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ABSTRACT

We study the implications of hedging for firm financing and investment. We do so using an extensive, hand-collected dataset on corporate hedging activities. Hedging can lower the odds of negative firm realizations, reducing the expected costs of financial distress. In theory, this should ease a firm's access to credit. Using a tax-based instrumental variable approach, we find that hedgers pay lower interest spreads and are less likely to have capital expenditure restrictions in their loan agreements. These favorable financing terms, in turn, allow hedgers to invest more. Our tests characterize two exact channels (cost of borrowing and investment restrictions) through which hedging affects corporate outcomes. The analysis we present shows that hedging has a first-order effect on firm financing and investment, and provides new insights into how hedging affects corporate wealth. More broadly, our study contributes novel evidence on the real consequences of financial contracting.

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Active corporate risk management would be irrelevant in a Modigliani-Miller world of perfect capital markets. Yet, risk management through financial hedging has become increasingly important in recent years. According to BIS, at the end of December 2009, the notional value of outstanding interest rate (IR) and foreign exchange (FX) derivatives held by non-financial customers was $35.6 trillion and $8.8 trillion, respectively. By comparison, at the end of 2000 those numbers were only $6.1 trillion and $3.3 trillion. The International Swaps and Derivatives Association (ISDA) reports that virtually all of the world's largest companies use derivatives to hedge their business and financial risks.

Despite their widespread use, there is limited evidence on the real and financial implications of derivatives hedging.[1] Starting with Nance et al. (1993), Tufano (1996), and Géczy et al. (1997), most prior studies investigate variables that explain cross-sectional variation in the use of derivatives by firms (hedging determinants). More recent papers look at the relation between hedging and corporate valuation. Allayannis and Weston (2001) and Carter et al. (2006), for example, find that hedging is associated with some 5% to 10% increase in firm value. Other studies, however, report more mixed results (see Jin and Jorion (2006)). Examining the relation between hedging and firm value is an intuitive way of gauging the welfare implications of hedging. Estimates of that relation, however, do not show *how* hedging affects corporate welfare.

This study identifies precise mechanisms through which hedging affects real and financial corporate outcomes. It does so by examining the impact of hedging on firms' external financing costs and investment spending. Theory proposes a straightforward connection between hedging and firms' ability to raise funds: hedging reduces the probability of lower-tail realizations, reducing the expected costs associated with financial distress and bankruptcy (Smith and Stulz (1985) and Stulz (1996)).[2] In theory, hedging commits firms to meeting obligations in states of the world in which they would fail (Bessembinder (1991)) and makes it more difficult for managers to engage in risk-shifting (Campbell and Kracaw (1990)). Both of these effects should improve the contract terms firms obtain from their lenders, including credit facilities that carry lower interest rates and have fewer investment restrictions.

It is possible, however, for firms to unwind their hedging positions after signing contracts with their lenders. After loans are granted, for example, managers may buy new instruments that offset their previous positions, or may cancel their hedging programs altogether. Contrary to this notion, Purnanandam (2008) presents a theory showing that it is optimal for managers facing distress to keep their hedges after issuing debt. In addition, reputational concerns may prevent firms from deceiving banks with ex-post changes in their hedging programs. Yet another safeguard against opportunistic behavior by firms is the use of "performance pricing" in loan agreements, which allows banks to increase interest spreads after loans are granted. If hedging programs are often reversed in the post-

[1] But see Petersen and Thiagarajan (2000) for a pioneering paper on the implications of hedging in the gold industry.

[2] These costs include direct bankruptcy costs (e.g., lawyers' charges and administrative fees) as well as indirect costs due to the potential loss of customers, suppliers, and growth opportunities (Bris et al. (2006) and Purnanandam (2008)).

loan period, one should not observe hedgers obtaining better contract terms with their lenders.

To investigate the ultimate effect of hedging on firm outcomes, we use a new, hand-collected dataset on derivatives contracts. For each firm in our dataset, we also gather detailed information on private credit agreements. These matched data allow us to identify links between hedging activity, external financing costs, and investment restrictions. While we describe the data gathering process below, it is worth highlighting the key features of our approach. We focus on private credit agreements in the syndicated loan market because this market has become the largest source of corporate funding in the last two decades.[3] Importantly, our investigation requires finely-defined data, and bank loans contain covenants that are more detailed, comprehensive, and tightly set than other credit instruments. With these considerations in mind, our data gathering process starts from a sample of loans collected from various sources. We then hand collect information on borrowers' derivatives usage from their SEC filings. This yields a dataset of over one thousand individual firms for which we obtain additional information on characteristics, such as size, profitability, and investment spending over several years.

Our evidence suggests that hedging reduces the cost of external financing and eases the firm's investment process. The results we find are economically and statistically significant. For example, a one-standard deviation increase in hedging intensity (the amount of interest rate and currency hedging over total assets) is associated with a reduction of about 54 basis points in loan spreads. This is a significant number when compared to the average loan spread of 189 basis points (a 29% reduction). We also estimate that a one-standard deviation increase in hedging intensity reduces by 20% the odds of having an investment restriction covenant in a loan contract. Our tests further characterize the direct, positive impact of hedging intensity on investment spending. In all, the estimates we present are new to the literature and highlight the economic significance of corporate hedging.

Simultaneity is a source of concern for any study dealing with financial decision-making, including corporate risk management. Relative to other studies, this issue is minimized in our tests because loan spreads and capital expenditure restrictions are set by the firms' creditors and by competitive forces in the market for loanable funds (i.e., observed outcomes are not firm-choice variables). Moreover, as we discuss below, there is an "institutional mismatch" between providers of loan and hedging contracts (outcomes and treatment status are not jointly set by the firm's creditors). Yet, firms choose to accept the contracts that are observed by the econometrician. Accordingly, our inferences could be biased in case firms' choices are confounded with factors that influence observed outcomes and that are not accounted for in our baseline model. To alleviate this problem, we need to find a variable (or instrument) that is related to firms' hedging policies, but that is not directly related to their creditors' decisions regarding interest rates and capital expenditure restrictions.

[3] Syndicated loan issuance grew from approximately $150 billion in 1987 to $1.7 trillion in 2007, surpassing corporate bond issuance to become the most important corporate financing channel.

The literature does not provide much guidance on this estimation issue and we fail to identify events that could work as surrogates for "natural experiments in hedging." However, we identify a plausible instrumental approach that arises from institutional features of the U.S. tax system. When their relevant tax schedule is convex, firms can reduce their expected tax liabilities by hedging in order to minimize income volatility (see, e.g., Smith and Stulz (1985), Graham and Smith (1999), and Petersen and Thiagarajan (2000)). The convexity of statutory tax rates thus provides firms with incentives to hedge (inclusion restriction). At the same time, tax convexity *per se* is unlikely to exert a direct, first-order effect on the terms creditors include in their financing agreements (exclusion restriction).[4] With these restrictions in place, we implement an instrumental variable–fixed effects estimator that deals with endogeneity by exploiting tax-related non-linearities in the demand for hedging.[5]

Our baseline results conform to a theory in which hedging eases firm financing by reducing the likelihood of states in which costs of financial distress are high and the firm engages in risk shifting. Those results, however, may not show direct evidence of these dynamics. To substantiate our inferences, we then examine whether variables that capture the potential for financial distress and asset substitution modulate the relation between hedging and loan contracts in tandem with our central hypothesis.

As a first check, we include Altman's Z-score and its interaction with hedging in our baseline model. We would expect Z-score to have a negative impact on loan spreads since riskier firms (those with lower Z-scores) should be charged higher interest. This is exactly what we find. More interesting, however, is the coefficient attracted by the hedging–Z-score interaction term. This term returns a positive, statistically significant coefficient, implying a pronounced dampening of the negative association between Z-scores and loan spreads for firms that hedge more.[6] Simply put, our estimations imply that hedging is more valuable for borrowers facing a higher likelihood of financial distress.

Examining whether asset substitution also changes the relation between hedging and loan spreads is more challenging. To capture that effect, we use a surrogate proxy that reflects a firm's investment growth options; namely, the ratio of market-to-book value of assets (M/B). The premise behind this strategy is that firms with more growth options should have greater latitude in shifting their investments towards riskier assets (see related approaches in Johnson (2003) and Eisdorfer (2008)). We interact that proxy with hedging, similarly to what we do with Z-scores above. Our tests return a negative coefficient on the hedging–M/B interaction, suggesting that the negative effect of hedging on loan spreads is greater for firms whose investment opportunity set is likely to allow for greater risk

[4] Notice that this is an idiosyncratic, time-varying effect that is difficult to measure and price in a loan. At a more practical level, the loan officers we consulted say they do not consider subtle tax issues (such as convexity) in their loan pricing schemes because their claims on firms' income are gross of taxes.

[5] We show in Section II.B that identification does not come from firm income level, which would influence loan spreads, but from well-identified non-linearities (e.g., kinks) in the tax schedules (after controlling for firm income level).

[6] As shown below, we reach similar conclusions when we study the interplay between financial distress and hedging using a "distance-to-default" proxy.

taking. In other words, hedging is more valuable for those firms with a higher ability to risk-shift.

Our base tests show that hedging reduces promised, contractual rates in loan contracts. Naturally, the firm's observed loan spread includes a portion compensating investors for the expected default loss due to idiosyncratic risks and a portion compensating investors for the undiversifiable risks of debt. Accordingly, the observed drop in spreads is a necessary but not a sufficient condition for the cost of capital to be reduced, since it could be caused by a drop in the expected default risk premium, rather than a drop in the (true) cost of debt. To better understand these effects, we decompose the promised interest rate into expected default risk premium and true cost of debt, and examine how hedging affects the true cost of debt. We find that hedging helps lower the true cost of debt, and the effect of hedging is stronger in firms that are near distress or that are more likely to engage in risk shifting.

We then turn our attention to the real-side implications of hedging. We do this by looking at the covenants associated with loan contracts, in particular those explicitly constraining investment. We find that hedging significantly reduces the likelihood of capital expenditure restrictions in loan agreements. Specifically, our tests suggest that the average IR/FX hedger is 20% less likely to have clauses restricting capital expenditures in its future credit agreements. Similarly, and also in line with our previous findings on the cost of borrowing, we find that hedging alters the link between measures of firm risk (e.g., Z-scores) and the likelihood of capital expenditure restrictions.

To gain further insight on the hedging–investment relation, we also examine the direct impact of hedging on capital spending. Relative to a non-hedger counterfactual, we find that the average IR/FX hedger is able to increase investment spending by about 13% of the sample mean level of investment. We also examine how heterogeneity in firm financial conditions shapes the relation between hedging and investment. We find, for example, that hedging ameliorates the strong, negative relation between financial distress risk and investment.

Our paper contributes to various literatures. Our primary contribution to the hedging literature is to show that hedging has a *first-order* effect on firm financing and investment. To our knowledge, we are the first to simultaneously investigate the impact of hedging on the cost of debt, the likelihood of capital expenditure restrictions, and investment. We show two precise mechanisms — cost of debt financing and investment restrictions — through which hedging affects corporate outcomes. Importantly, our findings on the negative relation between hedging and loan spreads provide new insights into *how* hedging affects corporate wealth. Unlike other papers, we focus on creditors' evaluation of corporate hedging — prior studies examine hedging from shareholders' perspective. In this regard, our paper adds to the loan literature by showing that corporate hedging is an important determinant of loan contract terms. Finally, by explicitly connecting hedging and investment spending, our study adds to a new line of research on the real implications of financial contracting (e.g., Almeida et al. (2009)). This line of inquiry is likely to offer important insights about the role of financial contracting in the economy for policymakers and future researchers.

The remainder of the paper proceeds as follows. The next section describes the sample selection process and construction of the hedging variables. Sections 3 and 4 present our empirical results on the interplay between hedging, loan spreads, and firm investment. Section 5 presents robustness checks. Section 6 looks at additional economic costs and benefits of hedging. Section 7 concludes the paper.

I Sample Selection and Variable Construction

A *Basic Sample Selection*

To gauge the impact of hedging on firms' access to credit, we need detailed information on contract terms. Importantly, the financing instruments examined need to be economically relevant and widely used by firms. Private loan agreements have become the most important mode of external financing by firms in the last two decades and firms report detailed information on the terms governing these agreements. We begin our sampling with the dataset used in Nini et al. (2009) (hereafter referred to as the NSS sample), which contains information on various dimensions of loan agreements between financial institutions and firms.[7] The NSS sample contains unique information on investment restrictions in loan covenants. This information enables us to examine whether hedging improves corporate investment by relaxing capital investment restrictions — evidence hitherto not reported in the literature. Notably, a sizeable window of the NSS sample coincides with a period in which rules governing the disclosure of derivatives usage allow for more precise measurement of hedging activities by firms.

For each loan contract in the NSS sample, we collect the borrower's hedging information from the 10-K filed in the previous year. This lag is meant to ensure that hedging information can be assumed to be pre-determined. Our sample starts in 1996, the first year in the NSS dataset, and ends in 2002, when FASB SFAS 133 became effective. SFAS 133 requires firms to disclose the "fair market values" of derivatives contracts (as opposed to the notional values previously required by FASB SFAS 119). Graham and Rogers (2002), among others, note that compared with notional value information, the fair value information reported under SFAS 133 reveals only limited information about derivatives usage. The authors warn against the use of information reported under SFAS 133 in studies on firm hedging.[8]

B *Hedging Variables*

B.1 *Data Collection Process*

We use a web crawler program searching for keywords in every 10-K, 10-KT, 10-K405, 10KSB, and 10KSB40 for each of the 2,288 firm-years of the NSS sample that fall in the 1996–2002 period. We use

[7] We thank Amir Sufi for making these data available in his website.

[8] SFAS 119 requires firms to disclose detailed derivatives information including the notional values, purpose, nature, and terms of their derivatives contracts. Some of this information is no longer required under SFAS 133.

the following keywords to locate information used in our data coding: "derivative", "hedg", "financial instrument", "swap", "market risk", "expos", "futures", "forward contract", "forward exchange", "option contract", "risk management", and "notional". When a keyword is found, we read the surrounding text and hand-code the hedging variables. As in prior derivatives studies (e.g., Allayannis and Weston (2001) and Graham and Rogers (2002)), we focus on the use of interest rate (IR) and foreign exchange (FX) derivatives for non-trading purposes. If a firm-year's 10-K has no reference of our hedging keywords, or contains such keywords but the surrounding text suggests the firm does not use derivatives, we treat that firm-year as non-user. We record a firm's notional value of derivatives contracts as well as the information on a firm's long and short positions in derivatives.[9]

One must recognize that a firm might not use derivatives because it has no relevant IR or FX exposure. To better understand the use of derivatives, we need to check whether the firm-years we classify as non-users are ex-ante exposed to fluctuations in IR and FX prices, or are otherwise taking speculative positions. We determine whether firms in our sample are ex-ante exposed to those market prices in two ways. First, we include keywords "expos" and "market risk" in our program search and we make a note if a firm explicitly states that it has IR and/or FX exposures when we read its 10-K filing. Second, we follow the procedure laid out in Graham and Rogers (2002, p.824) for identifying ex-ante IR and FX exposures. We infer that a firm has no ex-ante exposure if it meets the following three conditions: (1) it does not use any IR or FX derivatives; (2) it does not state in its 10-K that it has ex-ante IR or FX exposures; and (3) the Graham and Rogers' procedure implies that the firm has no ex-ante exposures. A total of 73 firms fall into this category. We exclude these firms from the non-user category because they are not suitable counterfactuals to those firms that are exposed to IR and FX prices and use hedging for risk management.

Finally, we match the sample of loan contracts with LPC's DealScan. This allows us to obtain additional characteristics on loan contracts (such as loan size and maturity). We then gather additional firm characteristics from COMPUSTAT. These include, among others, information on firm size, profitability, credit ratings, market valuation, asset tangibility, and cash flow volatility. Our final sample contains a total of 2,718 loan contracts signed by 1,185 individual firms.

B.2 *Proxies and Summary Statistics*

The majority of papers using derivatives data (e.g., Géczy et al. (1997), Allayannis and Weston (2001), and Purnanandam (2008))) measure hedging activity with a hedging dummy and/or a continuous aggregate notional value of derivatives contracts (irrespective of the direction of the positions). We follow this general approach and use multiple proxies for corporate hedging: (1) a dummy variable

[9] We use the definitions of long and short positions proposed by Graham and Rogers (2002). Specifically, a long (short) position is a contract that benefits from rising (declining) interest rates or the appreciation (depreciation) of a foreign currency. Net position is missing when information is insufficient for us to judge if a derivatives position is long or short.

for whether the firm reports IR hedging, (2) a continuous variable capturing the total notional value of IR derivatives contracts scaled by the firm's total assets, (3) a dummy variable for FX hedging, (4) a continuous variable for the total notional value of FX derivatives contracts scaled by the firm's total assets, (5) a dummy variable for the existence of IR and/or FX hedging, and (6) a continuous variable for the total notional value of IR and/or FX derivatives contracts scaled by the firm's total assets ("hedging intensity").[10]

Panel A of Table I shows the summary statistics for our hedging variables. About 35.6% and 27.3% of the sample firm-years use IR and FX derivatives, respectively. Some 50.1% of the sample firm-years use IR and/or FX derivatives. These proportions are somewhat higher than the corresponding figures reported in Graham and Rogers (2002), who examine a random sample of 469 firms (their corresponding figures are 25.0%, 24.2%, and 35.7%) for the fiscal year 1995-6. Regarding the intensity of derivatives use by our sample firms, the total notional value of derivatives contracts for derivatives users is about 13.8%, 7.5%, and 14.0% of total assets for IR hedging, FX hedging, and IR/FX hedging, respectively. These figures are similar to those reported in Graham and Rogers (2002), which equal 11.1%, 8.1%, and 13.2%.

INSERT TABLE I HERE

Panel A also reports summary statistics on loan characteristics. The average loan size is about 291.6 million dollars, the average loan spread (based on DealScan's all-in-spread drawn) is 188.6 basis points over LIBOR, and the average loan maturity is 1,345 days (about 45 months). In addition, 73.1% of loan contracts have contingent performance-based pricing terms and 37.3% of the loans contain an explicit restriction on capital expenditures. Finally, about 38.1% of the credit facilities in the sample are term-loans, whereas the remainder can be classified as revolving and other loans. These spread and maturity figures are higher than those found in related studies such as Chava et al. (2008) and Ivashina (2009), who report spreads that average around 117 to 140 basis points over LIBOR and maturity that averages about 39 months. The panel also reports summary statistics on firm characteristics such as firm size (the natural log of book value of total assets), asset tangibility (net PP&E over total assets), profitability (earnings before interest, tax, depreciation and amortization over total assets), cash flow volatility (the standard deviation of quarterly cash flows from operations over the four fiscal years before the loan initiation year scaled by total debt), growth opportunities (proxied by the market-to-book ratio), and leverage (defined as total debt/total assets).[11]

[10] Graham and Rogers (2002) is the only study using a net notional value (by offsetting long and short positions). We experiment with the use of net notional value as a robustness check for our main results.

[11] It is useful to briefly contrast the characteristics of the firms in our sample with those in the COMPUSTAT universe. Standard mean-difference tests suggest that our firms are somewhat larger. At the same time, firms in our sample and those in COMPUSTAT have similar levels of tangibility, market-to-book ratio, and leverage. Kolmogorov-Smirnov tests suggest that the industry composition (distribution) of our sample is indistinguishable from that of COMPUSTAT.

In Panel B, we compare the characteristics of firms with and without hedging contracts in place (hedgers versus non-hedgers). We find that hedgers are larger, more leveraged, and exhibit lower cash flow and asset volatility, as well as a lower default risk (as measured by Z-score). We also find that hedgers tend to have higher asset tangibility, although the difference is not statistically significant at the 5% test level. These results are largely consistent with the previous findings documented in the literature (e.g., Nance et al. (1993) and Géczy et al. (1997)). More importantly, hedgers are significantly different from non-hedgers with respect to loan characteristics and investment spending. Hedgers tend to access larger loans at lower loan spreads. Simple mean comparison between hedgers and non-hedgers indicates a 31 basis points difference in spreads, which is about 15% of the sample average spread for non-hedgers. We also find that hedgers, on average, are 20% less likely to have capital expenditures restrictions in their loan agreements, and they tend to invest roughly 10% more than non-hedgers. These univariate results provide preliminary support for our main hypotheses. We, however, shall perform more rigorous tests in the following sections.

II Hedging and the Cost of Credit

A *Baseline Model*

We use regression analysis to examine the effects of hedging on the cost of debt financing. While the literature offers many ways to model the pricing of private credit agreements, we largely follow the empirical model proposed by Graham et al. (2008) — itself a summary of prior modeling approaches. That model contains a long list of drivers of loan interest rates (including firm characteristics, loan characteristics, macroeconomic variables, and idiosyncratic-fixed effects) to which we add our hedging variables. Our baseline model can be written in condensed form as follows:

$$\begin{aligned} \textit{Log(Loan Spread)} &= f\,(\textit{Hedging Variables, Firm Characteristics, Loan Characteristics} \\ &\qquad \textit{Macroeconomic Variables, Idiosyncratic Fixed Effects}) \qquad (1) \end{aligned}$$

As in Graham et al. (2008), we take the natural logarithm of loan spread to mitigate the effect of skewness in data. Importantly, the model controls for firm and loan characteristics that may affect loan spreads. For instance, prior literature has hypothesized that when a borrower has dealt with the current lender in the past, there are fewer information asymmetries (e.g., Chava and Roberts (2008)). We include the natural logarithm of (1 + the number of previous loans with the current lender) as a proxy for the depth of the relationship between the borrower and lender, expecting it to be negatively related to loan spreads. In addition, we expect firms with higher credit ratings to obtain more favorable loan terms (e.g., a lower interest rate) than firms with lower or without ratings. Accordingly, we include dummies for the borrower's S&P ratings categories in the model. About 26%

of observations in our sample do not have a credit rating. To avoid loss of data, we assign a dummy variable that equals one when credit rating is missing.

Our firm-level controls include firm size, profitability, asset tangibility, M/B, cash flow volatility, and leverage.[12] We also include asset volatility in the model. In the presence of basis (unhedgeable) risk, a higher degree of asset volatility typically means less hedging (see Haushalter (2000) and Brown and Toft (2002)). To help assure that hedging is not simply capturing this effect, one must control for asset volatility.[13] We expect a positive link between asset volatility and loan spread. Finally, the modified Altman's (1968) Z-score is included to further control for default risk. A higher Z-score indicates better financial health and thus a lower default risk. We compute each of these proxies in standard ways. To save space we describe the details of their calculations in Appendix II. The model controls for industry-fixed effects by including industry dummies (2-digit SIC codes).

Importantly, all firm variables enter our models with a one-year lag from the loan origination. In other words, we work with *pre-determined* values of those variables. So, for example, whether the firm has a hedging policy in place is determined at least one year before the firm arranges the loan contract whose characteristics we consider. Our tests correct the error structure for within-firm correlation (clustering) and heteroskedasticity using the White-Huber's estimator.[14]

Following Graham et al. (2008), we also control for loan characteristics that might affect spreads. We include the natural log of loan size in the model to capture the potential economies of scale in bank lending, which might result in a lower spread. Furthermore, we control for loan maturity (defined as the natural log of maturity in days) because banks often require a liquidity premium for long-term debt and the premium will translate into a higher spread. We also include a dummy variable for performance pricing. We further control for the effects of loan type and loan purpose. Loans can be of different types, such as term loans, revolvers longer than one year, revolvers shorter than one year, and 364-day loans. Chava et al. (2008) report that the pricing of term loans can be very different from that of revolving loans, thus we include dummy variables for each loan type. Likewise, we classify loans in "loan purpose" categories: working capital or general corporate purpose, refinancing, acquisition, commercial paper backup, and others. For brevity, the coefficients of these dummies are not reported.

Macroeconomic conditions might also affect loan pricing Graham et al. (2008). Relatedly, recent literature (see Faulkender (2005) and Chernenko and Faulkender (2010)) shows that firms may

[12] We include leverage in our specification to conform to the existing literature (e.g., Graham et al. (2008) and Ivashina (2009)). While we are concerned about biases that could arise from the inclusion of this variable, we alternatively (1) use long lags of industry-level leverage as instruments for lagged firm-level leverage and (2) drop leverage altogether from our specifications. Our inferences are robust to any of these treatments.

[13] We compute asset volatility through the estimation of distance-to-default (DTD) using Merton's (1974) model. The details are presented in Apendix II. We thank an anoymous referee for suggesting this idea.

[14] We do not include firm-fixed effects in our baseline estimations (in Table II) because 426 firms have just one loan over the sample period that will be dropped from the firm-fixed effects estimation. In our robustness checks with firm-fixed effects (see Table V), our inferences remain the same.

selectively hedge their interest rate risks and time the use of derivatives based on macroeconomic conditions. It is thus possible that firms may time loans in a way that is correlated with aggregate conditions and hedging. To avoid this source of omitted variable bias, we follow this literature and include credit spread and term spread as controls in our model. Credit spread is computed as the difference between the yields of BAA and AAA corporate bonds, and term spread is the difference between the yield of 10-year and 1-year Treasury bonds. The literature suggests that term spread tends to widen in economic expansions and shrink in recessions. In contrast, the credit spread tends to widen in recessions and shrink in expansions (see Graham et al.). We thus expect a positive link between credit spread and loan spread and a negative link between term spread and loan spread.

In addition to the contract "timing mismatch" (imposed lag structure) described above, we highlight the "institutional mismatch" between providers of hedging and loan contracts. In the U.S., only a few, large financial institutions — many of which are nonbank firms — offer hedging contracts. In particular, according to 2002 statistics from the Fed's regulatory dataset, the top 5 (10) providers concentrated over 85% (95%) of the FX and IR hedging contracts outstanding. In contrast, the loan contracts we examine come from a large spectrum of commercial banks (there are nearly 1,500 different banks in our sample). Very rarely the same financial institution would provide the two contracts examined in our tests. Indeed, we spot-checked the 10-Ks of a random sample of firms in 2002 and found no match between the providers of hedging and loan contracts. We also verified that the largest 10 derivative providers lead only about 4% of the loans in our sample, and that our results are insensitive to the deletion of these observations.

B *A Tax-Based Instrumental Approach*

Although we have taken precautions to address the issue of biases arising from reverse-causality and omitted variables, endogeneity remains as a concern in our estimations. In this section, we develop an instrumental variable approach to more explicitly handle concerns about estimation biases.

We identify a candidate instrument for hedging that arises from a salient feature of the rules governing corporate taxes; namely, tax convexity. The risk management literature has long argued that hedging can lower the volatility of future taxable income, thus lowering expected tax liabilities for firms facing convex tax schedules (e.g., Smith and Stulz (1985) and Graham and Smith (1999)). Green and Talmor (1985), for example, show that in the presence of asymmetric tax treatment of positive and negative incomes, the tax liability of a firm can be thought of as a government-written call option on future income streams, with the strike price equal to the value of allowable deductions on taxable earnings. Accordingly, as the volatility of pre-tax earnings declines, the value of the call option — the amount of the tax liabilities — drops. This gives firms an incentive to hedge. Graham and Smith further report that roughly 50% of the firms in COMPUSTAT face effective tax functions that are convex.

In the U.S., tax convexity is a function of the non-linear treatment assigned to corporate earnings in the tax code (tax brackets), the existence of net operating loss carryforwards and carrybacks,[15] investment tax credits, and the alternative minimum tax. The tax convexity estimation of Graham and Smith (1999) captures all of the aforementioned features of the tax code and measures the expected tax savings from hedging. Notably, not all firms face the same tax convexities, nor would they benefit the same by hedging their income for tax reasons. Our instrumental approach builds on this source of heterogeneity in firms' hedging-related tax benefits.

In what follows, we employ the procedure described in Graham and Smith (p.2256) to calculate tax convexity. Specifically, the expected percentage savings in tax liability arising from a 5% reduction in the volatility of taxable income (denoted *Convexity*) is calculated for every firm-year as a follows:

$$\begin{aligned} Convexity &= 4.88 + 0.019 \times TIVol - 5.50 \times TICorr - 1.28 \times D_{ITC} \\ &\quad + 3.29 \times D_{NOL} + 7.15 \times D_{SmallNeg} + 1.60 \times D_{SmallPos} \\ &\quad - 4.77 \times D_{NOL} \times D_{SmallNeg} - 1.93 \times D_{NOL} \times D_{SmallPos}, \end{aligned} \tag{2}$$

where $TIVol$ is the volatility of taxable income, $TICorr$ is the serial correlation of taxable income, D_{ITC} is a dummy for investment tax credits, D_{NOL} is a dummy for net operating losses, $D_{SmallNeg}$ ($D_{SmallPos}$) is a dummy for a small negative (positive) taxable income. We calculate the volatility of taxable income and the serial correlation of taxable income on a rolling basis, using all available historical annual data up to the year of interest. The other elements of the tax savings calculation are directly observable in the firms' balance sheets. Notice that the Graham-Smith formula uses data from a small range of realizations around a zero-income tax kink. Instrument identification in that region comes from the *non-linear form* of the income taxation function, rather than the income level itself (which is already included in Eq. (1)). Indeed, *Convexity* is a highly non-linear function of income.

For our purposes, the key observation is that tax convexity provides incentives for firms to hedge (instrument inclusion restriction), but a priori, there is no reason to expect it to directly affect the terms of bank loans (exclusion restriction). Under this premise, tax convexity is a plausible instrument for hedging in a loan spread regression. Indeed, using the Graham-Smith tax-convexity construct, prior papers have found support for the hypothesis that firms hedge with the goal of minimizing taxes (e.g., Dionne and Garand (2003), Dionne and Triki (2005), and Lin et al. (2008)). Others, however, find only weak evidence of this effect (e.g., Graham and Rogers (2002)). Accordingly, we need to verify that our approach is robust to alternative assumptions about what is included in the instrument set. This set must also have good statistical properties (pass validity and relevance tests). The various tests reported below focus on demonstrating that our instrumental approach is sound.[16]

[15] Carryforwards and carrybacks tend to reduce the most extreme tax schedule curvatures, but they spread the progressivity of taxes over a broader range of corporate incomes.

[16] For example, one potential concern with our instrument is that it is simply a proxy for asset or cash flow volatility.

Our instrumental variable estimations are performed in two stages. In the first stage, hedging intensity is regressed on the lagged excluded instrument (*Convexity*) and all of the independent variables in the loan spread model (Eq. (1)). The "predicted hedging" from the first stage is then used in the second-stage loan spread model. The first-stage regression results are not reported in full to save space; instead, the relevant test statistics are reported in all of our tables. In all cases, the tax convexity variable is found to have a positive and statistically significant effect on hedging. Accordingly, as reported, the F-tests of the significance of the instrument in the first-stage model are always highly significant (p-values lower than 0.001). More illustrative than these exclusion F-tests, however, are the Shea's (1997) R^2's from the first-stage regressions (also reported in all tables). These R^2's all exceed the suggested ("rule of thumb") hurdle of 10%. These various statistics suggest that our instrument is relevant in explaining the variation of our models' potentially endogenous regressors.

C *Empirical Results*

C.1 *Baseline Loan Spread Model*

To gauge the direct effect of hedging on loan spreads, we study, separately, an IR hedging dummy for whether the firm has IR derivatives contracts in place; a continuous IR intensity hedging measure (i.e., total notional value of IR derivatives contracts scaled by the firm's total assets); a FX hedging dummy; a continuous FX hedging intensity measure (total notional value of FX derivatives scaled by total assets); an IR/FX hedging dummy combining the IR and FX dummies; and a continuous IR/FX intensity measure (total notional value of IR and FX derivatives scaled by total assets). Our inferences are similar for each one of these hedging proxies. To avoid redundancy, however, we only discuss the results based on the IR/FX hedging intensity measure.[17]

Table II presents the results from estimating Eq. (1). Column (1) reports the coefficients obtained from a standard OLS model. The sample size drops slightly due to missing values on hedging intensity. Column (2) reports estimates obtained from the IV approach. The results are qualitatively similar, and we focus on the latter approach to save space. The estimates in column (2) deliver a very significant result. They imply that hedgers with average usage of IR/FX derivatives are charged loan spreads that are 28% lower than non-hedgers ($= -2.021 \times 0.140$, where 0.140 is the mean of IR/FX hedging-to-asset ratio reported in Table I). Relative to the average loan spread of 189 basis points, this represents a reduction of about 53 basis points. To present these effects in an alternative way, a one-standard deviation increase in hedging intensity at the average level of hedging leads to a 29% reduction in spreads. Hedging has a strong, sizeable impact on the cost of credit.

To ameliorate this concern, we expunge from the calculation of *Convexity* those "suspicious" components proxying for volatility (e.g., $TIVol$). The results (available from the authors) are consistent with our the results presented below, suggesting again that we do obtain independent variation coming from the tax-based instrument.

[17] Key results based on IR/FX hedging dummy can be found in the Internet Appendix of the paper.

Regarding the control variables, each of the firm characteristics we use attracts the expected coefficient. For example, firms that have more established relations with their banks, are larger, are more profitable, have more tangible assets, are less leveraged, and have higher Z-scores all pay lower loan spreads for the funds received under private agreements. These results resemble those of Graham et al. (2008). Like those authors, we also obtain a negative relation between market-to-book ratios and loan spreads. Loan characteristics such as loan size and maturity also conform to our priors. The results for the macro variables, too, agree with our priors. Recall, our regressions, also include a performance pricing dummy, loan type and purpose dummies, and credit ratings dummies; their coefficients are largely significant, but omitted for brevity.

To our knowledge, this is the first study in the literature to show that corporate hedging is associated with lower loan interest rates. These initial results complement and extend the finding of Graham and Rogers (2002) that hedging increases a firm's debt capacity. Both studies are consistent with the notion that creditors value positively a firm's decision to hedge, and they provide more favorable credit terms to firms that hedge. Our results on the effect of hedging on loan pricing are also consistent with Petersen and Thiagarajan's (2000) findings on the moderating effect of hedging on the cost of equity. Together with these pieces of evidence, our results more broadly imply that hedging eases firms' access to external financing.

TABLE II ABOUT HERE

C.2 *Financial Distress and Risk-Shifting*

To better characterize our story, we examine in more detail factors underlying the negative association between hedging and loan spreads that we have uncovered. Smith and Stulz (1985) argue that if financial distress is costly, hedging can ease external funding by lowering income volatility. According to their theory, hedging may be particularly more valuable for firms with a higher probability of financial distress. In contrast, the benefits of hedging for financially strong borrowers may be more marginal. In what follows, we explore cross-sectional variation in firms' financial positions to verify whether our baseline results can indeed be attributed to existing hedging theories.

We examine the financial distress argument by including Altman's Z-score and its interaction with hedging in our baseline model. The result from this test is reported in column (3) of Table II. We expect the uninteracted Z-score to have a negative impact on loan spreads since, all else equal, healthier firms should be charged lower spreads. This is exactly what we find, with a high degree of statistical significance. More interesting, however, is the coefficient of the hedging–Z-score interaction term. This term returns a positive, statistically significant coefficient, implying a weakening of the negative association between Z-score and loan spreads for firms that hedge. Put differently, consistent with the theory, hedging is particularly more valuable for borrowers with a higher likelihood of financial distress. It is interesting to gauge the economic significance of our results. The estimates in column (3) imply that a one-standard deviation decline in Z-score increases the loan spread of an average hedger by 16 basis points *less* than a similar decline in Z-score for a non-hedger.

In addition to ameliorating financial distress risk, theory suggests that hedging may be beneficial for creditors by limiting firms' scope for substitution towards riskier investments (risk-shifting). It is thus interesting to examine if the dynamics of our hedging–loan spreads results are modulated by the degree to which firms might be able to engage in asset substitution. While it is difficult to gauge directly a firm's ability to risk-shift, standard finance theory suggests that firms with more growth opportunities tend to be riskier than firms with fewer growth opportunities (see, e.g., Jensen and Meckling (1976)). Under this conjecture, we would expect that the effect of hedging in lowering loan spreads to be greater for firms with more growth opportunities. To test this idea, we interact M/B with hedging in the loan spread model. The results are reported in column (4) of Table II. Our tests show that the coefficients of the hedging–M/B interaction term are always negative and statistically significant. Accordingly, the estimates we report suggest that the negative effect of hedging on loan spreads is greater — i.e., hedging is more valuable — for firms whose investment opportunity set is more likely to allow for risk-shifting. Another way to interpret the coefficients in the table is to recognize the benefits of hedging through the effect it has on the cost of funds of growth firms. Using the figures from column (4), we obtain that increasing M/B by one unit (which is about one standard deviation of M/B) decreases loan spreads of an average hedger by 11 basis points *less* than a similar increase in M/B for a firm without hedging contracts in place.

III Hedging and Investment

One way in which the benefits of hedging may manifest relates to the contractual restrictions creditors impose on firms that hedge. In particular, together with lower interest rates, it is likely that creditors will impose fewer contractual restrictions on firms' spending when "hedging insurance" is in place (see Bessembinder (1991)). Naturally, the relevant question is whether hedging ultimately shapes the firm's investment process. These important questions on the real-side implications of financial decisions have been largely ignored in the hedging literature. This section examines both of these questions.

A *Capital Expenditure Restrictions*

We first examine whether hedging has a direct impact on investment restrictions in loan agreements. Research suggests that investment restriction clauses in bank loans are particularly interesting because these clauses are tailored according to the particular characteristics of each borrower, differently from the "generally-worded" indentures of public bonds. Accordingly, the choice of including capital expenditures restrictions in debt contracts should closely reflect *creditors' assessment* of borrower-specific credit risk.

We examine this hypothesis by regressing a dummy variable denoting the existence of capital expenditure restrictions on IR/FX hedging intensity, controlling for various firm and loan characteristics. The controls used in these estimations are similar to those in Eq. (1). All models are estimated via probit-IV.

TABLE III ABOUT HERE

Our results are reported in Table III. To ease the exposition, the coefficient estimates are transformed to represent the marginal effects evaluated at the means of the independent variables from the regressions. The firm characteristic coefficients (e.g., size, profitability, and leverage) are comparable to those observed in the loan spreads of Table II (the same economic intuition applies, which we omit for brevity).

More important for our purposes are the coefficients associated with hedging. The estimates show a negative, statistically significant relation between hedging and the odds of having capital expenditure restrictions in loan agreements. Specifically, results from column (1), imply that being an average IR/FX hedger decreases the probability of having an expenditure restriction by about 20%. This number is quite significant. Relative to the sample mean, it represents a 54% decline in the odds of having a capital expenditure restriction.

The evidence in Table III suggests a new channel through which hedging improves corporate outcomes: it reduces the odds that creditors will impose constraints on firms' investment decisions. We believe our evidence is important in flashing out precise mechanisms that underlie links between financial and investment decisions inside the firm. While there is evidence that these decisions move together (see Stein (2003) for a review), we still know very little about *how* they are connected. The evidence introduced by this paper helps us better understand these connections.

Finally, we have shown that financial distress and risk-shifting proxies modulate the effect of hedging on the cost of external funding. The same rationale used in the tests of Section C.2 applies when examining the impact of hedging on the investment covenants: higher financial distress risk and higher potential for asset substitution should make hedging particularly more desirable for creditors, leading to a relaxation on investment covenants. We verify these hypotheses in turn.

We augment the capital restriction covenants of column (1) with the inclusion of an interaction term for hedging and Z-score (similar to the approach of Table II). The results are reported in column (2). The estimates show that firms with a higher chance of financial distress (as denoted by a low Z-score) are more likely to be imposed capital expenditure restrictions. At the same time, given an hypothetical one-standard deviation drop in Z-score, a non-hedger will see a 15.5% increase in the likelihood that its lender will impose a capital expenditure restriction, while for a counterfactual hedger firm the increase in the likelihood of a restriction is only one third of that, or a statistically insignificant 5.2%.

In column (3) we interact M/B with hedging intensity. The coefficient returned for the hedging–M/B interaction term is negative and statistically significant. The estimation suggests that growth firms that hedge have lower odds of having capital expenditure restrictions in their loans.

B *The Impact of Hedging on Investment Spending*

Our findings suggest that hedging reduces the incidence of investment restrictions in loan agreements. This should give firms greater flexibility in their investment decisions. Since we also find that hedgers raise funds at lower costs, it would be natural to investigate whether financial hedging programs ultimately shape firms' investment spending (see also Petersen and Thiagarajan (2000)). In this section, we estimate empirical investment models in which a firm's asset-scaled capital expenditures are regressed on a large set of variables containing information on firm and loan characteristics, as well as on hedging. This set of variables, which come from Eq. (1), encompasses those commonly found in the corporate investment literature (see, e.g., Kaplan and Zingales (1997)).[18]

The results from the IV estimations of our investment model are in Table IV. All of our estimations return a positive, statistically significant coefficient for hedging, suggesting that hedgers are able to invest more than non-hedgers. The results under column (1), for example, suggest that being an average IR and/or FX hedger increases a firm's investment by about 12.9% relative to the sample mean level of annual investment ($= 0.071 \times 0.14/0.077$). Other regressors in the model obtain expected coefficients. For example, investment is positively related to greater access to loans (as indicated by having prior relations with the current lender, larger loan size, and longer loan maturity) and higher Z-scores. Investment also responds positively to M/B and profitability.

TABLE IV ABOUT HERE

We also interact hedging with Z-score and M/B. We do so because we expect the impact of hedging on investment to vary across firms that face different likelihood of distress and have different investment choice sets. Results under column (2) of Table IV show that the coefficient on the interaction term between hedging and Z-score is negative and significant, implying that hedging relaxes the link between Z-score and investment. In particular, they imply that low Z-score firms that hedge invest more than low Z-score firms that do not hedge. To use a concrete example, consider again a one-standard deviation drop in Z-score. For a firm that does not hedge that decline will lead to a drop in investment of about 9.5% of the average sample investment rate. For an average hedger, the same drop in Z-score would imply an equivalent drop in investment of only 4.6% of the sample mean.

Column (3) reports results from a model in which we interact hedging and M/B. The hedging–M/B interaction term is positive and statistically significant, supporting the idea that hedging allows firms

[18] Standard investment models are quite parsimonious and often include only proxies for "Q" (equivalent to M/B in our analysis) and cash flow (or profitability).

with greater growth options to invest more. For example, increasing M/B by one unit boosts annual investment rate by 3% for average hedgers, which is about 39% of the sample mean of investment.

The findings of this section complement and extend the existing evidence on financing frictions and investment. Chava and Roberts (2008) find that a borrower's capital expenditures decline by about 13% in response to a financial covenant violation. Nini et al. (2009) further document that capital expenditure restrictions are common, and borrowing firms' investment rate fall by 15% (relative to the sample mean) after an investment restriction is imposed on their loans. In contrast, we find that being an average IR/FX hedger reduces the chance of having a capital expenditure restriction by about 20%, and that engaging in hedging activities increases a firm's annual investment rate by about 13% (relative to sample mean). Further analyses that we conduct considering financial distress risk and growth opportunities provide additional insights about the impact of hedging on investment spending.

IV Robustness Checks

In this section, we test the robustness of our inferences to the use of alternative hedging measures and estimation methods. We do so perturbing the estimation that produces our weakest results (under column (1) of Table II). First, Graham and Rogers (2002) argue that the *net* notional value of derivatives might be a better measure of a firm's hedging position than the *total* notional value. As a robustness check, in column (1) of Table V we measure the extent of hedging as the net notional value of derivatives contracts scaled by total assets. As some firms are vague in reporting the direction of hedging positions in their SEC filings, we follow Graham and Rogers and exclude these "unsure cases" from the analysis. Still, the estimated hedging "premium" (reduction in loan spreads) associated with a one-standard deviation increase in hedging remains economically significant, equal to 23%. The conclusion that hedging lowers loan spread is robust to the use of net notional value of derivatives.

TABLE V ABOUT HERE

Second, we experiment with proxies for the likelihood of future default in our baseline model. Recent research has proposed the use of "distance-to-default" (DTD) as a plausible candidate. In the bank loan literature, Drucker and Puri (2009) use this measure to assess whether a borrower may default in the future, which affects the expected length of the relationship with its lender. Following Drucker and Puri, we implement the DTD measure that is operationalized in Crosbie and Bohn (2003). In column (2) of Table V, we use this proxy in lieu of Z-score. The DTD proxy attracts the expected negative coefficient, but this brings no significant changes to the coefficient of the IR/FX hedging-to-asset variable. Although not reported in the table, we reestimate all our hedging–Z-score interactive models replacing Z-score with DTD. Our conclusions about the interplay between distress and hedging remain the same.

About 60% of our sample firms have more than one loan in the 1996–2002 period. We exploit the panel data structure of part of our sample to check whether our results are robust to the inclusion of controls for time-invariant firm characteristics. In column (3) of Table V, we estimate a firm-fixed effects regression. Naturally, the firms that have just one loan in our sample period are dropped from the estimation. Yet, the reduced sample provides an opportunity to gauge the tenor of our results. We find that the IR/FX hedging proxy still attracts a negative and highly significant coefficient.

While the statistics reported in Table I suggest little evidence of gross outliers in loan spreads, we estimate a median regression as an additional check. The result on the IR/FX hedging ratio in column (4) of Table V is qualitatively similar to that of our baseline regressions

Finally, note that our analysis is conducted at the loan level. However, as discussed in Graham et al. (2008), individual loans are often part of a multiple-loan deals, and their terms may simply reflect the deal-level negotiation (i.e., they are not completely independent observations). Treating these loans as independent credit facilities could inflate the statistical significance of our results. To check whether this is an issue, we follow Graham et al. and aggregate loans into "deals" using loan-size weighted averages of the relevant loan terms. The slope estimate for the IR/FX hedging variable in column (5) of Table V indicates the deal-level bias story does not affect our inferences.

We also perform robustness checks for our regression models on the probability of having a capital expenditure restriction in a loan contract. These checks (available upon request) indicate that our inferences about investment restrictions are equally robust to changes in model specification, sample selection, and use of alternative econometric techniques.

V The Economic Value of Corporate Hedging

Our analysis shows evidence that hedging reduces interest rate spreads and the incidence of investment restrictions in loan agreements, which in turn result in higher investment rates. These findings are consistent with existing evidence on the valuation gains associated with hedging (e.g., Allayannis and Weston (2001)). It is therefore natural that we dig deeper into the economic value of corporate hedging. In this section, we first study the relation between hedging and the true cost of corporate debt; i.e., we go beyond the analysis of loan spreads. We then look at the value implication of investment increases that come from hedging. While the tests performed here are more tentative, they provide a step forward in our understanding of the economic implications of hedging.

A *Hedging and the True Cost of Debt*

Our tests show that hedging lowers contractual loan spreads. These results are interesting in their own right, however, they need not imply that hedging reduces the firm's true cost of debt.

The firm's observed debt spread includes a portion compensating investors for the expected default loss and a portion compensating investors for the undiversifiable risk of debt (i.e., the expected return premium or "true" cost of debt).[19] More precisely, the contractual debt yield can be expressed as:

$$\textit{Promised Debt Yield} = \textit{Cost of Debt} + \textit{Yield Equivalent of Expected Default Loss.} \tag{3}$$

In our case, the observed drop in the loan spread (promised debt yield) for hedgers could be caused by a drop in the expected default risk premium, rather than a drop in the (true) cost of debt, as a result of hedging. This distinction is important in that only the latter effect is a sufficient condition for hedging to increase firm value via debt financing.[20]

In this section, we examine how hedging affects the cost of debt. Our analysis builds on recent empirical studies decomposing promised interest rates into expected default risk premia and underlying debt costs (e.g., Elton et al. (2001) and Cooper and Davydenko (2007)). We leave the details of the computation of these different components to Appendix I. Here, we are interested in testing the empirical relation between the computed cost of debt and hedging.

Table I shows that the mean cost of debt in our sample is 132 basis points, roughly 70% of the mean promised loan spread. This relative ratio is very similar to the 66% figure reported in Elton et al. (2001).[21] Table VI presents results from regressing the log of true cost of debt on firm hedging. The estimated models are similar to Eq. (1), except that the dependent variable (*Cost of Debt*) is computed as Eq. (5) in Appendix I. The results in the table show a negative and statistically significant relation between hedging intensity and *Cost of Debt*, suggesting that hedging helps lower not only the promised loan spreads (as in Table II), but also the true cost of debt. When we include the interaction between hedging and Z-score or the interaction between M/B ratio and hedging, we obtain results that, again, resemble those of Table II. That is, hedging has a particularly strong effect on the true cost of debt of those firms that are near distress or that are more likely to risk-shift.

TABLE VI ABOUT HERE

B *Estimating the Real-Side Benefits and Costs of Corporate Hedging Programs*

A natural and interesting question is whether hedging adds value by boosting a firm's real-side activities. In our context, a firm may benefit from the additional investment that is made possible as a result of hedging. Hedging programs, however, are not cost-free. Bearing in mind the limitations of the data, we try to provide a rough estimation of the *net* gains from hedging for the average firm in our sample.

Benefits. The proportional change in loan spreads that is brought about by hedging can be calculated by multiplying the regression coefficient in column (2) of Table II (= −2.02) by the firm's

[19] See Elton et al. (2001) and Cooper and Davydenko (2007) for detailed discussions.

[20] We thank Mitchell Petersen (the editor) for raising this point.

[21] Estimates for comparable subsamples in Cooper and Davydenko (2007) range from 74% to 85%. The sample size drops due to missing values of variables used to estimate the true cost of debt.

hedging amount (IR/FX hedging). The annual interest rate saving can be then estimated by multiplying the reduction in loan spread and the total amount of loans in a firm-year. The return from additional investment can be computed as follows: regression coefficient in column (1) of Table IV ($= 0.07$) $\times$ hedging amount $\times$ lagged total assets $\times$ mean ROA in the previous five years.

Costs. The firm needs to pay a bid-ask spread when entering an IR/FX derivatives contract, and it also needs to pay a premium for buying an option contract. Costs arising from bid-ask spreads in forward and swap contracts are calculated at 1.5 basis points of the notional value of those derivatives (cf. Hull (2008)). The costs associated with the options contract is calculated at 1.5 basis points of the notional value (estimated from Brown (2001)). Option premium may vary according to the underlying security, time to maturity, and other factors. While information on premiums for over-the-counter option contracts is not available, we use the average 1% premium rate for an at-the-money option traded at the Philadelphia Stock Exchange as a proxy. Annual cost of running a hedging program is estimated at 1.5 basis point of annual sales (see Brown (2001)).

We then compute the difference between the above benefits and costs. Finally, after applying a firm's simulated marginal tax rate to the computed net gain, we compare it to the firm's income before extraordinary items.[22] We find that the average firm in our sample has an annual net gain from hedging of about 4.7% of its annual income. It is worth noting, however, that our estimate is likely to be a conservative figure. First, we do not consider many other benefits of hedging in the analysis (e.g., improved contract terms when dealing with stakeholders such as suppliers and employees). Second, our calculation is likely to overstate the cost of hedging. For example, firms engaging in the use of options may buy and sell options simultaneously (e.g., using a collar strategy) in order to lower the cost of derivatives hedging. Indeed, the firm analyzed in Brown (2001) reports a negative option premium, suggesting that the firm sells more options than that it buys.

While the evidence in this section is arguably more tentative, it substantiates the notion that hedging contributes to corporate valuation. This is an important finding in that it may help us understand — though not fully explain — evidence suggesting that hedging adds value (e.g., Allayannis and Weston (2001)). Future research should further our knowledge of the value implications of corporate hedging.

VI Concluding Remarks

While research on corporate risk management has long focused on the determinants of corporate hedging, recent studies investigate the value implications of hedging. This paper advances the research in the area by examining the effects of hedging policies on firms' access to capital (the price of bank loans) and on their ability to invest (contractual restrictions on investment spending). We

[22] We thank John Graham for providing us the simulated marginal tax rates.

present evidence that firms pay lower interest rate spreads and are less likely to have covenants restricting their investment in private credit agreements after hedging programs are put in place. The results we find are consistent with theories proposing that hedging works as a commitment mechanism that limits the set of possible cash flow realizations, which in turn eases firms' access to external funding. Confirming the logic of our base results, we find that the effects of hedging on loan prices and covenants are modulated by proxies associated with firm risk. For example, firms with higher financial distress costs pay lower interest rates on their loans when they have hedging policies put in place prior to signing their credit agreements.

Our paper provides new insights into the importance of corporate hedging, characterizing the channels through which hedging affects corporate outcomes — effects that are likely to be reflected in firm valuation. For example, the negative relation between hedging and loan spreads that we uncover shows *how* hedging affects a firm's financing costs. Our findings on the effect of hedging on the odds of contractual restrictions on capital expenditures illustrate yet another channel of how financial contracting affects investment and corporate welfare.

Taken altogether, our findings provide additional rationales for hedging showing that these policies are positively valued by creditors and might ultimately translate into gains for all corporate stakeholders by facilitating the investment. These insights might help us better understand the role of corporate hedging and may help delineate the size and scope of the market for derivatives instruments.

Appendix I: A Note on Estimating The Cost of Debt

We follow the procedure suggested by Cooper and Davydenko (2007) to decompose the loan spread into the cost of debt and the expected default loss on the outstanding debt. First, we solve for asset volatility (σ) and maturity of debt (T) from the two simultaneous equations in the risky debt pricing model of Merton (1974); i.e., $(1-p_D) = \mathrm{N}(d_1) - p_D e^{sT}\ \mathrm{N}(d_2)$ and $\sigma_E\ (1-p_D) = \sigma\ \mathrm{N}(d_1)$, where p_D is the firm's leverage, s is the loan spread, σ_E is the equity volatility, N(.) is the cumulative normal distribution function, $d_1 = [\,-\ln(p_D) - (s - 0.5\ \sigma^2)T\,]/(\sigma\sqrt{T})$, and $d_2 = d_1 - \sigma\ \sqrt{T}$.

Second, we estimate the cost of equity (r_E) based on the Capital Asset Pricing Model using the market risk premium calculated as the average annual premium of the CRSP value-weighted index return over the risk-free rate over the preceding 30 years. We then calculate the risk premium on assets as $\pi = (r_E - r)\ \sigma\ /\ \sigma_E$, where r is risk-free rate.

Third, we estimate the expected default loss on the debt:

$$\delta = -(1/T)ln[e^{(\pi-s)T}N(-d_1-(r_E-r)\sqrt{T}/\sigma_E)/p_D + N(d_2+(r_E-r)\sqrt{T}/\sigma_E)] \tag{4}$$

Finally, the cost of debt is obtained as:

$$\textit{Cost of Debt} = \textit{Loan Spread}\ (s) - \textit{Yield Equivalent of Expected Default Loss}\ (\delta) \tag{5}$$

Appendix II: Data Definitions

Variable names	Variable definitions and corresponding COMPUSTAT data items
Firm hedging information	
IR hedging dummy	Equals one if a firm/year engages in interest rate hedging.
IR hedging	Total notional value of interest rate derivatives contracts/total assets (data6).
FX hedging dummy	Equals one if a firm/year engages in foreign exchange rate hedging.
FX hedging	Total notional value of foreign currency derivatives contracts/total assets (data6).
IR/FX hedg. dummy	Equals one if a firm/year engages in IR and/or FX hedging.
IR/FX hedging	Total notional value of interest rate and foreign currency derivatives contracts/total assets (data6).
Net IR/FX hedging	(Absolute net notional value of interest rate derivatives contracts + absolute net notional value of foreign currency derivatives contracts)/total assets (data6). Net notional value in each class of derivatives is calculated by offsetting long and short positions in the manner of Graham and Rogers (2002). A long position is a contract that benefits from rising interest rates or the appreciation of a foreign currency. We add basis swaps (that are an exchange of floating rate indices) to the absolute net notional value of IR derivatives. Cases when information is not sufficient for us to judge whether a derivatives position is long or short are excluded from the calculation of net position.
Firm characteristics	
Log assets	Natural log of total assets = log(data6).
Profitability	Earnings before interest, tax, depreciation and amortization (EBITDA)/total assets = data13/data6.
Tangibility	Net property, plant and equipment/total assets = data8/data6.
Cash flow volatility	Standard deviation of quarterly cash flows from operations (quarterly data 108) over the four fiscal years prior to the loan initiation year/total debt.
M/B (Market-to-book)	(Market value of equity plus the book value of debt)/total assets = (data25 ×data199 + data6 – data60)/data6.
Leverage	(Long-term debt + debt in current liabilities)/total assets = (data9 + data34)/data6.
Z-score	Modified Altman's (1968) Z-score = (1.2×working capital + 1.4 ×retained earnings + 3.3×EBIT + 0.999×sales)/total assets = (1.2×data179 + 1.4×data36 + 3.3×data170 + 0.999×data12)/data6. The ratio of market value of equity to book value of total debt is omitted from calculation, because market-to-book enters the regressions as a separate variable.
Distance-to-default	A market-based measure of default risk based on KMV-Merton methodology described in Crosbie and Bohn (2003) and is equal to $(V_a - D)/(V_a\ \sigma_a)$, where D is debt, defined as the debt in current liabilities plus one-half long-term debt, V_a is the market value of assets, and σ_a is the one-year asset volatility. V_a and σ_a are unobservable. They are approximated by using the market value of equity (V_e), the one-year equity volatility (σ_e), the three-month treasury bill rate (r), and debt (D) to solve Merton's (1974) model of pricing a firm's debt and equity for a one-year time horizon (T = 1): $V_e = V_a\ N(d_1) - e^{-r}\ D\ N(d_2)$, and $\sigma_e = N(d_1)\ \sigma_a\ V_a\ /\ V_e$, where $d_1 = (\ \ln(V_a/D) + r + 0.5\ \sigma_a^2\ )\ /\ \sigma_a$, and $d_2 = d_1 - \sigma_a$.
Asset volatility	Defined as σ_a in the calculation of distance-to-default.

Covenant restrictions on CAPEX	Dummy variable that takes the value one when there is a restriction on capital expenditure in debt covenant.
Investment/lagged assets	Capital expenditure/lagged total assets = (data128/lagged data6).
Firm's previous loans	Natural log of (1 + the number of previous loan contracts between the borrowing firm and the current bank lender), a proxy for previous lending relationship.
Marginal tax rate	Marginal tax rate is the simulated marginal tax rates that are obtained from John Graham and is measured before a firm/year's hedging activities.
Tax convexity	A dollar amount of tax saving from a five percent reduction in the volatility of taxable income, calculated as a function of a small negative taxable income dummy, a small positive taxable income dummy, volatility of taxable income, serial correlation of taxable income, the existence of investment tax credit in balance sheet, the existence of net operating losses and its interaction with the small negative and positive income dummies. Further detailes are in Graham and Smith (1999, p.2256). We calculate both volatility of taxable income and serial correlation of taxable income on a rolling basis using all available historical annual data (since 1965) up to a particular calculation year. Since our regression models have separately included a cash flow volatility measure, we also estimate a modified tax convexity by omitting volatility of taxable income from the convexity calculation and the results are robust.
Credit rating dummies	Dummy variable for each category of S&P firm ratings including AAA, AA, A, BBB, BB, a B or worse rating. We also assign a dummy for firms without the S&P rating.
Loan characteristics	
Loan spread	Loan spread is measured as all-in-spread drawn charged by the bank over LIBOR for the drawn portion of the loan facility, reported in the DealScan database.
Cost of debt	Loan spread minus yield equivalent of expected default loss (δ), calculated according to the procedure suggested by Cooper and Davydenko (2007).
Log maturity	Natural log of the loan maturity in days.
Log loan size	Natural log of the loan (facility) amount, measured in millions of dollars.
Performance pricing dummy	Dummy variable that equals one if the loan facility uses performance pricing.
Loan type dummies	Dummy variable for each loan type, including term loan, revolver greater than one year, revolver less than one year, and 364-day facility.
Loan purpose dummies	Dummy variable for loan purposes, including corporate purpose, working capital, debt repayment, acquisition, backup line for commercial paper, and others.
Others	
Industry dummies	Industry dummies are based on 2-digit SIC code.
Credit spreads	The difference between the yields of average BAA corporate bond and AAA corporate bond.
Term spreads	The difference between the yields of 10-years Treasury bonds and 1-year Treasury bonds.

REFERENCES

Allayannis, George, and James Weston, 2001, The use of foreign currency derivatives and firm market value, *Review of Financial Studies* 14, 243–276.

Almeida, Heitor, Murillo Campello, Bruno A. Laranjeira, and Scott J. Weisbenner, 2009, Corporate debt maturity and the real effects of the 2007 credit crisis, NBER Working Paper #14990.

Altman, Edward I., 1968, Financial ratios, discriminant analysis, and the prediction of corporate bankruptcy, *Journal of Finance* 23, 589–609.

Bessembinder, Hendrik, 1991, Forward contracts and firm value: Investment incentive and contracting effects, *Journal of Financial and Quantitative Analysis* 26, 519–532.

Bris, Arturo, Ivo Welch, and Ning Zhu, 2006, The costs of bankruptcy, *Journal of Finance* 61, 1253–1303.

Brown, Gregory W., 2001, Managing foreign exchange risk with derivatives, *Journal of Financial Economics* 60, 401–448.

Brown, Gregory W., and Klaus Bjerre Toft, 2002, How firms should hedge, *Review of Financial Studies* 15, 1283–1324.

Campbell, Tim S., and William A. Kracaw, 1990, Corporate risk management and incentive effects of debt, *Journal of Finance* 45, 1673–1686.

Carter, David A., Daniel A. Rogers, and Betty J. Simkins, 2006, Does hedging affect firm value? Evidence from the U.S. airline industry, *Financial Management* 35, 53–87.

Chava, Sudheer, Dmitry Livdan, and Amiyatosh Purnanandam, 2008, Do shareholder rights affect the cost of bank loans? *Review of Financial Studies* 22, 2973–3004.

Chava, Sudheer, and Michael Roberts, 2008, How does financing impact investment? The role of debt covenants, *Journal of Finance* 63, 2085–2121.

Chernenko, Sergey, and Michael Faulkender, 2010, The two sides of derivatives usage: Hedging and speculating with interest rate swaps, Working Paper, Harvard University.

Cooper, Ian A., and Sergei A. Davydenko, 2007, Estimating the cost of risky debt, *Journal of Applied Corporate Finance* 19, 90–95.

Crosbie, Peter J., and Jeffrey R. Bohn, 2003, Modeling Default Risk (KMV, LLC, San Francisco, CA).

Dionne, Georges, and Martin Garand, 2003, Risk management determinants affecting firms' values in the gold mining industry: New empirical results, *Economics Letters* 79, 43–52.

Dionne, Georges., and Thouraya Triki, 2005, Risk management and corporate governance: The importance of independence and financial knowledge for the board and the audit committee, Working Paper, HEC Montreal.

Drucker Steven, and Manju Puri, 2009, On loan sales, loan contracting, and lending relationships, *Review of Financial Studies* 22, 2835–2872.

Eisdorfer, Assaf, 2008, Empirical evidence of risk shifting in financially distressed firms, *Journal of Finance* 63, 609–637.

Elton, Edwin J., Martin J. Gruber, Deepak Agrawal, and Christopher Mann, 2001, Explaining the rate spread on corporate bonds, *Journal of Finance* 56, 247–277.

Faulkender, Michael, 2005, Hedging or market timing? Selecting the interest rate exposure of corporate debt, *Journal of Finance* 60, 931–962.

Financial Accounting Standards Board, 1994, Disclosure about derivative financial instruments and fair value of financial instruments, Statement No. 119.

Financial Accounting Standards Board, 1998, Accounting for derivative instruments and hedging activities, Statement No. 133.

Géczy, Christopher, Bernadette A. Minton, and Catherine Schrand, 1997, Why firms use currency derivatives, *Journal of Finance* 52, 323–354.

Graham, John R., and Daniel A. Rogers, 2002, Do firms hedge in response to tax incentives? *Journal of Finance* 57, 815–839.

Graham, John R., and Clifford W. Smith, 1999, Tax incentives to hedge, *Journal of Finance* 54, 2241–2262.

Graham, John R., Si Li, and Jiaping Qiu, 2008, Corporate misreporting and bank loan contracting, *Journal of Financial Economics* 89, 44–61.

Green, Richard C., and Eli Talmor, 1985, The structure and incentive effects of corporate tax liabilities, *Journal of Finance* 40, 1095–1114.

Haushalter, G. David, 2000, Financing policy, basis risk, and corporate hedging: Evidence from oil and gas producers, *Journal of Finance* 55, 107–152.

Hull, John, 2008, *Options, Futures, and Other Derivatives* (Prentice Hall), 7th Edition.

Ivashina, Victoria, 2009, Asymmetric information effects on loan spreads, *Journal of Financial Economics* 92, 300–319.

Jensen, Michael, and William Meckling, 1976, Theory of the firm: Managerial behavior, agency costs, and capital structure, *Journal of Financial Economics* 3, 305–360.

Jin, Yanbo, and Philippe Jorion, 2006, Firm value and hedging: Evidence from U.S. oil and gas producers, *Journal of Finance* 66, 893-919.

Johnson, Shane A., 2003, Debt maturity and the effects of growth opportunities and liquidity risk on leverage, *Review of Financial Studies* 16, 209–236.

Kaplan, Steven N., and Luigi Zingales, 1997, Do investment-cash flow sensitivities provide useful measures of financing constraints? *Quarterly Journal of Economics* 112, 169–215.

Lin, Chen-Miao, Richard D. Phillips, Stephen D. Smith, 2008, Hedging, financing and investment decisions: Theory and empirical tests, *Journal of Banking and Finance* 32, 1566–1582.

Merton, Robert C., 1974, On the pricing of corporate debt: The risk structure of interest rates, *Journal of Finance* 29, 449–470.

Nance, Deana R., Clifford W. Smith, Jr., and Charles W. Smithson, 1993, On the determinants of corporate hedging, *Journal of Finance* 48, 267–284.

Nini, Greg., David C. Smith, and Amir Sufi, 2009, Creditor control rights and firm investment policy, *Journal of Financial Economics* 92, 400–420.

Petersen, Mitchell A., and S. Ramu Thiagarajan, 2000, Risk measurement and hedging: With and without derivatives, *Financial Management* 29, 5-30.

Purnanandam, Amiyatosh, 2008, Financial distress and corporate risk management: Theory and evidence, *Journal of Financial Economics* 87, 706–739.

Shea, John, 1997, Instrument relevance in multivariate linear models: A simple measure, *Review of Economics and Statistics* 79, 348–352.

Smith, Clifford W., and René M. Stulz, 1985, The determinants of firms' hedging policies, *Journal of Financial and Quantitative Analysis* 20, 391–405.

Stein, Jeremy C., 2003, Agency, information and corporate investment, in George Constantinides, Milt Harris and René M. Stulz, eds.: *Handbook of the Economics of Finance* (Elsevier North-Holland), 111–165.

Stulz, René M., 1996, Rethinking risk management, *Journal of Applied Corporate Finance* 9, 8–24.

Tufano, Peter, 1996, Who manages risk? An empirical examination of risk management practices in the gold mining industry, *Journal of Finance* 51, 1097–1137.

Table I. Summary Statistics

Panel A: Full sample summary statistics	Obs.	Mean	Std. Dev.	p25	p50	p75
Firm hedging information						
IR hedging dummy	2,718	0.356	0.479	0	0	1
IR hedging (for hedgers)	869	0.138	0.124	0.044	0.107	0.201
FX hedging dummy	2,718	0.273	0.446	0	0	1
FX hedging (for hedgers)	602	0.075	0.105	0.011	0.037	0.091
IR/FX hedging dummy	2,718	0.501	0.500	0	1	1
IR/FX hedging (for hedgers)	1,143	0.140	0.142	0.040	0.100	0.196
Net IR/FX hedging	886	0.133	0.131	0.039	0.093	0.185
Firm characteristics						
Firm's previous loans	2,718	1.547	0.866	1.099	1.609	2.197
Log assets	2,718	6.538	1.617	5.324	6.521	7.579
Profitability	2,718	0.136	0.101	0.089	0.131	0.181
Tangibility	2,718	0.333	0.230	0.151	0.274	0.466
Cash flow volatility	2,711	0.759	1.865	0.076	0.148	0.342
M/B	2,718	0.825	1.039	0.142	0.484	1.015
Leverage	2,718	0.295	0.245	0.126	0.259	0.415
Z-score	2,718	1.861	1.220	1.070	1.835	2.543
Distance-to-default	2,718	2.464	2.079	0.984	1.861	3.308
Asset volatility	2,718	0.452	0.375	0.227	0.374	0.574
Covenant restrictions on CAPEX	2,429	0.373	0.483	0	0	1
Investment/lagged assets	2,449	0.077	0.087	0.030	0.052	0.089
Syndicated loan characteristics						
Log loan spread (all-in-drawn)	2,718	4.939	0.824	4.382	5.165	5.570
Loan spread (all-in-drawn)	2,718	188.602	157.722	80.000	175.000	262.500
Cost of debt	1,482	131.563	110.803	49.987	99.008	187.276
Log loan size ($M)	2,718	4.697	1.501	3.807	4.828	5.704
Loan size ($M)	2,718	291.566	712.596	45	125	300
Log maturity (days)	2,679	6.995	0.720	6.579	7.065	7.496
Maturity (days)	2,679	1,344.697	747.454	720	1,170	1,800
Performance pricing	2,718	0.731	0.444	0	1	1
Term loan	2,718	0.381	0.486	0	0	1
Working capital/ corporate purposes	2,718	0.264	0.441	0	0	1
Refinancing	2,718	0.360	0.480	0	0	1
Acquisitions	2,718	0.250	0.433	0	0	1
Backup line	2,718	0.105	0.307	0	0	0
Other	2,718	0.027	0.163	0	0	0
Macro controls						
Credit spreads	2,718	0.841	0.245	0.630	0.790	0.910
Term spreads	2,718	0.913	0.985	0.210	0.590	1.610

Panel B: Non–hedgers vs. hedgers	(1)	(2)	(3)
Variable	Non-hedgers	Hedgers	Diff:(1)–(2)
Loan spread	201.724	170.521	31.203***
Covenant restrictions on CAPEX	0.413	0.329	0.084***
Investment/lagged assets	0.074	0.081	-0.007**
Log assets	6.058	7.174	-1.116***
Tangibility	0.326	0.344	-0.017*
M/B	0.819	0.826	-0.006
Leverage	0.274	0.323	-0.049***
Z-score	1.825	1.919	-0.094**
Cash flow volatility	0.897	0.560	0.337***
Asset volatility	0.491	0.398	0.092***
Log loan size ($M)	4.312	5.211	-0.900***
Log maturity (days)	6.992	6.997	-0.004
Cost of debt	137.980	126.093	11.887**

Notes: The summary statistics are based on the sample used in regression analyses.
***, ** and * denote statistical significance of the t-tests at the 1%, 5%, and 10% levels, respectively

Table II. Hedging and Loan Spreads

	(1)	(2)	(3)	(4)
IR/FX hedging	-1.639***	-2.021***	-2.028***	-1.743***
	(0.375)	(0.315)	(0.343)	(0.281)
IR/FX hedging × Z-score			0.496***	
			(0.165)	
IR/FX hedging × M/B				-0.407***
				(0.114)
Firm's previous loans	-0.067**	-0.056*	-0.052*	-0.051**
	(0.033)	(0.030)	(0.031)	(0.024)
Log asset	-0.132*	-0.133*	-0.138**	-0.135
	(0.077)	(0.076)	(0.070)	(0.084)
Profitability	-0.602**	-0.535*	-0.573	-0.548**
	(0.246)	(0.297)	(0.378)	(0.266)
Tangibility	-0.121	-0.122**	-0.131	-0.141**
	(0.094)	(0.053)	(0.089)	(0.068)
Cash flow volatility	0.004	0.004	0.003	0.002
	(0.010)	(0.014)	(0.007)	(0.008)
M/B	-0.121***	-0.124***	-0.129***	-0.081**
	(0.038)	(0.039)	(0.030)	(0.038)
Leverage	0.342*	0.363**	0.318*	0.334
	(0.183)	(0.178)	(0.174)	(0.267)
Z-score	-0.105**	-0.098***	-0.099**	-0.107***
	(0.049)	(0.032)	(0.045)	(0.022)
Asset volatility	0.263***	0.374***	0.330***	0.373***
	(0.078)	(0.101)	(0.089)	(0.093)
Log loan size	-0.062	-0.057	-0.065*	-0.060
	(0.046)	(0.036)	(0.038)	(0.037)
Log maturity (in days)	0.132	0.167	0.176*	0.172
	(0.084)	(0.123)	(0.099)	(0.244)
Credit spread	0.382*	0.471*	0.442**	0.497**
	(0.218)	(0.260)	(0.174)	(0.235)
Term spread	-0.039	-0.042	-0.048	-0.044
	(0.032)	(0.036)	(0.033)	(0.035)
Credit rating dummies	Yes	Yes	Yes	Yes
Performance pricing	Yes	Yes	Yes	Yes
Loan type	Yes	Yes	Yes	Yes
Loan purpose	Yes	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes	Yes
Observations	2,464	2,267	2,267	2,267
Shea's partial R^2 (hedging term)	n.a.	0.129	0.138	0.131
Shea's partial R^2 (interaction term)	n.a.	n.a.	0.149	0.173
1st-stage F-test (p-value)	n.a.	0.000	0.000	0.000
Adjusted R^2 (2nd-stage)	0.512	0.576	0.578	0.581

Notes: The dependent variable is log of loan spread. In column (1), results are estimated via OLS. In columns (2) to (4), results are obtained from IV estimations. The instrumental variable for hedging is a firm's tax convexity (Graham and Smith (1999)). Shea (1997)'s partial R^2 is a measure of IV relevance. 1st-stage F-test is the test of excluded IV in the 1st-stage regression. IR/FX hedging is the total amount of interest rate and currency hedging scaled by assets. All variable definitions are reported in Appendix II. Heteroskedasticity-consistent standard errors clustered at the firm level are reported in parentheses. *, **, and *** represent statistical significance at the 10%, 5%, and 1% level, respectively.

Table III. Hedging and Capital Expenditure Covenant Restrictions

	(1)	(2)	(3)
IR/FX hedging	-1.471***	-1.738***	-1.507***
	(0.278)	(0.307)	(0.300)
IR/FX hedging × Z-score		0.603***	
		(0.123)	
IR/FX hedging × M/B			-0.362***
			(0.071)
Firm's previous loans	-0.022	-0.027**	-0.026*
	(0.014)	(0.012)	(0.014)
Log asset	-0.209**	-0.216**	-0.212**
	(0.095)	(0.096)	(0.091)
Profitability	-0.206*	-0.223	-0.211**
	(0.119)	(0.179)	(0.103)
Tangibility	-0.104*	-0.106**	-0.098
	(0.058)	(0.051)	(0.067)
Cash flow volatility	0.003	0.003	0.004
	(0.004)	(0.004)	(0.007)
M/B	-0.104***	-0.110***	-0.113***
	(0.027)	(0.030)	(0.031)
Leverage	0.143*	0.243**	0.154*
	(0.085)	(0.115)	(0.080)
Z-score	-0.135***	-0.127**	-0.132***
	(0.038)	(0.050)	(0.044)
Asset volatility	0.195**	0.175**	0.194**
	(0.090)	(0.085)	(0.086)
Log loan size	0.025*	0.035*	0.034**
	(0.013)	(0.020)	(0.014)
Log maturity (in days)	0.183*	0.181*	0.184**
	(0.098)	(0.097)	(0.088)
Credit spread	0.223**	0.197*	0.189
	(0.104)	(0.113)	(0.146)
Term spread	-0.038*	-0.017	-0.027
	(0.022)	(0.014)	(0.023)
Credit rating dummies	Yes	Yes	Yes
Performance pricing	Yes	Yes	Yes
Loan type	Yes	Yes	Yes
Loan purpose	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes
Observations	2,235	2,235	2,235
Pseudo R^2	0.253	0.258	0.257

Notes: The dependent variable is a dummy that is one if there is covenant restriction on capital expenditure, otherwise it is zero. The results are obtained from probit-IV estimations. The instrument for hedging is a firm's tax convexity. IR/FX hedging is the total amount of interest rate and currency hedging scaled by assets. All variable definitions are reported Appendix II. The table reports the marginal effects that are evaluated at the means of continous independent variables. Heteroskedasticity-consistent standard errors clustered at the firm level are reported in parentheses. *, **, and *** represent statistical significance at the 10%, 5%, and 1% level, respectively.

Table IV. Investment Equations

	(1)	(2)	(3)
IR/FX hedging	0.0711***	0.0652***	0.0782***
	(0.0201)	(0.0250)	(0.0240)
IR/FX hedging × Z-score		-0.0223***	
		(0.0041)	
IR/FX hedging × M/B			0.0230***
			(0.0053)
Firm's previous loans	0.0021	0.0033**	0.0022*
	(0.0022)	(0.0014)	(0.0011)
Log asset	0.0011	0.0008*	0.0010**
	(0.0007)	(0.0005)	(0.0005)
Profitability	0.0010*	0.0006	0.0011**
	(0.0005)	(0.0004)	(0.0005)
Cash flow volatility	-0.0016	-0.0017	-0.0015
	(0.0027)	(0.0021)	(0.0026)
M/B	0.0262***	0.0170**	0.0268***
	(0.0100)	(0.0081)	(0.0091)
Leverage	-0.0025	-0.0027	-0.0031**
	(0.0025)	(0.0018)	(0.0015)
Z-score	0.0047**	0.0060***	0.0050**
	(0.0021)	(0.0018)	(0.0023)
Asset volatility	-0.0121**	-0.0106**	-0.0105**
	(0.0056)	(0.0051)	(0.0050)
Log loan size	0.0015	0.0014**	0.0016
	(0.0010)	(0.0006)	(0.0013)
Log maturity (in days)	0.0035**	0.0035	0.0031*
	(0.0014)	(0.0024)	(0.0018)
Credit spread	-0.0191*	-0.0161	-0.0286**
	(0.0111)	(0.0189)	(0.0133)
Term spread	0.0061	0.0068*	0.0051
	(0.0043)	(0.0038)	(0.0043)
Credit rating dummies	Yes	Yes	Yes
Performance pricing	Yes	Yes	Yes
Loan type	Yes	Yes	Yes
Loan purpose	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes
Observations	2,267	2,267	2,267
Adjusted R^2	0.332	0.334	0.331

Notes: The dependent variable is capital expenditure divided by lagged total assets. The results are obtained from IV estimations. The instrument for hedging is a firm's tax convexity. IR/FX hedging is the total amount of interest rate and currency hedging scaled by assets. All variable definitions are reported in Appendix II. Heteroskedasticity-consistent standard errors clustered at the firm level are reported in parentheses. *, **, and *** represent statistical significance at the 10%, 5%, and 1% level, respectively.

Table V. Robustness Tests

	(1)	(2)	(3)	(4)	(5)
Net IR/FX hedging	-1.737***				
	(0.385)				
IR/FX hedging		-1.542***	-1.177***	-1.471***	-1.171***
		(0.269)	(0.394)	(0.544)	(0.372)
Firm's previous loans	-0.059*	-0.073**	-0.051**	-0.070**	-0.078**
	(0.032)	(0.033)	(0.025)	(0.031)	(0.033)
Log asset	-0.127*	-0.139**	-0.108*	-0.157*	-0.150**
	(0.073)	(0.064)	(0.060)	(0.093)	(0.067)
Profitability	-0.520**	-0.692**	-0.401*	-0.692**	-0.559*
	(0.227)	(0.297)	(0.218)	(0.304)	(0.306)
Tangibility	-0.112	-0.137	-0.105	-0.142*	-0.150*
	(0.104)	(0.091)	(0.117)	(0.081)	(0.089)
Cash flow volatility	0.001	0.002	0.001	0.002	0.003
	(0.010)	(0.014)	(0.011)	(0.007)	(0.007)
M/B	-0.103**	-0.110***	-0.117**	-0.125***	-0.142**
	(0.046)	(0.035)	(0.050)	(0.044)	(0.056)
Leverage	0.302	0.383**	0.257	0.345*	0.327*
	(0.196)	(0.177)	(0.173)	(0.200)	(0.183)
Z-score	-0.124**		-0.096**	-0.126**	-0.111**
	(0.050)		(0.043)	(0.056)	(0.050)
Distance-to-default		-0.076***			
		(0.022)			
Asset volatility	0.210***	0.102	0.262**	0.225***	0.212***
	(0.042)	(0.247)	(0.119)	(0.036)	(0.038)
Log loan size	-0.062	-0.056	-0.03	-0.063	-0.066
	(0.044)	(0.039)	(0.027)	(0.053)	(0.053)
Log maturity (in days)	0.144	0.154	0.118	0.165	0.194
	(0.098)	(0.101)	(0.100)	(0.124)	(0.166)
Credit spread	0.377**	0.384**	0.450**	0.374*	0.381*
	(0.177)	(0.183)	(0.184)	(0.218)	(0.213)
Term spread	-0.042	-0.075	-0.036	-0.043	-0.057
	(0.031)	(0.049)	(0.049)	(0.034)	(0.040)
Credit rating dummies	Yes	Yes	No	Yes	Yes
Performance pricing	Yes	Yes	Yes	Yes	Yes
Loan type	Yes	Yes	Yes	Yes	Yes
Loan purpose	Yes	Yes	Yes	Yes	Yes
Industry effect	Yes	Yes	No	Yes	Yes
Firm effect	No	No	Yes	No	No
Observations	2211	2464	2038	2464	1860
Adjusted R^2	0.554	0.56	0.522	0.37	0.576

Notes: The dependent variable is log of loan spread. In columns (1) and (2), the estimations are via OLS. Column (3) is a firm-fixed effect estimation. Column (4) is a median regression with pseudo-R^2 reported. Column (5) is the deal-level OLS regression. Net IR/FX hedging is net interest rate and net currency hedging scaled by assets. IR/FX hedging is the total amount of interest rate and currency hedging scaled by assets. All variable definitions are reported in Appendix II. Heteroskedasticity-consistent standard errors clustered at the firm level are reported in parentheses. *, **, and *** represent statistical significance at the 10%, 5%, and 1% level, respectively.

Table VI. Hedging and the Cost of Debt

	(1)	(2)	(3)
IR/FX hedging	-1.920***	-1.960***	-1.706***
	(0.305)	(0.324)	(0.264)
IR/FX hedging × Z-score		0.476***	
		(0.152)	
IR/FX hedging × M/B			-0.394***
			(0.110)
Firm's previous loans	-0.044*	-0.042*	-0.040**
	(0.026)	(0.025)	(0.017)
Log asset	-0.127	-0.131**	-0.124
	(0.078)	(0.060)	(0.086)
Profitability	-0.493	-0.532	-0.512**
	(0.321)	(0.397)	(0.246)
Tangibility	-0.106**	-0.116*	-0.111*
	(0.048)	(0.066)	(0.062)
Cash flow volatility	0.003	0.003	0.004
	(0.015)	(0.003)	(0.009)
M/B	-0.098***	-0.101***	-0.064*
	(0.029)	(0.026)	(0.038)
Leverage	0.348**	0.250	0.318
	(0.161)	(0.153)	(0.249)
Z-score	-0.090***	-0.090**	-0.096***
	(0.031)	(0.043)	(0.026)
Asset volatility	0.329***	0.322***	0.355***
	(0.082)	(0.072)	(0.076)
Log loan size	-0.053	-0.061*	-0.060*
	(0.035)	(0.036)	(0.036)
Log maturity (in days)	0.135	0.150*	0.162
	(0.120)	(0.079)	(0.198)
Credit spread	0.379	0.332	0.428**
	(0.243)	(0.256)	(0.215)
Term spread	-0.035	-0.04	-0.036
	(0.029)	(0.028)	(0.027)
Credit rating dummies	Yes	Yes	Yes
Performance pricing	Yes	Yes	Yes
Loan type	Yes	Yes	Yes
Loan purpose	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes
Observations	1,455	1,455	1,455
Adjusted R^2	0.484	0.486	0.489

Notes: The dependent variable is log of cost of debt (Cooper and Davydenko (2007)). The results are obtained from IV estimations. The instrument for hedging is a firm's tax convexity. IR/FX hedging is the total amount of interest rate and currency hedging scaled by assets. All variable definitions are reported in Appendix II. Heteroskedasticity-consistent standard errors clustered at the firm level are reported in parentheses. *, **, and *** represent statistical significance at the 10%, 5%, and 1% level, respectively.