486***	13.73212***	22.32357***
	(7.65775)	(7.55750)	(4.30576)	(7.67045)
Natural log of assets	-2.61282***	-2.58740***	-2.00020***	-2.72795***
	(0.44217)	(0.44395)	(0.41682)	(0.47627)
ROA	-1.13361***	-1.13546***	-1.20485***	-1.13512***
	(0.12284)	(0.12269)	(0.11506)	(0.12173)
Current ratio	1.00626**	0.98855**	1.70991***	0.98362**
	(0.46508)	(0.46163)	(0.59940)	(0.46284)
Excess return	0.01198	0.01223	0.01486	0.01186
	(0.00769)	(0.00768)	(0.00903)	(0.00767)
Constant	69.14115***	68.90809***	64.09833***	57.57054***
	(4.42771)	(4.41782)	(5.26394)	(4.19877)
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	4484	4484	3132	4484
Adjusted R_2	0.345	0.345	0.355	0.350

Table 16: OLS Regressions of 5-year Price Volatility (Annual Reports & CAPIQ)

This table provides the results of OLS regressions of 5-year price volatility. The net floating swap percentage is the net share of the firm's total debt that is swapped to floating. Its absolute value represents the amount of interest rate swaps outstanding at the fiscal year end as a percentage of the firm's debt. Data on these variables are collected from annual reports & S&P CIQ. The sample period is 1999-2015. Standard errors in parentheses are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
|Swapped to floating (%)|	-0.03527*						
	(0.02061)						
|Swapped to floating (%)| (Swapped to floating)		0.00583					
		(0.02747)					
|Swapped to floating (%)| (Swapped to fixed)			-0.06948				
			(0.04488)				
|Swapped to floating (%)| (Swapped to floating & swap non-users)				-0.01205			
				(0.02614)			
|Swapped to floating (%)| (Swapped to fixed & swap non-users)					-0.08046**		
					(0.03233)		
Swapped to floating (%)						0.03505**	
						(0.01590)	
Swap into floating (dummy)							-2.79330
							(1.80027)

Swap into fixed (dummy)							-4.62173**
							(2.22556)
Book leverage	27.83581**	19.07356***	44.86694**	17.67412***	37.98948**	28.34297**	29.64681**
	(12.02347)	(5.43235)	(20.01125)	(5.28594)	(19.11854)	(12.10157)	(11.75068)
Natural log of assets	-3.48717***	-3.16385***	-4.82070***	-2.97752***	-3.62489***	-3.70287***	-3.36435***
	(0.89693)	(0.69022)	(1.77107)	(0.52634)	(1.21198)	(0.93895)	(0.94332)
ROA	-1.24788***	-1.41143***	-1.04513***	-1.31919***	-1.09533***	-1.24887***	-1.24467***
	(0.18854)	(0.16773)	(0.34563)	(0.17426)	(0.27280)	(0.18945)	(0.18758)
Current ratio	0.82276	1.61461*	0.71614	0.68553	0.29067	0.80198	0.65695
	(0.63059)	(0.89679)	(0.92742)	(0.69473)	(0.63679)	(0.63165)	(0.63549)
Excess return	0.01377	0.03883***	0.00323	0.01657	-0.01346	0.01268	0.01374
	(0.00979)	(0.01410)	(0.02318)	(0.01232)	(0.01532)	(0.00972)	(0.00979)
Constant	109.54101***	124.23753***	49.79716***	114.20751***	47.83639***	109.70885***	110.10022***
	(6.32454)	(6.76403)	(9.93415)	(6.59375)	(6.45203)	(6.04840)	(6.18959)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2220	1117	707	1513	1103	2220	2220
Adjusted R_2	0.324	0.365	0.349	0.373	0.325	0.326	0.326

Table 17: OLS Regressions of 1-year Beta (Annual Reports)

This table provides the results of OLS regressions of 1-year beta, defined as the slope of the 52-week regression line of the percentage price change of the stock relative to the percentage price change of its benchmark. Data on interest rate derivatives and the directions of swaps are collected from annual reports. The sample period is 1999-2015. Standard errors in parentheses are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)
Interest rate derivatives	-0.03395			
	(0.02686)			
Interest rate swaps		-0.03715		
		(0.02507)		
Swap into floating				-0.03392
				(0.03929)
Swap into fixed			-0.05191	-0.06801**
			(0.03865)	(0.02846)
Swap into both			0.00181	-0.03595
			(0.04315)	(0.04215)
Cannot determine swap direction			0.02881	0.00914
			(0.04068)	(0.03267)
Book leverage	0.04294	0.04367	0.01956	0.06069
	(0.08427)	(0.08343)	(0.09928)	(0.08470)
Natural log of assets	0.08742***	0.08796***	0.08193***	0.08657***
	(0.00963)	(0.00975)	(0.01029)	(0.01017)
ROA	-0.01293***	-0.01296***	-0.01735***	-0.01295***
	(0.00336)	(0.00336)	(0.00348)	(0.00335)
Current ratio	0.05162***	0.05147***	0.05646***	0.05125***
	(0.01254)	(0.01254)	(0.01420)	(0.01253)
Excess return	-0.00024	-0.00024	-0.00058**	-0.00024
	(0.00025)	(0.00024)	(0.00028)	(0.00024)
Constant	0.18751	0.18355	0.09357	0.20153
	(0.13568)	(0.13637)	(0.17760)	(0.13980)
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	4842	4842	3380	4842
Adjusted $R2$	0.180	0.180	0.216	0.181

Table 18: OLS Regressions of 1-year Beta (Annual Reports & CAPIQ)

This table provides the results of OLS regressions of 1-year beta, defined as the slope of the 52-week regression line of the percentage price change of the stock relative to the percentage price change of its benchmark. The net floating swap percentage is the net share of the firm's total debt that is swapped to floating. Its absolute value represents the amount of interest rate swaps outstanding at the fiscal year end as a percentage of the firm's debt. Data on these variables are collected from annual reports & S&P CIQ. The sample period is 1999-2015. Standard errors in parentheses are adjusted for clustering by firm. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
|Swapped to floating (%)|	-0.00072*						
	(0.00042)						
|Swapped to floating (%)| (Swapped to floating)		0.00049					
		(0.00064)					
|Swapped to floating (%)| (Swapped to fixed)			-0.00089				
			(0.00073)				
|Swapped to floating (%)| (Swapped to floating & swap non-users)				-0.00005			
				(0.00063)			
|Swapped to floating (%)| (Swapped to fixed & swap non-users)					-0.00164***		
					(0.00053)		
Swapped to floating (%)						0.00052	
						(0.00034)	
Swap into floating (dummy)							-0.08871**
							(0.03781)

Swap into fixed (dummy)							-0.11043***
							(0.04155)
Book leverage	0.20338	0.08787	0.49321***	0.05468	0.32606**	0.20908	0.24727*
	(0.13524)	(0.20115)	(0.16871)	(0.16436)	(0.15053)	(0.13583)	(0.13934)
Natural log of assets	0.09602***	0.08906***	0.11202***	0.09269***	0.11610***	0.09264***	0.10129***
	(0.01280)	(0.01782)	(0.02205)	(0.01423)	(0.01548)	(0.01345)	(0.01376)
ROA	-0.01104**	-0.00746	-0.01255*	-0.01079**	-0.01361***	-0.01097**	-0.01096**
	(0.00428)	(0.00777)	(0.00683)	(0.00474)	(0.00379)	(0.00427)	(0.00427)
Current ratio	0.03130***	0.04958***	0.04528**	0.02665*	0.01802	0.03138***	0.02722**
	(0.01121)	(0.01596)	(0.01866)	(0.01382)	(0.01404)	(0.01136)	(0.01142)
Excess return	0.00007	0.00046	-0.00125	0.00058	-0.00032	0.00006	0.00008
	(0.00046)	(0.00063)	(0.00091)	(0.00051)	(0.00068)	(0.00046)	(0.00046)
Constant	-1.87162***	-1.40742***	0.22130	-1.84208***	-0.35692**	-1.85588***	-1.85448***
	(0.15812)	(0.20396)	(0.19387)	(0.18869)	(0.14123)	(0.15466)	(0.15625)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2334	1154	753	1581	1180	2334	2334
Adjusted R_2	0.171	0.168	0.174	0.189	0.201	0.171	0.173

Figure 1: Time-series Plot of Mean Probability of Default (S&P CIQ PD) of Interest Rate Swap Users and Non-users

This figure displays the time-series variation in default probability by plotting the mean values of PD for interest rate swap users and non-users during the period 2002-2015.

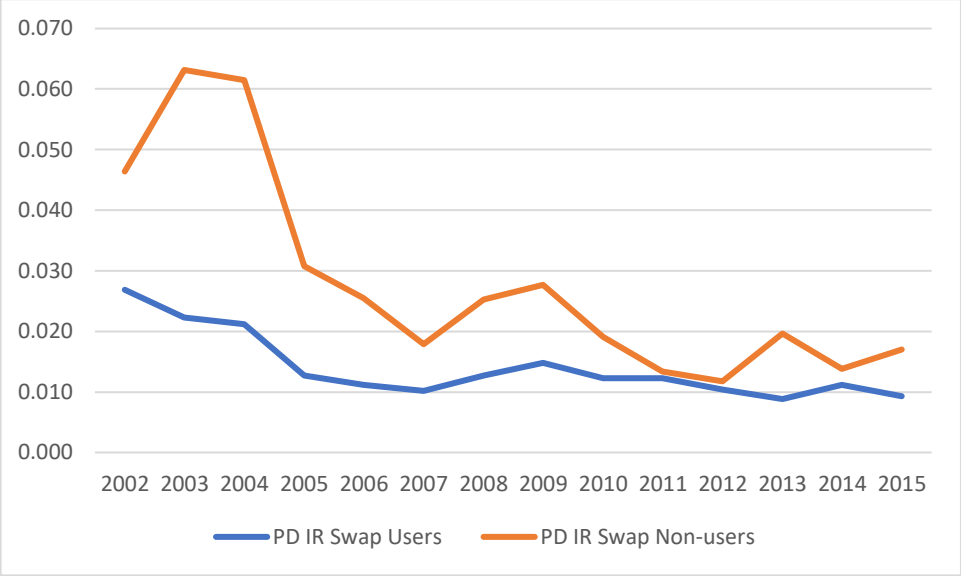


Figure 2: Time-series Plot of Mean Expected Default Frequency (Moody EDF) of Interest Rate Swap Users and Non-users

This figure displays the time-series variation in default probability by plotting the mean values of EDF for interest rate swap users and non-users during the period 1999-2015.

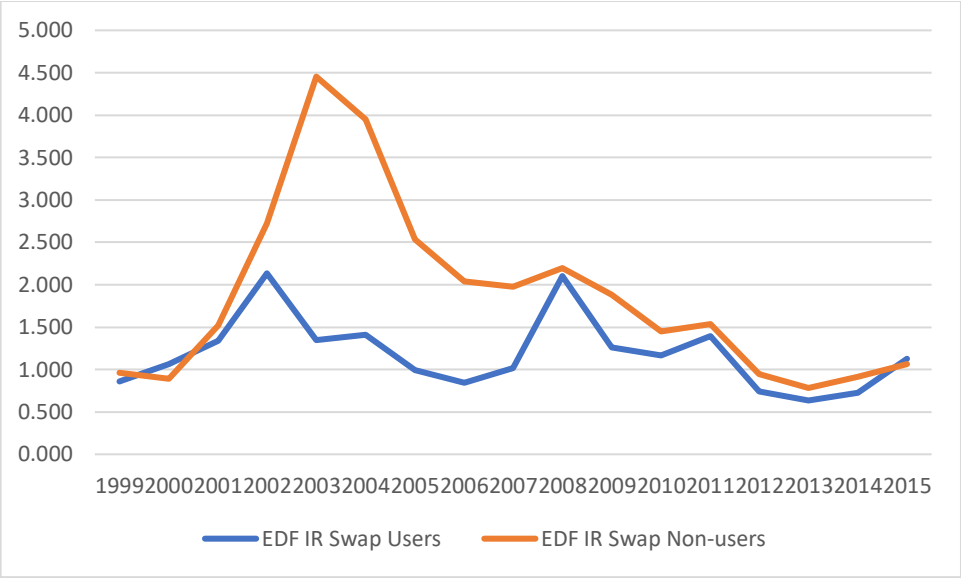
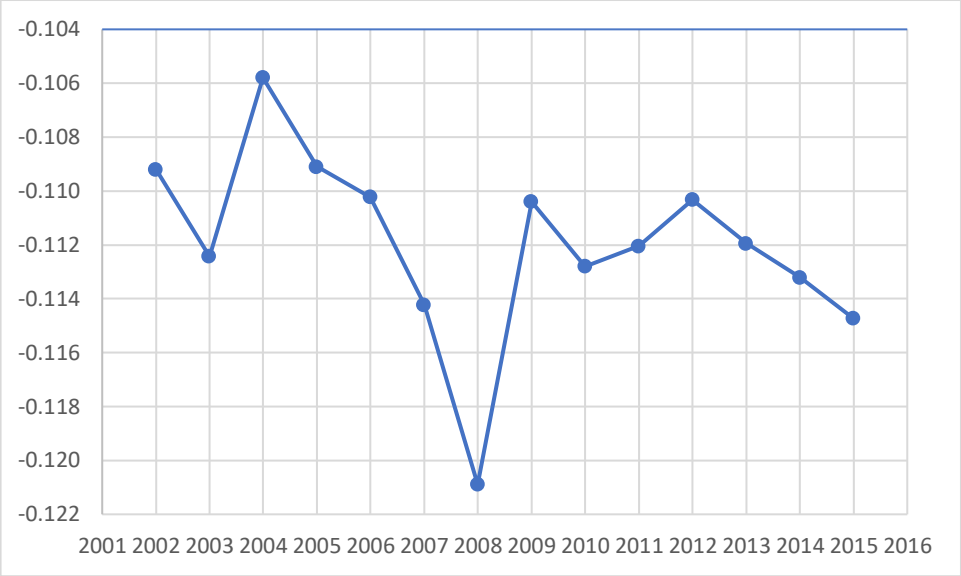


Figure 3: Time-varying Effects of Interest Rate Swap Usage on Default Probability

This figure displays the time-varying effects of interest rate swap usage on the probability of default, proxied by the fundamental probability of default (PD) sourced from S&P CIQ, over the sample period 2002-2015.



Chapter 5: Conclusion

This thesis discusses two aspects in the theory and practice of corporate debt structure: fixed versus floating mix of debt and currency mix of debt.

The first essay shows that the key drivers of initial debt structure are the sources of debt. Firms may then use interest rate swaps to alter the initial interest sensitivity of their debt. The final interest rate exposure, incorporating the effect of swaps, best reflects their interest rate risk management activities. Overall, the results suggest that firms are hedging when selecting the interest rate exposure of their debt. However, the choices of those exposures differ before and after the 2007 financial crisis. Prior to the crisis, firms were both hedging and timing the market. The level of floating-rate debt by currency is quite similar and the currency mix of debt does have an impact on the fixed versus floating debt mix. This essay also shows that firms that initially use more floating-rate debt are less likely to swap towards floating. Firms are getting closer in their desired interest rate exposure, regardless of the direction of interest rate swaps.

As firms were both hedging and timing the market before the financial crisis, this leads to the question of why corporate treasurers engage in this type of behavior. It is possible that managers are evaluated on their current performance or approaching retirement age. In that case, by "actively managing" the interest rate exposure of their firm's debts, they can reduce interest expense at least in the short term and report higher earnings. Alternatively, some managers take a view on future interest rate movements when selecting fixed- and floating-rate funding. It is, however, questionable whether such behaviors increase shareholder value. These results are timely given changes in the regulation of financial derivatives. As firms use derivatives both to hedge and to speculate, any regulatory changes should not make it too easy for them to disguise speculative transactions as hedging transactions.

The second essay suggests that foreign exchange exposure and firm size are the key drivers of foreign currency debt use, at both the aggregate and currency level. There is evidence that, before the 2007 financial crisis, firms tended to borrow more in euros which on average have a lower interest rate than sterling in an attempt to lower interest costs. Firms with greater level of exposure, proxied by greater foreign sales, have a higher share of their debt that is swapped to foreign currency. Direct costs of debt are an important determinant of foreign currency swap use at the currency level. An

increase in the differential between the UK and US/EU interest rates increases the net US dollar/euro swap percentage. The results show that firms that swap into sterling initially have more foreign currency debt compared to those that do not use swaps, and firms that swap into foreign currency initially have less foreign currency debt compared to those that swap into sterling. After incorporating the effect of swaps, there is a convergence in the currency profiles of firms' debt. This essay shows that firms that use foreign currency swaps have higher probabilities of default. There is a higher likelihood of bankruptcy for firms that swap into foreign currency compared to those that do not use foreign currency swaps. The effects of swap use on default probability vary over time, consistent with the prevailing macroeconomic and financial conditions.

Overall, our results show that hedging foreign exchange exposure is important, but pricing considerations also matters. As relative interest rates are an important element when firms consider borrowing in a foreign currency prior to the crisis, these results mimic the findings for the fixed/floating mix of debt. Again, it is possible that incentive contracts for managers place great emphasis on current performance, or that managers are reaching retirement age. In that case, they may choose to borrow in currencies where interest rates are low, thereby reducing the total interest paid in the short run. Given that foreign currency swap users have higher probabilities of default, our findings suggest that financial institutions (e.g. central banks and IMF) should develop emergency plans for stabilizing the foreign currency swap market in times of financial crisis.

The third essay shows that interest rate swap users have lower probabilities of default, controlling for other firm characteristics that may affect default risk. There is a lower likelihood of bankruptcy for firms that swap toward fixed compared to those that swap toward floating or do not use interest rate swaps. This essay examines the time-varying effects of interest rate swap usage on firm default and shows stronger effects during periods of heightened macroeconomic uncertainty. It further assesses the impact of interest rate swaps on firm risk by looking at the volatility of stock prices and the sensitivity of stock returns to market returns and shows that swap usage is associated with lower levels of price volatility and return sensitivity.

These results have important implications. Despite public concern over the effect of derivatives use on firm risk, we find evidence that interest rate swaps usage reduces default risk, indicating that interest rate swaps are used for hedging. From a policy making perspective, the lack of evidence on the use of derivatives by UK firms for

speculative purposes suggests that further regulations on financial derivatives reporting in the UK may not be necessary. However, current derivative disclosure requirements need to be strictly enforced in order to protect shareholders' wealth.