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Bank borrowing and corporate risk management

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ABSTRACT

We examine whether banks better protect themselves against risk-shifting as compared to non-bank lenders by comparing risk management polices across firms that borrow from different lenders using a unique, hand-collected data set of hedging and borrowing practices. Consistent with banks being effective monitors, we find hedging is positively associated with the proportion of bank debt amongst firms with large risk-shifting incentives. We present descriptive evidence showing that banks use covenants as one of the channels to mitigate risk-shifting.

1. Introduction

Debt financing engenders the agency problem of risk-shifting, as shown by Jensen and Meckling, 1976. Once debt is issued, equity holders have a payout similar to a call option on the firm's assets, giving them incentives to unduly increase firm risk to expropriate wealth from debt holders.

We examine whether expropriation of debt holders through risk-shifting systematically differs across different types of lenders. Financial intermediation theory suggests that banks have a comparative advantage over other lenders in preventing expropriation by their borrower. (See Diamond, 1991;

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Rajan, 1992.) Bank debt ownership is concentrated, making monitoring economically feasible.[2] A bank typically also provides investment and commercial banking services to its lenders, allowing the bank to collect lots of additional information about its borrowers operations. Therefore, a bank can potentially monitor its borrowers' activities much more effectively than other lenders.

Whether banks do in fact manage the risks of their borrowers more aggressively as compared to non-bank lenders is an empirical question, and we address it in this paper. We examine how firms that borrow from banks hedge their risks as compared to non-bank borrowers. We conduct our analysis using a unique hand-collected data set of hedging and borrowing practices for a sample of firms in the oil and gas exploration and production industry. This industry is particularly suitable for our analysis for several reasons. First, these firms have significant exposure to commodity price volatility and hedging this risk can reduce the likelihood of default. Second, firms in this industry raise debt from different sources, providing sufficient cross-sectional variation for identification in our econometric analysis. Restricting the sample to a single industry also eliminates the substantial variation in financial policies driven by cross-industry effects, albeit at the expense of a smaller sample.

Our main finding is that banks are more effective than other lenders in protecting themselves against risk-shifting. Among firms with large risk-shifting incentives, bank borrowers hedge a greater proportion of their exposure to commodity price volatility as compared to non-bank borrowers. Banks use hedging covenants as a channel for risk-mitigation, with explicit requirements for hedging being more common for larger loans. We also find that high insider ownership mitigates risk-shifting, possibly because the risk-aversion of undiversified managers aligns their risk-taking incentives with that of the debt holders.[3] This internal governance mechanism complements external supervision by a bank.

By demonstrating how the source of debt influences a firm's hedging behavior, this paper contributes to two areas of financial economics. First, it contributes to the financial intermediation literature by identifying a specific mechanism through which bank monitoring mitigates risk-shifting problems, namely, requiring borrowers to reduce exposure to market risks. Second, it improves our understanding of why firms hedge by documenting the role of institutional lenders on a firm's risk management decisions – a class of agents that have been ignored by the existing literature on corporate risk management. To our knowledge, we are the first to examine the role of *debt* ownership on hedging policy; the previous literature focuses on the *level* of debt and the nature of *equity* ownership on a firm's hedging policy. Our findings also offer a possible explanation for the puzzling variation in the association between hedging and leverage documented across different studies. Some studies suggest that hedging and leverage are positively related whereas others suggest they are unrelated. With the notable exception of Purnanandam (2008) and Nain (2005), hedging has been modeled as a linear function of leverage, which necessarily limits the relationship to be monotone. Our results suggest that the hedging-leverage relation will be monotone only if firms are financed with bank debt, but distinctly non-monotone if firms use non-bank debt. Hence, the linear specification used in earlier studies will systematically detect an association in samples where banks are a significant source of debt financing and fail to detect one in samples where non-banks are the primary source of debt financing.

The rest of the paper is organized as follows: Section 2 reviews the literature. Section 3 discusses the hypothesis and the data set. Section 4 describes the econometric specification. The main result is presented in Section 5. Robustness tests to address a series of potential concerns including endogeneity of the choice of leverage and source of debt is presented in Section 6. The role of insider ownership in mitigating the risk-shifting problem is analyzed in Section 7. Descriptive evidence on hedging covenants is presented in Section 8. Finally, Section 9 concludes.

2. Literature review

This paper is related to the risk management literature analyzing agency and leverage motivations for hedging, and the financial intermediation literature analyzing how bank borrowing mitigates agency conflicts.

[2] In contrast, public debt ownership is typically very diffuse, making monitoring difficult to coordinate and prohibitively costly for an individual bond holder.

[3] The incentives of managers to alter firm risk is discussed in greater detail in Section 7.

Stulz (1984), Smith and Stulz (1985) and Stulz (1996) argue that leverage motivates firms to hedge in order to reduce bankruptcy and financial distress costs.[4] In contrast, Jensen and Meckling (1976) argue that leverage motivates firms to speculate. In a levered firm, equity is a convex claim on the firm's assets because shareholders now have the option to declare bankruptcy. Given ambiguous theoretical predictions, the association between hedging and leverage, and the role of different stakeholders in setting the firm's risk management policy is an empirical issue. The empirical evidence on the hedging-leverage relationship is mixed. Haushalter (2000) and Nain (2005), among others, document a positive association between hedging and leverage. However, other scholars find conflicting evidence. In a sample of international firms, Bartram et al. (2003) find that leverage and hedging are positively correlated only in certain countries. Adam and Fernando (2006) document a positive, negative or insignificant relationship depending on the hedging horizon considered. Using a non-linear specification, Purnanandam (2008) documents a hump-shaped relationship between leverage and hedging, consistent with equity holders maximizing their wealth by either decreasing or increasing firm risk depending on whether the option to default is "in the money." Morellec and Smith (2007) examine risk-shifting versus risk-management incentives for shareholders in a framework that considers the agency conflicts between shareholders and debt holders and between shareholders and managers. In their setup, hedging is motivated by shareholders to smooth cash flows to reduce over and under investment costs. Our work focuses on hedging motivated by debt holders, specifically, banks, to protect themselves against losses in bankruptcy. Another recent paper that examines risk-shifting versus risk-taking incentives is Rauh (2008) who examines risk-taking in the context of defined benefit pension plans.

Stulz (1984) and Smith and Stulz (1985) also suggest agency motivations for hedging. They argue that managers hedge or speculate on the firm's account to maximize their own wealth. Consistent with this hypothesis, Knopf et al. (2000) and Graham and Rogers (2002) document that hedging is positively associated with the delta of the manager's portfolio with respect to the company's stock and negatively associated with its Vega. However, Haushalter (2000) finds weak contrary evidence.

As this survey suggests, the existing literature has focused on share holder and managerial motives for hedging. However, the influence of different debt holders on hedging policy has not been examined. We extend the literature by examining whether bank monitoring measurably affects a firm's risk management policy. To our knowledge, we are the first to examine whether the *source* of *debt* has an economically significant impact on a firm's hedging policy.

We also extend the financial intermediation literature by documenting *how* banks are special. Diamond (1991), Rajan (1992), Berlin and Loeys (1988) motivate *why* banks are special by arguing that bank monitoring mitigates agency problems between debt and equity holders. Denis and Mihov (2003), Cantillo and Wright (2000) and Johnson (1997) empirically examine the determinants of the financing decision of bank versus non-bank debt.[5] In contrast, our paper focuses on examining whether bank monitoring does indeed mitigate risk-shifting.

3. Hypothesis development and data

Our central hypothesis is that the extent of risk-shifting will be lesser for firms with bank versus non-bank debt.

We test this hypothesis by estimating a model for the hedging decision of a firm using a data set of hedging and financing practices of firms in the oil and gas exploration and production sector. We interpret reduction in hedging as an indication of risk-shifting. Details of the data set and construction of the dependent and explanatory variables is described below.

[4] In turn, the literature suggests several possible motives for increasing leverage. Acting in the interests of shareholders, managers increase to reduce tax liabilities. Or, if debt financing is cheaper than equity financing, as posited by the pecking order theory of capital structure, leverage reduces the overall cost of capital. Alternately, in the spirit of Tufano (1998), managers might hedge to increase debt capacity for personal gain. For instance, managers might issue debt to fund their pet projects. Since suppliers of debt financing are primarily concerned about bankruptcy risk rather than the upside potential of the investment opportunity, managers may find it easier to raise debt versus equity to fund such projects. See also Ross (1997) and Leland (1998). Some of the financial distress costs identified in the literature include: forgone investment opportunities, restrictions placed on the firm's operations by its lenders, and time spent by managers in renegotiating debt contracts with its lenders.

[5] Additional related papers include Kang et al. (2000), Gilson et al. (1990) and Chemmanur and Fulghieri (1994).

Table 1
Summary statistics.

Variable	*N*	Mean	Std Dev	5th %ile	Median	95th %ile
Production hedged	146	0.297	0.253	0.000	0.245	0.760
Total assets	146	1031	1833	55	322	5503
Debt-to-assets	146	0.372	0.230	0.000	0.362	0.760
Cash-to-assets	146	0.050	0.062	0.002	0.025	0.187
Capital expenses-to-assets	146	0.216	0.131	0.052	0.196	0.453
Dividend dummy	146	0.185	0.390	0.000	0.000	1.000
KZ index	146	1.054	1.491	−0.561	0.985	2.951
XINSIDER	146	0.062	0.106	0.000	0.014	0.370
Bank-to-total-debt (ϕ)	146	0.497	0.406	0.000	0.489	1.000

This table provides descriptive statistics of firms in the sample. *Production hedged* is the fraction of next year's production hedged against low commodity prices. *Total assets* is the book value of the firm in millions of dollars. *Debt-to-assets* is book value of long-term debt, scaled by total assets. *Cash-to-assets* is the cash and cash equivalents held by the firm, scaled by total assets. *Capital expenses-to-assets* is the capital expenditure scaled by book value of total assets. *Dividend dummy* equals one if the firm issues common dividends. *KZ index* is the modified Kaplan–Zingales index, calculated according to Baker et al. (2003). *XINSIDER* is fraction of common shares held by managers. *Bank-to-total-debt* is the fraction of the total long-term debt held by a bank. For firm-years with zero long-term debt, this ratio is set to zero.

We begin our sample formation by selecting all firms in the oil and gas exploration and production (E&P) industry in the 1999 and 2000 annual COMPUSTAT files, based on their 4-digit SIC code of 1311. To facilitate data collection, we limit our sample to firms that have their 10-Ks available electronically at the SEC EDGAR database. After an initial screening, we further limit the sample to firms that have total assets greater than $20 million and are incorporated in the US, Canada or the Cayman Islands; data required for our analysis is typically not reported for smaller firms and those incorporated elsewhere.[6] Finally, to ensure that commodity price volatility is a uniformly large risk for all firms in the sample, we only include firm-years where revenues from hydrocarbon production constitute at least 80% of total revenues.[7] Our final sample consists of 146 firm-years and is comparable in size to samples used for other single-industry studies on hedging policy. For example, Carter et al. (2006) use a sample of 154 observations from the airline industry, and Tufano (1996) uses a sample of 108 firm-years from the gold mining industry.

We read through the 1999 and 2000 annual reports to hand-collect information on hedge positions, source of debt and on pertinent operations data such as production levels and oil and natural gas reserves. The vast majority of hedging in our sample is done using conventional derivative contracts, such as forwards, puts or collars. Some firms also hedge using bilateral fixed price sales contracts. We obtain firm ownership data from the proxy statements. The balance of the required data is from the annual COMPUSTAT database.

The summary statistics for the data is shown in Table 1. Despite using a single-industry sample, there is considerable variation in both, hedging policy and fraction debt that is bank debt. Both variables vary between 0 and 100%, and fewer than 10% of firm-years have no debt, suggesting that this data set is suitable to test our hypothesis.[8] The hedging intensity in our sample is comparable to that reported for other studies. For example, the median fraction of production hedged in the sample of gold mining firms used in Adam and Fernando (2006) is 0.38 versus 0.25 in our sample. The intensity of bank borrowing in our single-industry sample seems to be representative of economy-wide practice. Cantillo and Wright (2000) document a mean private-to-total-debt ratio of 0.77 in a broad sample, which is consistent with a mean bank-to-total-debt ratio of 0.50 for our sample.[9]

[6] The vast majority of our sample consists of US firms. Our results are qualitatively similar if the non-US firms are dropped.
[7] We repeated our analysis using 70% and 100% as the cutoff. Our main findings are unaltered.
[8] The 95th percentile value for the fraction of production hedged is reported in Table 1. The maximum value in the sample is 100%.
[9] Note that private debt is bank debt plus private non-bank borrowing.

4. Model estimation

We test our hypothesis by estimating a model of the form:

$$XHEDGE = \beta_0 + \beta_{RSI\phi} * RSI\phi + \beta_{RSI} * RSI + \beta_{\phi} * \phi + \beta_X * X + \varepsilon \quad (1)$$

where *XHEDGE* is the fraction of next year's production hedged, *RSI* the proxy for risk-shifting incentives, ϕ the ratio of bank to total debt, and *X* is a set of controls that have typically been used in the hedging literature to model a firm's hedging decision. Since our dependent variable is censored at zero, we estimate Eq. (1) using a Tobit model. Additional details on construction of the variables is given below.

4.1. Dependent variable – extent of commodity price risk hedged

Our firms are naturally long commodity price volatility because of their operations.[10] Our dependent variable measures the degree of reduction of exposure to this risk. Hedging, denoted by *XHEDGE*, is defined as: the quantity of next year's production hedged against a fall in commodity prices, divided by the expected production for the next year. The quantity hedged is the sum of the net notional amounts of the various derivatives contracts used for hedging, such as forwards, collars or options, plus the quantities effectively hedged through long-term fixed price delivery contracts or advance sales.[11] The current year's production is used as the proxy for next year's production.[12] Several other papers that use commodity producing firms to examine risk management policies also define the hedging variable in a similar manner (see Haushalter, 2000; Tufano, 1996; Adam and Fernando, 2006, for example).[13]

4.2. Explanatory variables

We now describe how our proxies for risk-taking incentives and source of debt are constructed.

4.2.1. Risk-shifting incentives

As suggested by Jensen and Meckling (1976), highly levered firms have strong incentives to indulge in risk-shifting because the option to declare bankruptcy is valuable for equity holders of such firms. Accordingly, our proxy for risk-shifting incentives, denoted *RSI*, is based on whether the firm is highly levered or not. The main results are presented using a 0–1 dummy for the risk-shifting incentive proxy. The dummy equals unity if the leverage ratio is in the top decile of leverage for firms in our sample. (The 90th percentile value for leverage is 0.66 for our sample.) As a robustness check, alternate proxies are also employed. Following existing literature (see Tufano, 1996; Purnanandam, 2008) we define leverage, denoted D/A, as the ratio of book value of long-term debt to book value of total assets.

4.2.2. Risk-shifting by bank borrowers

To examine whether bank monitoring measurably impacts a firm's ability to act on its risk-shifting incentives, our main tests are based on the explanatory variable $RSI\phi$, which is the interaction of *RSI* with ϕ. Setting up the model with this interaction term as an explanatory variable provides a convenient way to examine whether the source of debt has an impact on a firm's hedging policy in a model that nests existing work as special cases.

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[10] The sample is described later in Section 3.

[11] Fixed-price delivery contracts are effectively forward contracts, and advance sales contracts are equivalent to a standard debt contract bundled with a forward contract.

[12] For the few firms that have experienced significant growth or contraction during the current year ($\pm$50% change in total assets), we scale the current year's total production by total assets to estimate the next year's production. Our implicit assumption is that total production is proportional to the firm's assets. For example, if a firm began the year with \$100MM in total assets, but then added on another \$50MM in assets on July 1, we would estimate the next year's production as: $\frac{\text{current years production}}{100*0.5+150**0.5} * 150$.

[13] Petersen and Thiagrajan (2000) describe some alternate proxies for a firm's hedging policy.

The benefit of constructing our proxy for the source of debt, ϕ, in the manner described above is that we are consistent with the existing empirical financial intermediation literature. However, the downside is that ϕ is economically meaningful only for firms with non-trivial amounts of debt.[14] However, this limitation has a negligible impact on our analysis because our main variable of interest, $RSI\phi$, is zero at low levels of debt regardless of the value of ϕ. As a robustness check, we repeat our main analysis after excluding observations with trivial leverage ratios.

4.3. Control variables

Risk management theories posits several motivations for hedging unrelated to the source of borrowing. We describe the control variables used for these motivations next. Our construction of control variables is broadly consistent with those used in the existing literature (see Haushalter, 2000; Purnanandam, 2008).

4.3.1. Financial distress

Several authors argue that firms hedge to avoid financial distress costs brought about by their debt servicing obligations. (See, for example, Smith and Stulz, 1985; Graham and Rogers, 2002.) Following the literature, we use leverage (D/A) to control for financial distress motivations.

4.3.2. Underinvestment costs

Froot et al. (1993) argue that firms hedge to reduce underinvestment costs. Since these costs depend on a firm's growth options, we include the ratio of capital expenses to total assets to control for growth options.

4.3.3. Liquidity considerations

Firms that are not financially constrained or have liquid assets have less of a need to smooth their cash flows via hedging. Therefore, such firms are expected to hedge less. We use a firm's cash holdings, normalized by total assets, as a proxy for liquid assets. To control for lack of financing constraints, we use a dummy that equals unity if the firm pays dividends on its common stock. As a robustness check, we also use the Kaplan–Zingales index as an alternate proxy for financing constraints.[15]

4.3.4. Managerial motivations

Smith and Stulz (1985), among others, argue that a firm's hedging policy also depends on the portfolio considerations of its managers. Managers with large stock holdings in their own firm hedge to reduce the risk of their undiversified portfolio. We control for managerial hedging motivations by including insider ownership as a control. This variable is defined as the fraction of common stock held by insiders.

Given the recent empirical findings by Cremers et al. (2007) between ownership structure and borrowing costs, in Section 7 we explore whether the potential channel through which insider ownership could reduce borrowing costs is by mitigating risk-shifting.

4.3.5. Scale

A firm's size might also affect its hedging policy. However, theory does not provide guidance regarding whether the association between hedging and firm size should be positive or negative. Economies of scale in setting up and managing a hedging program should provide larger firms a greater incentive to hedge. However, larger firms typically have easier access to external financing, reducing incentives to smooth cash flows through hedging. We use the log of total assets as a control for firm size effects.

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[14] For firms with zero debt, we set $\phi = 0$, a procedure that while admittedly somewhat ad-hoc does not affect our main results.

[15] Readers unfamiliar with this index may wish to refer to Kaplan and Zingales (1997) for additional details. The index ranks firms according to the degree to which they are likely to be financially constrained, with a larger value of the index being interpreted to mean that the firm is more constrained. The index is a linear combination of financial ratios such as cash flow, cash holdings, dividend yield, leverage and Tobin's Q. We use the modified Kaplan–Zingales index, calculated according to Baker et al. (2003).

4.3.6. Changes in macroeconomic conditions

We include year dummies to control for any changes in the macroeconomic environment.

5. Results

We expect that share holders act on their risk-shifting incentives by reducing their hedge positions, and anticipate β_{RSI} in Eq. (1) will be significantly negative. However, if bank monitoring mitigates risk-shifting, bank borrowers should not scale back their hedging activities as much as non-bank borrowers and we anticipate that $\beta_{RSI\phi}$ will be significantly positive.

Recall that we use $RSI\phi$ to proxy for firms with high risk-shifting incentives that also borrow primarily from banks. Ignoring terms independent of *RSI*, the level of hedging for a firm with high risk-shifting incentives and zero bank debt is β_{RSI}. In contrast, the level of hedging for a firm with high risk-shifting incentives that borrows exclusively from banks is $\beta_{RSI} + \beta_{RSI\phi}$. Therefore, $\beta_{RSI\phi}$ measures the difference in risk management practices among firms with high risk-shifting incentives when they borrow from banks versus non-banks.

The existing literature uses a model similar to that specified in Eq. (1) to estimate a firm's hedging policy, but without the $RSI\phi$ term. Hence, existing models are special cases of our model, where β_{RSI} is set to zero.

The results for estimating the model specified in Eq. (1) are shown in Table 2, with the regression coefficients reported as marginal effects.[16] All *p*-values reported in this paper are for a 2-sided test.

As seen in Table 2, β_{RSI} is significantly *negative* suggesting that share holders with strong risk-shifting incentives scale back their firm's hedging activity to increase firm risk and expropriate wealth from the debt holders. In contrast, $\beta_{RSI\phi}$ is significantly *positive*, suggesting that banks seem to mitigate risk-shifting. To our knowledge, this is the first paper to document that the source of debt has a significant effect on a firm's hedging policy.

We use bank debt share, ϕ, as opposed to simply the presence of bank debt to proxy for the monitoring role of the bank. We posit that banks weigh the costs of additional monitoring of a particular borrower against the magnitude of bankruptcy costs in deciding whether to require a firm to hedge. Given this trade-off, hedging is required only for firms where the bank's investment in the firm is significant, or where ϕ is large. The descriptive evidence on covenants, described later, is consistent with this supposition. Explicit requirements for hedging are more prevalent when banks finance a larger portion of the firm.

We test an alternate hypothesis would be that banks require firms to hedge whenever they lend to a firm, so that the mere presence as opposed to the quantity of bank debt determines a firm's hedging decision.[17] We perform this test by re-estimating Eq. (1), but restricting the sample to only include observations with a positive amount of bank debt. If the alternate explanation holds, then, the $RSI\phi$ term should no longer be significant in this restricted sample. In unreported results, we find that $RSI\phi$ remains significant, suggesting that it is the magnitude of the bank's exposure rather than simply the existence of a lending relationship that drives our results.

The economic impact of bank monitoring on a firm's risk management policy is significant. In our modeling framework, $\beta_{RSI\phi}$ measures the difference in hedging policy between two firms that have high risk-shifting incentives and are identical in all respects, except that one firm borrows exclusively from a bank and the other exclusively from a non-bank. Our results suggest that the exclusive bank borrower will hedge an additional 66% of its projected production for next year as compared to the exclusive non-bank borrower. In comparison, the median fraction of production hedged in our sample is 25%, suggesting that bank borrowing has an economically significant effect on a firm's hedging practices.

[16] The parameter estimates from a Tobit regression represent the marginal effect of each regressor on the *unobserved* dependent variable, Y^*. However, we are more interested in the marginal effect on the *observed* dependent variable, *Y*. We calculate the marginal effect of a change in the *k*th regressor as $\Phi(z)\beta_k$, where $\Phi(z)$ is the normal CDF evaluated at $z = \beta' X/\sigma$, where *X* is the means of the independent variables and β_k is the vector of coefficients. See Maddala (1983) for additional details.

[17] We thank an anonymous referee for suggesting these alternate explanations.

Table 2
Effect of bank debt on hedging.

Dependent variable: fraction of next year's production hedged Explanatory variables	Slope	p-value
$RSI\phi$	**0.658**	**0.001**
RSI	−0.335	0.008
Debt-to-assets	0.367	0.008
Log(total assets)	−0.054	0.022
Cash-to-assets	−1.424	0.002
Capital expenses-to-assets	0.408	0.015
Dividend dummy	0.002	0.971
$XINSIDER$	0.309	0.257
ϕ	−0.001	0.863
N	146	
Log likelihood	−14.0	
Pseudo-R^2	0.225	

This table shows results of estimating

$$XHEDGE = \beta_0 + \beta_{RSI\phi} * RSI\phi + \beta_{RSI} * RSI + \beta_\phi * \phi + \beta_X * X + \varepsilon$$

using a panel random effects Tobit regression. *XHEDGE* is the fraction of next year's production hedged, *RSI* is the proxy for risk-shifting incentives, ϕ is bank-to-total long term debt and X is a set of controls. See Table 1 for a description. The coefficients for the intercept and time dummy are not shown to conserve space. *Pseudo*$-R^2$ is calculated by regressing the actual fraction of production hedged on the estimated value from the Tobit model. The regression coefficients are reported as marginal effects. The p-values are reported for a two-sided test for all coefficients.

6. Robustness tests

We conduct a series of robustness tests to address a variety of potential concerns. Section 6.1 examines whether our results are robust to limiting the sample to observations with non-trivial leverage. Section 6.2 examines whether the results are robust to alternate proxies for the different regressors and Section 6.3 presents results for an alternate econometric specification. Section 6.4 examines whether our results are robust to the endogenous choice of leverage and source of borrowing.

6.1. Excluding observations with trivial leverage

As discussed in Section 4.2, the bank debt ratio, ϕ, is not economically meaningful when the total amount of long-term debt is trivial. To reassure ourselves that our results are not pathologically driven by observations with trivial levels of debt, we re-estimate the hedging model after restricting the sample to observations where $D/A \geqslant 0.05$. The estimation results are shown in Table 3. The results are qualitatively similar to the full-sample results, confirming that the results are not driven by observations with trivial leverage. In unreported results, we repeated our analysis while restricting the sample to $D/A \geqslant 0.1$ and $D/A \geqslant 0.2$. The results are qualitatively similar.

6.2. Alternate construction of explanatory and control variables

6.2.1. Alternate proxies for risk-shifting incentives

We re-estimate the hedging model using several different proxies for risk-shifting incentives to examine whether our results crucially depend on the particular choice of proxy. The estimation results are summarized in Table 4. The previously reported results using the 0–1 dummy for *RSI* are reproduced in Panel A to facilitate comparison. First, we use a 'hockey stick' function defined as: $(1/0.34) * \max[0, D/A - 0.66]$, where D/A is the debt-to-asset ratio and 0.66 is the 90th percentile value for D/A. We normalize by the factor of 0.34 so that this proxy equals unity when the D/A ratio equals unity. These results are reported in Panel B of Table 4. Next, we use $(D/A)^2$ as the proxy for

Table 3
Estimation excluding observations with trivial leverage.

Dependent variable: fraction of next year's production hedged		
Explanatory variable	Slope	p-value
$RSI\phi$	**0.681**	**0.001**
RSI	−0.317	0.013
Debt-to-assets	0.237	0.176
Log(total assets)	−0.078	0.002
Cash-to-assets	−1.756	0.001
Capital expenses-to-assets	0.333	0.070
Dividend dummy	0.006	0.925
XINSIDER	0.277	0.354
ϕ	−0.088	0.276
N	131	
Log likelihood	−9.3	
Pseudo-R^2	0.216	

This table shows results for estimating

$$XHEDGE = \beta_0 + \beta_{RSI\phi} * RSI\phi + \beta_{RSI} * RSI + \beta_\phi * \phi + \beta_X * X + \varepsilon$$

using a panel random effects Tobit regression. The sample is restricted to observations where $D/A \geqslant 0.05$. See Table 2 for a description of the variables. The coefficients for the intercept and time dummy are not shown to conserve space. $Pseudo{-}R^2$ is calculated by regressing the actual fraction of production hedged on the estimated value from the Tobit model. The regression coefficients are reported as marginal effects. The p-values are reported for a two-sided test for all coefficients.

Table 4
Alternate proxies for risk-shifting incentives.

Explanatory variables	Slope	p-value
Dependent variable: fraction of next year's production hedged		
	Panel A: $RSI = I_{D/A \geqslant 0.66}$	
$RSI\phi$	**0.658**	**0.001**
RSI	−0.335	0.008
	Panel B: $RSI = \frac{1}{0.34} * \max[0, D/A - 0.66]$	
$RSI\phi$	**1.995**	**0.002**
RSI	−0.581	0.000
	Panel C: $RSI = (D/A)^2$	
$RSI\phi$	**0.686**	**0.054**
RSI	−0.636	0.021

This table summarizes the results of estimating the hedging model using different proxies for risk-shifting incentives. Panel A uses the 0–1 dummy and reproduces results from Table 2. Panel B uses a 'hockey stick' function, while Panel C uses $RSI = (D/A)^2$. Only coefficients for RSI and $RSI\phi$ are reported. The p-values are reported for a two-sided test.

risk-shifting incentives, which is the proxy used in (Nain, 2005; Purnanandam, 2008). These results are reported in Panel C of Table 4.

As seen from Table 4, our findings are qualitatively unchanged, with $\beta_{RSI\phi}$ remaining significantly positive for all the proxies used.

6.2.2. *Alternate control variables*

In unreported regressions, we re-estimated the hedging model specified in Eq. (1) using different proxies for growth, financing constraints and financial distress. We used capital expenses scaled by sales (instead of assets) as the proxy for growth options and the Kaplan–Zingales index (instead of the dividends dummy) as the proxy for financing constraints.

Table 5
Explicit control for risk-shifting incentives for non-bank borrowers.

Dependent variable: fraction of next year's production hedged		
Explanatory variable	Slope	*p*-value
$(NB/A)^2$	**-0.650**	**0.027**
$(D/A)^2$	−0.064	0.864
Debt-to-assets	0.651	0.018
Log(total assets)	−0.051	0.017
Cash-to-assets	−1.259	0.006
Capital expenses-to-assets	0.373	0.025
Dividend dummy	0.007	0.920
XINSIDER	0.322	0.227
ϕ	−0.053	0.457
N	146	
Log likelihood	−14.2	
Pseudo-R^2	0.241	

This table shows results for estimating

$$XHEDGE = \beta_0 + \beta_{(NB/A)^2} * (NB/A)^2 + \beta_{(D/A)^2} * (D/A)^2 + \beta_\phi * \phi + \beta_X * X + \varepsilon$$

using a panel random effects Tobit regression. NB/A is the non-bank debt to asset ratio. See Table 2 for a description of the other variables. The coefficients for the intercept and time dummy are not shown to conserve space. $Pseudo{-}R^2$ is calculated by regressing the actual fraction of production hedged on the estimated value from the Tobit model. The regression coefficients are reported as marginal effects. All *p*-values are reported for a two-sided test.

6.3. Alternate econometric specification

Our main tests are performed using a proxy for risk-shifting incentives, and an interaction variable of the measure for risk-shifting incentives and fraction of bank debt. We specified our model in this manner so as to highlight the impact of bank monitoring on a firm's ability to act on its risk-shifting incentives. As a robustness test, we also test an alternate model where we explicitly include a proxy for risk-shifting incentives for firms that do *not* borrow from banks, and then examine whether the proxy for risk-shifting incentives for firms in general remains significant.[18]

Specifically, we now estimate a model of the form:

$$XHEDGE = \beta_0 + \beta_{(NB/A)^2} * (NB/A)^2 + \beta_{(D/A)^2} * (D/A)^2 + \beta_\phi * \phi + \beta_X * X + \varepsilon \tag{2}$$

where NB/A, is the ratio of non-bank debt to total assets, and $(NB/A)^2$ measures risk-shifting incentives for firms that borrow from non-banks. As before, $(D/A)^2$ measures risk-shifting incentives for firms in general, and X is a set of controls. We include ϕ as a control in order to be consistent with our earlier results; our results are essentially unchanged if ϕ is excluded. Recall that D/A is included in the set of controls. We anticipate that with the $(NB/A)^2$ term included in the model, the $(D/A)^2$ term will no longer be significant, while the $(NB/A)^2$ term will be negative and significant.

The estimation results for Eq. (2) are shown in Table 5. Consistent with our earlier results, now only the $(NB/A)^2$ term is significantly negative whereas the $(D/A)^2$ term is not. This result provides additional confirmation that only firms which borrow from non-banks act on their risk-shifting incentives.

6.4. Endogeneity

We interpret the significantly positive $\beta_{RSI\phi}$ in Eq. (1) as supportive of a causal link between bank monitoring and a reduction in the extent of opportunistic risk-shifting. Since the leverage, source of debt and extent of hedging are choice variables, a concern about our results is that they are simply an artifact of endogeneity. For instance, a variable omitted in the hedging model specification might be influencing the hedging decision as well as the leverage and bank/non-bank borrowing decisions.

[18] We thank an anonymous referee for suggesting this robustness test.

Table 6
Differences regression.

Explanatory variables	Slope	*p*-value
Intercept	0.329	0.814
RSIφ	**0.516**	**0.026**
RSI	−0.263	0.076
Debt-to-assets	0.428	0.037
Log(total assets)	0.184	0.069
Cash-to-assets	−2.010	0.000
Capital expenses-to-assets	0.315	0.163
N	69	
R^2	0.366	

This table shows the results of estimating an OLS model of the change in the fraction of production hedged against changes in the explanatory and control variables. The model estimated is of the form:

$$\Delta XHEDGE = \beta_0 + \beta_{RSI\phi} * \Delta(RSI\phi) + \beta_{RSI} * \Delta RSI + \beta_{X'} * \Delta X' + \varepsilon$$

where, for any variable Z, ΔZ_i is defined as $Z_{i,t} - Z_{i,t-1}$. *XHEDGE* is the fraction of production hedged, *RSI* is the 0–1 dummy to proxy for risk-shifting incentives, ϕ is the bank-to-total debt ratio, and X' is the set of control variables used. See Table 2 for a description of the independent variables. The *p*-values are corrected for heteroskedasticity using White (1980) standard errors and are for a two-sided test for all variables.

This omitted variable could potentially lead to a spurious correlation between $RSI\phi$ and the hedging variable. We attempt to address these endogeneity concerns using a series of tests, described below.

6.4.1. Differences regressions

We now estimate a differences specification of the hedging model so that coefficients are identified only by the within-firm time series changes of the variables. The differences specification removes any firm-specific omitted variables from the error term in the hedging model. Therefore, if such variables were the source of spurious correlation between the hedging and the borrowing decisions, $RSI\phi$ should not be significant in the differences specification. Using the differences specification comes at the cost of a considerably smaller sample. Each pair of valid same-firm observations yields only a single observation for the differences specification. Further, firms with data for only one of the sample years cannot be used. To improve the statistical power of the estimation with the reduced sample size, we drop variables that are not significant in the level regression and estimate a model of the form:

$$\Delta XHEDGE = \beta_0 + \beta_{RSI} * \Delta RSI + \beta_{RSI\phi} * \Delta(RSI\phi) + \beta_{X'} * \Delta X' + \varepsilon \quad (3)$$

where, for any variable Z, $\Delta Z_i = Z_{i,t} - Z_{i,t-1}$ for firm i. Recall that *XHEDGE* is the fraction of production hedged, *RSI* is the 0–1 dummy to proxy for risk-shifting incentives, ϕ is the bank-to-total debt ratio, and X' is the set of control variables used.

Estimation of the differences specification is shown in Table 6. As seen, $\beta_{RSI\phi}$ remains significantly positive, its magnitude is similar to that estimated using the level regression (0.516 versus 0.658). These findings assuage some of the concerns about endogeneity in our results.

In an effort to further mitigate the effect of leverage and source of debt decisions on our estimation, we re-estimate the differences specification with the sample restricted to firms where the dollar amount and source of debt is about the same across both sample years and use the change in asset values that are plausibly exogenous to identify $\beta_{RSI\phi}$. For instance, low commodity prices will decrease the value of the firms's assets, such as its oil and gas reserves, and in turn increase its risk-shifting incentives even if the firm's dollar amount of debt outstanding remains unchanged.

We form the restricted sample to only include firms where the absolute change in the dollar amount of outstanding debt is less than 20% of assets and the absolute change in the bank debt ratio is less than 20%. That is, for each firm i, $\text{abs}(D_{i,t} - D_{i,t-1})/A_{i,t-1} \leqslant 0.2$ and $\text{abs}(\phi_{i,t} - \phi_{i,t-1}) \leqslant 0.2$.

The estimation results using the restricted sample is presented in Table 7. These results are qualitatively similar to those for the unrestricted sample shown in Table 6, again suggesting that bank monitoring leads to lower risk-shifting.

Table 7
Differences regression restricted to similar levels or source of debt.

Explanatory variables	Slope	*p*-value
Intercept	0.027	0.383
$RSI\phi$	**0.479**	**0.014**
RSI	−0.218	0.048
Debt-to-assets	−0.125	0.640
Log(total assets)	0.079	0.501
Cash-to-assets	−2.010	0.000
Capital expenses-to-assets	0.284	0.260
N	50	
R^2	0.316	

This table shows the results of estimating the differences specification of the hedging model where the sample has been restricted to firm-year pairs where the changes in the level and source of debt are small. Specifically, each firm *i* in the restricted sample, $\text{abs}(D_{i,t} - D_{i,t-1})/A_{i,t-1} \leqslant 0.2$ and $\text{abs}(\phi_{i,t} - \phi_{i,t-1}) \leqslant 0.2$. The model estimated is of the form:

$$\Delta XHEDGE = \beta_0 + \beta_{RSI\phi} * \Delta(RSI\phi) + \beta_{RSI} * \Delta RSI + \beta_{X'} * \Delta X' + \varepsilon$$

where, for any variable Z, ΔZ_i is defined as $Z_{i,t} - Z_{i,t-1}$. *XHEDGE* is the fraction of production hedged, *RSI* is 0–1 the dummy to proxy for risk-shifting incentives, ϕ is the bank-to-total debt ratio, and X' is the set of control variables used. See Table 2 for a description of the independent variables. The *p*-values are corrected for heteroskedasticity using White (1980) standard errors and are for a two-sided test for all variables.

6.4.2. Two-stage estimation

As discussed earlier, D/A and ϕ are potentially endogenous variables in the hedging model. Further, since *RSI* and $RSI\phi$ are constructed using D/A and ϕ, *RSI* and $RSI\phi$ are also potentially endogenous. We now use a two-stage estimation procedure to examine whether endogeneity drives our results. In the first stage, we estimate models for D/A, ϕ, *RSI* and $RSI\phi$. Then, in the second stage, we estimate the hedging model using the predicted values from the first stage. With four endogenous variables in the hedging model, we are faced with the formidable task of identifying a system of five equations. Given the difficulties inherent in such an estimation, the results of the two-stage estimation should be interpreted with some caution.[19]

For the first-stage estimation, we first select instruments to identify D/A and ϕ. Since *RSI* is a non-linear function of D/A, we then use a non-linear function of the same variables used to estimate D/A to identify *RSI*. Next, using the estimated values of *RSI* and ϕ, we construct an instrument to estimate $RSI\phi$, so that $RSI\phi$ is identified using a non-linear function of the variables used to estimate D/A and ϕ. Since the two-stage procedure requires estimating ϕ in the first stage, we restrict the sample to $D/A \geqslant 0.05$ as ϕ is not economically meaningful if the leverage ratio is trivial.

The models used for the first stage estimation are described next.

Leverage. Following the work of Graham and Rogers (2002), Purnanandam (2008) and Faulkender and Petersen (2006), we use the following instruments for leverage:

- *ISRATED*, which is a 0–1 dummy that takes the value of 1 if the firm has a rating and zero otherwise. We use this variable to proxy for access to public debt markets and anticipate firms with a debt rating have higher leverage.
- *Neg-BM*, which is a 0–1 dummy that takes the value of 1 if the firm's book-to-market ratio for share holder's equity is negative. We use this variable to proxy for financial distress and anticipate firms in financial distress have higher leverage.
- $DTAX/A$, which is the ratio of deferred tax liabilities scaled by total assets. Deferred tax liabilities arise because of differences in the timing of when depreciation is recognized for calculating taxes and for accounting purposes. Firms with large amounts of deferred tax liabilities already have con-

[19] I thank an anonymous referee for highlighting the difficulties of estimating a model with five endogenous variables.

siderable tax shields because of depreciation expenses so that the tax benefit of issuing debt will be small for such firms. Accordingly, we anticipate firms with greater deferred taxes have lower leverage.

We estimate the leverage equation as:

$$D/A = \beta_0 + \beta_{ISRATED} * ISRATED + \beta_{Neg-BM} * Neg{-}BM + \beta_{DTAX/A} * DTAX/A + \beta_W * W + \varepsilon \tag{4}$$

where *W* are the variables treated as exogenous in the hedging model, namely, cash-to-assets, capital expenses-to-assets, dividends dummy, insider ownership and an indicator variable for the year 1999. We estimate the leverage equation using linear regression.[20]

Risk-shifting incentives, RSI. Our main proxy for risk-shifting incentives is the 0–1 dummy that takes the value of 1 if the firm is highly levered and zero otherwise. Since *RSI* is a step function of leverage, we estimate *RSI* as a logistic model of the same set of instruments and exogenous variables used to estimate leverage in Eq. (4), namely, *ISRATED*, *Neg-BM*, *DTAX/A* and *W*. Hence, a non-linear function of these variables is used to identify *RSI*.

We estimate the *RSI* equation as:

$$RSI = \beta_0 + \beta_{ISRATED} * ISRATED + \beta_{Neg-BM} * Neg{-}BM + \beta_{DTAX/A} * DTAX/A + \beta_W * W + \varepsilon. \tag{5}$$

Bank-to-total-debt, ϕ. Following the work of Johnson (1997), Cantillo and Wright (2000), Denis and Mihov (2003), we use the following instruments for ϕ:

- *ISRATED* dummy: Firms that have access to public debt markets will use more of public debt as compared to private bank debt. We anticipate firms with access to public debt markets will have less of their debt held by banks.
- *X-developed*, which is the fraction of the firm's proved oil and gas reserves that are developed. We use this variable to proxy for assets that can be used as collateral. Since bank loans are typically secured, we anticipate firms with a greater fraction of developed reserves will have more of their debt held by banks.

Using a Tobit regression, we estimate the bank-to-total-debt model as follows:

$$\phi = \beta_0 + \beta_{ISRATED} * ISRATED + \beta_{X-developed} * X{-}developed + \beta_W * W + \varepsilon. \tag{6}$$

Risk-shifting amongst bank borrowers, RSIϕ. We construct an instrument for *RSI*ϕ by multiplying the predicted value of *RSI* from the risk-shifting incentives model with the predicted value of ϕ from the bank-to-total-debt model and estimate the model as follows:

$$RSI\phi = \beta_0 + \beta_1 * \widehat{RSI} * \widehat{\phi} + \beta_W * W + \varepsilon \tag{7}$$

where $\widehat{RSI}$ and $\widehat{\phi}$ are estimated values of *RSI* and ϕ, from Eqs. (5) and (6), respectively. Hence, *RSI*ϕ is identified by a non-linear function of *W* and the instruments used for leverage and for bank-total-debt. We estimate *RSI*ϕ as a Tobit model.

After performing the first-stage estimation, we use the predicted values of D/A, *RSI*, ϕ and *RSI*ϕ from Eqs. (4), (5), (6) and (7), respectively, to estimate the hedging model in the second stage.

To estimate standard errors, we use a bootstrap procedure. In each iteration of the procedure, we form a simulated data set by sampling with replacement from the original data set and perform the first and second stage estimation procedures described above using this simulated data set. We repeat

[20] We also examined a specification using plant, property and equipment scaled by total assets and fraction of developed reserves, described later, as instruments to measure collateral. However, since neither of these variables were significantly related to leverage, we did not use them in the final specification. We also considered using alternate proxies for tax-motivated reasons for leveraging, such as the simulated before-financing marginal tax rate used in Graham et al. (1998) or net operating loss carryforwards. Unfortunately, both of these proxies are missing for a large proportion of our sample.

Table 8
Two-stage estimation of the hedging model.

Dependent variable: fraction of next year's production hedged Explanatory variables	Slope	p-value
$RSI\phi^*$	**0.646**	**0.066**
RSI^*	−0.287	0.094
D/A^*	0.529	0.168
Log(total assets)	−0.057	0.072
Cash-to-assets	−1.140	0.083
Capital expenses-to-assets	0.425	0.076
Dividend dummy	0.024	0.834
XINSIDER	0.103	0.354
ϕ^*	−0.062	0.620
N	131	
Log likelihood	−15.0	
Pseudo-R^2	0.210	

This table shows the second-stage results of estimating the hedging model. In the first stage, we model D/A, RSI, ϕ and $RSI\phi$ as a function of suitable instruments as well as the exogenous control variables used in the hedging model. Next, we use the predicted values from the first stage to estimate the hedging model:

$$XHEDGE = \beta_0 + \beta_{RSI\phi} * RSI\phi^* + \beta_{RSI} * RSI^* + \beta_{D/A} * D/A^* + \beta_\phi * \phi^* + \beta_W * W + \varepsilon$$

using a panel random effects Tobit regression. The p-values are estimated using a bootstrap procedure based on re-sampling the data with replacement 2000 times. The sample is restricted to observations where $D/A \geqslant 0.05$. See Table 2 for a description of the variables. The coefficients for the intercept and time dummy are not shown to conserve space. $Pseudo{-}R^2$ is calculated by regressing the actual fraction of production hedged on the estimated value from the Tobit model. The regression coefficients are reported as marginal effects. The p-values are reported for a two-sided test for all coefficients.

this iteration 2000 times to construct a bootstrap distribution of the coefficients of the second-stage. We then use this bootstrap distribution for computing the reported bootstrap p-values. The results for the second stage are shown in Table 8. Results for the first stage are not shown to conserve space. As seen, the estimation results for the two-stage estimation are qualitatively similar to earlier results.

7. Internal governance mechanisms

We now briefly explore how internal corporate governance structures can also mitigate risk-shifting. Increasing σ_A has two effects on equity. Since equity is an option on the firm's assets, increasing σ_A increases the value of equity. But, increasing σ_A also increases the volatility of equity. Therefore, whether a particular class of equity holders would want to increase σ_A depends on how they will be affected by these competing effects of increasing equity volatility. A *diversified* shareholder will want to increase σ_A as he enjoys the benefit of an increase in the value of his portfolio, while the downside of increased volatility is simply diversified away. In contrast, an *undiversified* shareholder – such as a manager with a large stake in the company's stock – might have opposite incentives. Since an increase in equity volatility results in a large increase of the volatility of her own portfolio, given her risk-aversion, she may prefer to reduce asset volatility, even though it results in a slight decrease in the value of her portfolio.

We examine whether insider holding affects a firm's risk shifting incentives by expanding the base model to include an interaction term of risk-shifting incentives and insider ownership and estimate a model of the form:

$$XHEDGE = \beta_0 + \beta_{RSI-XINSIDER} * RSI * XINSIDER + \beta_{RSI\phi} * RSI\phi + \beta_{RSI} * RSI + \beta_\phi * \phi + \beta_X * X + \varepsilon \quad (8)$$

where, *XHEDGE* is the fraction of production hedged, *RSI* the 0–1 dummy for risk-shifting incentives, *XINSIDER* the fraction of common shares owned by insiders, ϕ the bank-to-total debt ratio and X the set of controls used previously. Recall that X includes *XINSIDER*. With the $RSI * XINSIDER$ term included as an explanatory variable, β_{RSI} now measures hedging policy of firms with high risk-shifting

Table 9
Effect of insider ownership on risk-shifting.

Dependent variable: fraction of next year's production hedged		
Explanatory variables	Slope	p-value
$RSI \times XINSIDER$	0.859	0.054
$RSI\phi$	0.738	0.001
RSI	−0.487	0.001
Debt-to-assets	0.372	0.007
Log(total assets)	−0.055	0.018
Cash-to-assets	−1.454	0.002
Capital expenses-to-assets	0.380	0.022
Dividend dummy	0.003	0.969
$XINSIDER$	0.204	0.463
ϕ	−0.010	0.881
N	146	
Log likelihood	−12.1	
Pseudo-R^2	0.241	

This table shows results of estimating a panel random effects Tobit model of the form:

$$XHEDGE = \beta_0 + \beta_{RSI-XINSIDER} * RSI * XINSIDER + \beta_{RSI\phi} * RSI\phi + \beta_{RSI} * RSI + \beta_{\phi} * \phi + \beta_X * X + \varepsilon$$

where *XINSIDER* is the fraction of common shares owned by insiders. See Table 1 for a description of the other variables. Coefficients for the intercept and time dummy are not shown to conserve space. $Pseudo-R^2$ is calculated by regressing the actual fraction of production hedged on the estimated value from the Tobit model. The regression coefficients are reported as marginal effects. The p-values are reported for a two-sided test for all coefficients.

incentives that have low levels of insider ownership and borrow exclusively from non-banks. $\beta_{RSI-XINSIDER}$ measures differences in hedging policy among firms with high risk-shifting incentives with high versus low insider ownership.

The results for estimating the model described by Eq. (8) is shown in Table 9. $\beta_{RSI-XINSIDER}$ is significantly positive, suggesting that insider ownership mitigates the risk-shifting problem. The effect is economically significant, with a high insider ownership firm hedging 32% more than a comparable low insider ownership firm. This estimate is computed as the differences in model-implied hedging behavior across two firms with high risk-shifting incentives that are identical in all respects, except that insider ownership is low (5th percentile) in one firm and high (95th percentile) in the other.[21]

Several recent papers document an association between corporate governance and borrowing costs. (See Ashbaugh et al., 2006; Bhojraj and Sengupta, 2003; Chava et al., 2007; Cremers et al., 2007.) These results suggest that hedging policy is a potential causal link, with high insider ownership leading to less risk-shifting, which in turn leads to lower borrowing costs.

Comparing the results of Tables 2 and 9, we see that $RSI * XINSIDER$ does not reduce the significance of the $RSI\phi$ term.[22] This finding suggests that internal and external governance are complementary mechanisms in mitigating risk-shifting.

We also perform an analogous analysis using institutional ownership. In unreported results, we find no significant differences between firms with high and low institutional ownership.

8. Hedging covenants

We now examine hedging-related covenants in bank loan contracts to better understand how a bank monitors its borrower's risk-management activities. Since hedging covenant information is not tabulated in commercial databases such as *DealScan*, we hand-collect this information using a procedure similar to Nini et al. (2008). We search through a company's 10-K, 10-Q and 8-K filings for the bank loan contract. We then manually search through the loan contract as well as the entire 10-K for

[21] For our sample, the 5th percentile value of insider ownership is 0%, and the 95th percentile value is 34%.
[22] Instead, the magnitude of $\beta_{RSI\phi}$ increases somewhat from 0.658 to 0.738.

any specific requirement placed on the borrower by the lender to hedge its exposure to volatility in commodity prices. Given the high data collection cost, we concentrate our efforts on firms where bank leverage is non-trivial ($B/A \geqslant 0.1$) for at least one of the sample years.[23] There are 47 such firms in our sample, and we are able to collect loan agreement information for 38 of these firms. We find that banks use three types of covenants to monitor and restrict risk-shifting.

The first type of covenants explicitly require the borrower to hedge. We find such covenants for 12 of the 38 firms. For 10 of these 12 firms, we are able to find the specific hedge positions required by the loan agreement; for the remaining two firms, we find indirect references to hedging being required as part of the bank loan contract.[24] We examine whether the incidence of these covenants depends on bank leverage by sorting these 38 firms into bank leverage quartiles and comparing covenant incidence across these quartiles.[25] The incidences are: quartile 1 (highest bank leverage) – incidence = 56%, quartile 2 – incidence = 40%, quartile 3 – incidence = 20%, quartile 4 (lowest bank leverage) – incidence = 11%. The incidence increases with bank leverage, suggesting that banks require hedging only when their investment in the firm is large enough for risk-shifting to be a concern. The hedging intensity is somewhat higher in the presence of explicit hedging covenants (55% versus 42%), suggesting that such covenants are one of the channels used by banks for monitoring and control.

The second type of covenants restrict how derivatives are used by the borrowers. Virtually all of the bank loan contracts explicitly prohibit the borrower from using derivatives for speculation. Additionally, virtually all contracts restrict the maximum hedge position to 100% of annual production. Since over-hedging is analogous to taking a naked short position, the over-hedging restriction effectively prohibits borrowers from speculatively shorting oil and gas.

The third type of hedge covenants are reporting related. Virtually all of the bank loan contracts require the borrower to provide the bank with detailed information of the borrower's hedge positions at monthly or quarterly intervals.

Banks also seem to rely on informal bundling of the loan and hedging contract as a monitoring channel. For example, Esenjay Corporation in its 2000 annual report states, "In February of 2000, in conjunction with its financing with Deutsche Bank, the Company established natural gas hedges with an affiliate of Deutsche Bank." Being a counterparty for the hedges additionally facilitates monitoring of the firm's risk management policies.

9. Conclusion and implications

We empirically examine whether banks mitigate expropriation by risk-shifting by examining hedging policies of commodity producers that borrow from bank versus non-bank sources. Consistent with banks being effective monitors, we find that among firms with high risk-shifting incentives, firms that borrow from banks hedge a significantly greater fraction of their exposure to commodity price volatility as compared to firms with non-bank debt. To our knowledge, we are the first to document the importance of the source of debt on a firm's hedging policy, and our findings have implications for corporate risk management and financial intermediation.

Our findings provide a possible explanation for the puzzling variation of the association between hedging and leverage documented across different studies. The risk management literature has traditionally modeled this relation using a linear specification.[26] Our results suggest that the hedging-leverage relation is monotone only for bank debt and distinctly non-monotone for non-bank debt. Therefore, the linear specification can systematically fail to detect a significant relation in samples where non-bank debt is prevalent.

[23] B/A is the ratio of book value of long-term bank debt divided by the book value of total assets.

[24] For one firm, we find a reference to a hedging agreement between the firm and the lender in the 10-K. For the other firm, we find a requirement for the firm to list out its current hedging positions as of the closing date in the loan contract, which suggests that these hedge positions are required as part of the loan contract.

[25] For firms where we have observations for both of the sample years, we use the higher of the bank leverage over the two sample years to classify the firm into the appropriate bank leverage quartile. Results using the average bank leverage across the two years are qualitatively similar.

[26] The only notable exceptions that we are aware of are Purnanandam (2008) and Nain (2005).

Our results also suggest a potential explanation for differences in hedging intensity across countries. For example, Bodnar et al. (2003) find that 78% of German firms use derivatives, as compared with only 57% of US firms.[27] Since German firms rely more heavily on bank financing as compared to their US counterparts, our findings suggest that the higher incidence of derivatives use in Germany might be a result of greater bank monitoring.

Our findings also have implications for the banking sector. Our perusal of the SEC filings suggest that firms sometimes enter into the hedges required by the bank loan contract with the lending bank itself. Hence, a bank with an active derivatives book may have a comparative advantage in pricing its loans because its costs to monitor hedging covenants are lower. Further, a derivatives desk might make a bank *less* risky because the market risk of the derivatives book offsets some of the credit risk of the loan book.

Our analysis focuses on risk management using financial instruments. The work of Petersen and Thiagrajan (2000) suggests that firms also manage their risks using operational of accounting strategies. Understanding how bank monitoring affects enterprise-wide risk management is a fruitful avenue for future research.

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