Corporate risk management and the structure of loan contracts

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Abstract

Although theory suggests small, young, privately held firms should have the greatest incentive to engage in corporate risk management, there is currently little evidence of this, in that such firms make almost no use of 'traditional' derivatives-based hedging strategies. In this paper I examine an alternative margin along which firms manage market risk, by analyzing firms' choices between fixed and variable rate loans. First I develop a simple agency model in which both firms and lenders are financially constrained. In equilibrium, banks charge a premium on fixed rate debt to compensate them for assuming the interest rate risk of the loan. Firms who are likely to be financially constrained in future periods will be willing to pay this premium, firms who are likely to be unconstrained will not. I test these and other predictions using microeconomic data on a sample of bank dependent US firms. Small firms and young firms (two measures of financial constraints) as well as firms with higher growth rates, lower current cash flows and less wealthy owners are significantly more likely to choose fixed rate debt. Firms also adjust their exposure depending on how interest rate shocks covary with industry cash flows. I also find evidence that lenders do charge a premium on fixed rate loans even after controlling for the term premium. Finally, I provide supporting anecdotal evidence from a series of interviews with business lenders and present some quantitative comparisons of the significance of this risk management channel. I conclude that small US firms use the banking system to help manage interest rate risk, and discuss implications for the balance sheet and bank lending channels of monetary policy.

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1 Introduction

Theoretical work in corporate finance argues that capital market imperfections provide the key to understanding why firms engage in risk management. One natural implication of this view is that since small, young, privately held firms face the greatest financial frictions, such firms should have the greatest incentive to insure against exogenous shocks to cash flows.

To date, however, empirical evidence provides little support for this prediction. Existing studies generally focus on firms' use of financial derivatives and find that large, mature firms are overwhelmingly *more* likely to use such risk management tools. For example, in Fenn, Post and Sharpe's (1996) sample of 4000 non-financial public corporations, 52 per cent of firms with greater than $2500m in assets used interest rate derivatives, compared to only 1 per cent of the firms with less than $100m in assets. In interviews I have conducted, bank relationship managers report that virtually none of the small and medium sized enterprises they deal with make any use of derivatives.

Are young, small, credit constrained firms really so uninterested in corporate risk management? While extremely interesting and important in its own right, examining firms' use of derivatives has at least two limitations as a clean test of the 'demand for risk management'. Firstly, as several papers have noted, there are substantial economies of scale in setting up and managing a derivatives hedging program.[1] Secondly, as the misadventures of Enron, Barings, Procter and Gamble, Orange County and others has highlighted, the use of derivatives is beset with its own set of agency problems, which might make intermediaries reluctant to lend to opaque firms who actively use derivatives-based hedging strategies.[2]

This paper focuses on an alternative setting for examining corporate risk management by analyzing the structure of loan contracts, in particular firms' choices between fixed rate and variable rate loans. This financing decision affects how sensitive the firm's cash flows are to market risk (in this case fluctuations in interest rates) just as does the decision to use derivatives. But it has several important advantages over the latter as a laboratory for testing risk management theories:

(i) Unlike derivatives, there are no obvious fixed costs of hedging via fixed rate debt that might disproportionately affect small or young firms and produce perverse relationships between agency

[1] For example, Dolde (1993) presents evidence on risk management practices from a survey of Fortune 500 firms, and shows that firms with active hedging programs employ several full-time risk management professionals to manage their derivatives portfolios.

Firm owners and managers may also face substantial fixed cognitive costs learning enough about derivatives to even make an informed decision about whether such instruments would be beneficial for the firm. (Consistent with this, in interviews I have conducted with business lenders in commercial banks, respondents often cited complexity and lack of understanding by managers as primary reasons why small and medium sized firms make little use of derivatives.)

[2] This may help to explain sometimes divergent findings in the literature. For example, several papers including Haushalter (2001) and Graham and Rogers (2003) find that firms with higher probability of financial distress (proxied by leverage) and higher growth opportunities are more likely to use derivatives. But Purnanandam (2003) finds that more leveraged banks are *less* likely to use derivatives, while Mian (1996) finds that growth opportunities (proxied by market-to-book) are associated with a lower probability of derivatives use. See Section 2 for further review of this literature.

cost variables and the decision to insure against interest rate risk.

(ii) I am able to observe the fixed rate vs variable rate decision for a large sample of privately held small and medium sized firms. Although this class of firms is generally believed to face the most severe financial constraints, it has received little attention within the corporate risk management literature.

(iii) As I later show, the choice between fixed and variable rate debt has a comparatively important effect on cash flow volatility for my sample of firms. (My point of comparison is the intensity of derivatives use by Fortune 500 companies).

The first part of this paper develops a simple agency model to highlight various costs and benefits of fixed and variable rate debt. As well as providing a clear organizing framework for interpreting my empirical results, the model also makes a new theoretical contribution by analysing risk management behavior in an environment where both the 'buyer' (the firm) and the 'seller' (in this context, a financial institution) are credit constrained. This highlights a new cost of risk management: when lenders also face financial constraints, banks will in equilibrium charge a premium on fixed rate debt to compensate them for assuming the interest rate risk of the loan. Small, young firms who expect to be credit constrained in the future will be willing to pay this premium to avoid interest rate risk; larger, mature firms will not be.

These and other predictions are tested using data from three waves of the Federal Reserve Board Survey of Small Business Finance (SBF). Controlling for firm, loan and ownership characteristics, small firms and young firms (two measures of the degree of financial constraints) are significantly more likely to choose fixed rather than variable rate loans. A doubling of firm size reduces the probability of the firm choosing a fixed rate loan by 5-7 percentage points, while a doubling of firm age reduces this probability by 3-4 percentage points. Firms with greater future investment opportunities (proxied by sales growth) and lower current cash flows (proxied by return on assets) are more likely to use fixed rate debt, also consistent with the hypothesis that firms hedge to reduce the severity of credit constraints in future periods.

The data also supports several other of the model's predictions. Using national industry accounts data I estimate the relative sensitivity of different industries to interest rate shocks; armed with these estimates I find evidence that firms in industries where current cashflows covary positively with interest rates are less likely to use fixed rate debt. This is consistent with theory, since such firms have a 'natural hedge' against interest rate shocks. Secondly, my model predicts that the 'fixed vs variable rate' decision is more likely to be monotonic in agency costs when the size of the loan is large - I find substantial evidence of this. Thirdly, I find evidence that banks do charge an interest rate premium on fixed rate debt, after controlling for firm and loan characteristics as well as the shape of the yield curve.

Finally, I find some evidence that this corporate finance decision responds to ownership risk characteristics: namely, firms with wealthier owners are less likely to choose fixed rate debt (consistent with either a buffer stock model of consumption, or the idea that risk aversion is decreasing in wealth). Unlike several recent papers, I find only weak evidence of 'market timing' behavior (the idea that firms switch between fixed and variable rate debt in a predictable way depending on the shape of the yield curve).

Taken together, the results in this paper provide substantial evidence that small US firms use the banking system to manage interest rate risk. This finding has several interesting implications for macroeconomic fluctuations and for the bank lending and balance sheet channels of monetary policy. Krishnamurthy (2003) shows that hedging helps to reduce the (perhaps implausibly large) amplification of shocks implied by the 'financial accelerator' mechanisms in Kiyotaki and Moore (1997); this paper provides one example of how such hedging may occur in practice. Another implication is that over time interstate branching, the recent wave of banking mergers, and the increased use of financial engineering by large banks are all likely to improve the banking system's overall ability to manage interest rate risk. The model and results in this paper suggest that such developments should then lead to improved interest rate risk management by *firms* and a weakening of the balance sheet channel: as the risk management practices of banks improve, they are able to absorb the interest rate risk faced by firms by offering more customized, flexibly state-contingent loan contracts.

The remainder of this paper proceeds as follows. Section 2 places this paper in the context of the existing theoretical and empirical risk management literature. Sections 3 and 4 develop the basic theoretical model. Section 5 shows that historically, fixed rate debt is associated not only with more stable nominal interest payments, but also more stable *real* interest payments. Section 6 explains the data and empirical methodology. Section 7 presents the main estimation results regarding firms' choice between fixed and floating rate debt. Section 8 presents evidence from the SBF and from financial markets that lenders do charge a premium on fixed rate loans. Section 9 summarizes the results of interviews I conducted with business bankers in the Boston and Washington DC metro areas, which provide institional details and an alternative source of evidence about the costs and benefits of fixed and variable rate loans. Section 10 presents evidence about the quantitative importance of the decision to fix or float on the firm's cash flows: the point of comparison is the intensity of derivatives use by large publicly traded firms. Section 11 concludes, discusses implications for the bank lending and balance sheet channels of monetary policy, and discusses avenues of future research.

2 Related Literature

The imperfect capital markets view of risk management is proposed in Smith and Stulz (1985) and further developed in Froot, Scharfstein and Stein (1993, hereafter FSS).[3] In FSS, the firm's

[3] Other motivations for risk management (besides those that focus on costly external finance) have also been proposed and tested. Smith and Stulz (1985) argue that since tax losses cannot always be carried forward to future

production function is concave and raising external finance is costly; these assumptions ensure that firm value is concave in internal funds and that fluctuations in internal funds destroy firm value. The intution is that a negative shock to internal funds cannot be costlessly offset by increasing external financing and thus results in lower investment; this fall in investment has a large impact on firm profit because the marginal product of investment is high when the level of investment is low. The spirit of Smith and Stulz is similar: hedging reduces the probability of financial distress, this increases firm value because of exogenous fixed costs of bankruptcy.

Empirical work to test these ideas has generally focused on firms' use of financial derivatives. Some papers analyse broad cross sections of non-financial firms, while others focus on particular industries (such as mining or banking) where derivatives use is particularly prevalent. The table below summarizes results from several papers on the relationship between derivatives use and measures of either financial frictions, or cash flows relative to investment opportunities.

	dependent variable	Firm size	Investment opportunities	Leverage	Quick ratio	Prob. financial distress
Géczy et. al. (1997)	binary	+++	++	n/s	n/s	
Mian (1996)	binary	+++	- - -			
Haushalter (2001)	binary	++	n/s	n/s		+
	continuous	n/s	n/s	+++		+++
Purnanandam (2003)	binary	+++	n/s	- - -	- - -	- - -
	continuous	++	n/s	- -	- - -	++
Lin and Smith (2003)	continuous	+++	+++	+++	-	
Tufano (1997)	continuous	n/s	-	n/s		
Graham and Rogers (2003)	continuous	+++	- - -	+++		

Binary dependent variable = 1 if the firm uses derivatives, = 0 otherwise. Continuous dependent variable measures the intensity of derivatives use (eg. the proportion of total production hedged using derivatives). +/++/+++ (-/–/—) means the variable is positive (negative) and significant at the 10 per cent/5 per cent/1 per cent level. n/s means the estimated coefficient was not statistically significant. Results are taken from Table 4 of Geczy et. al, Table 4 of Mian, Tables 9 and 7 of Haushalter, Tables 6 and 8 of Purnanandam, Table 5 of Lin and Smith, Table 5 of Tufano and Table 3 of Graham and Rogers.

As the table shows, the sign of these relationships is often not consistent across studies. Moreover the most robust finding, between firm size and derivatives use, suggests large firms are more

periods, tax payments are convex in firm profits, providing an incentive for firms to hedge. Leland (1998) makes a different tax-related argument: effective risk management allows firms to increase their debt capacity, and enjoy the associated debt tax shield. Graham and Rogers (2002) test these two hypotheses, finding evidence for the Leland debt capacity hypothesis, but not the tax convexity hypothesis. That is, firms with active hedging programs have higher debt ratios, but firms with more convex tax schedules are not more likely to engage in derivatives hedging.

Also Smith and Stulz (1985) argue that hedging could be motivated by managerial risk aversion (since managers have a large, non-diversifiable stake in the firm) while DeMarzo and Duffie (1991) develop a career concerns type model in which managers hedge to influence labor market perceptions of their managerial quality. Tufano (1996) finds evidence that managerial variables affect the degree of hedging in the gold mining industry. I also present some evidence consistent with managerial-risk-aversion motivations for insuring against interest rate risk (see section 7.3 for details).

prevalent users of risk management. Géczy, Minton and Schrand (1997), who find that both smaller firm size and less analyst coverage are associated with less derivatives use, suggest economies of scale may be responsible: if hedging involves large fixed costs then smaller or more opaque firms may be less likely to engage in such activities, even if they face greater problems obtaining external finance.

Other papers have examined how the decision to hedge affects other aspects of the firm's corporate finance policy. Fenn, Post and Sharpe (1996) find that firms who use interest rate swaps issue more short-term and floating-rate debt, since they are able to better hedge the resulting interest rate risk. Guay (1999) finds that the introduction of a derivatives hedging program is associated with decreases in firm risk, suggesting derivatives are being used for hedging rather than pure speculation. Allayanis and Weston (2001) argue that initiating a deriatives hedging program is associated with a substantial increase in firm market value (as much as 4.8 per cent). However, Guay and Kothari (2002) show that firms' derivatives positions are quite small relative to firm size and cash flows, which suggests that Allayanis and Weston's estimates of the effect of hedging on firm value may be implausibly large.

The paper most closely related to this one is Faulkender (2003), who analyses the determinants of the 'final' interest rate exposure of 275 corporate debt issuances for a sample of firms in the chemical industry. This final exposure reflects the sum of two choices: whether the original loan was issued at a fixed or floating rate, and then whether the firm subsequently used an interest rate swap to convert an originally floating rate liability to a fixed rate. Faulkender finds no evidence that firms are hedging when choosing the interest rate exposure of their debt (like other papers in the literature finds a positive association between firm size and the probability of interest rate risk management). However, he finds that firms are 'market timing': in that they are more likely to choose fixed rate debt when the yield curve is upward sloping. Although I too find some weak evidence of market timing, I also find strong relationships between the fixed vs variable decision and measures of agency costs. This may in part reflect differences in the target sample. I study small, privately held firms (for whom financial frictions are more significant) rather than large public companies. Also, Faulkender's sample is a mix of firms who raise debt directly from capital markets and those who issue bank debt, as well as a mix between firms who use derivatives and those who do not; this might potentially obscure relationships between agency cost proxies and the decision to fix or float. (For example, the smaller firms in Faulkender's sample are more likely to use bank debt, while the larger firms are more likely to directly issue debt in the corporate fixed interest market; since corporate debt is generally issued at a fixed rate, this alone could generate a positive association between size and the probability of using fixed rate debt).

Finally, Campbell and Cocco (2003) develop and calibrate a model of household mortgage choice. Their analysis is based on a buffer-stock life cycle model with credit constraints, and predicts that households with little wealth should eschew variable rate loans because of the risk that a short run increase in interest rates might force a large decline in consumption. Thus, their rationale for risk management is quite similar to this paper, although the root motivation to hedge stems from risk aversion, rather than corporate finance considerations.

3 A simple model

In this section, I develop an agency model of corporate risk management in which a credit constrained firm chooses beween a fixed rate loan and a variable rate loan. Fixed rate debt is valuable because it reduces the volatility in the firm's level of internal funds. However, banks in the model are also financially constrained and charge a premium on fixed rate debt to compensate them for assuming the interest rate risk of the loan. In equilibrium, borrowers with a low probability of being credit constrained in future periods will be unwilling to pay this premium and will choose a variable rate loan; borrowers who are very likely to be credit constrained will choose a fixed rate. Two other factors also affect the firm's choice: (i) the correlation between interest rates and other shocks to the firm's profitability, and (ii) the fact that shocks to interest rates affect not just the level of internal funds, but also the marginal cost of funds in future periods.

The model makes a number of clear predictions and thus provides a clear organizing framework for interpreting the empirical results in the second half of the paper. It also makes a contribution to the literature in its own right, (i) by analysing risk management in an environment where both the 'buyer' and the 'seller' of risk management are financially constrained, and (ii) by explicitly examining how the 'demand for risk management' varies with the intensity of agency costs. For example, one might expect the critique of Kaplan and Zingales (1997) - who show that investment-cashflow sensitivities are not necessarily monotonic in internal funds or the degree of agency costs - might apply equally well here. I show however that their result applies with somewhat less force in this context (because the willingness to pay for risk management depends on expected future, not current, financial constraints).

3.1 Basic setup

There are two periods ($t = 0, 1$) and two types of risk neutral agents: firms and lenders. In the first period, firms invest in a riskless project of fixed size I_0, which produces return R_0. In the second period, firms invest in an variable-scale investment project: an investment of I produces return $f(I)$ if the project succeeds, where $f(.)$ is an increasing concave function. This second project succeeds with probability p_H, and if the project fails it yields a return of 0.

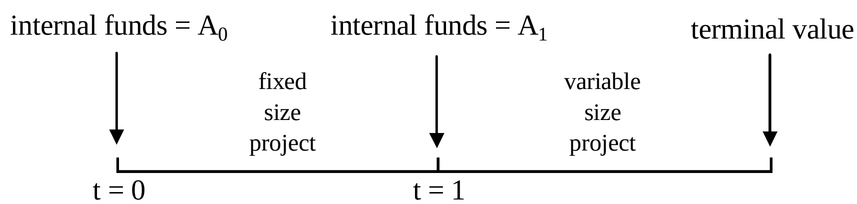
To help finance these projects, firms begin period t with internal funds of A_t[4]. Firms may also borrow additional funds from lenders, who in turn can borrow funds at a gross risk free rate of

[4] A_t will differ across firms. To save on notation, I suppress the firm subscript on A_t, I_t etc. unless otherwise necessary.

$1 + r_t$. Lenders behave competitively, and make zero profits in equilibrium.

The ability of the firm to borrow funds externally at date 1 is limited by a moral hazard problem. Namely, firms also have access to an alternative project which has a lower probability of success $p_L < p_H$, but produces a stream of private benefits proportional to the size of the project (BI). Lenders observe only whether the project succeeds or fails, not which project is chosen.

The timing of events is shown below:



Firms begin with internal funds of A_0, and invest these plus any borrowed funds in the project at $t = 0$. At the end of date 0, the firm has internal funds of A_1 (equal to A_0 plus net profits from project), which it uses to help fund the project at date 1. The firms' objective is to maximize the expected value of its funds at the end of date 1.

3.2 Solving the firm's problem

At $t = 0$, the firm borrows $I_0 - A_0$ and invests I_0 in the riskless project. The firm's internal funds after repaying the lender at the end of date 0 will thus be $A_1 = R_0 - (1 + r_0)(I_0 - A_0)$. The firm's problem at date 1 is:

$$max\ V = f(I_1) - R_1^l \tag{1}$$

subject to:

$$p_H R_1^l \geq (1 + r_1)(I_1 - A_1) \quad [lender\ IR]$$
$$p_H V \geq p_L V + BI_1 \quad [firm\ IC]$$

The lender's individual rationality constraint requires the expected payment to the lender ($p_H R_1^l$) is not less than the funds lent to the firm ($I - A_1$). The firm's incentive compatibility constraint requires the firm's expected return if it undertakes the high level of effort ($p_H V$) is greater than the sum of the expected return if it shirks ($p_L V$) plus the private benefits from shirking (BI_1). This implies the firm's payment must be at least $\frac{B}{p_H - p_L}$ per unit of investment.

The lender's IR constraint always binds in equilibrium. If the firm IC constraint binds, the solution to the program is given by:

$$\left[\frac{B}{p_H - p_L} + \frac{1 + r_1}{p_H}\right] I_1^* = f(I_1^*) + \frac{1 + r_1}{p_H} A_1 \tag{2}$$

By implicitly differentiating (2), it can be confirmed that $\frac{dI_1^*}{dA_1} > 0$: the higher the level of internal funds, the higher the repayment to the firm (and the smaller the repayment to the lender) for a given project size; this allows the firm to invest in a larger project without violating incentive compatibility. Also, $\frac{d^2 I_1^*}{dA_1^2} < 0$, investment is concave in internal funds as a consequence of the firm's concave production function. See Appendix A.1 for the details of this calculation.

If A_1 is large enough, the firm's IC constraint no longer binds, in which case the project size is given by:

$$f'(I_1^{**}) = \frac{1 + r_1}{p_H}$$

The firm will never invest more, since expanding I_1 beyond I_1^{**} will be profit-reducing even if it is incentive-compatible.

Although the model so far is deterministic, it can be shown the value of the firm is concave in the level of internal funds (ie. $V_{AA} < 0$; see Appendix A.2 for the calculations). As in Froot, Scharfstein and Stein (1993), this provides the basic motivation for risk management: a negative shock to cash flows has a larger effect on firm value (in absolute value terms) than a positive shock, because the marginal product of investment is higher when investment is low.

4 Banks and interest rate risk

I now take the framework from the previous section and introduce an explicit source of interest rate risk. At the same time, I also introduce a financial friction at the level of the lender, so that both firms and banks have a motivation to engage in interest rate risk management. The model of financial intermediation is a stripped-down version of Stein (1998). Each bank has the following balance sheet identity:

$$\text{Loans } (L_t) + \text{Reserves } (R_t) = \text{Deposits } (D_t) + \text{Non-deposit finance } (E_t)$$

For simplicity, it is assumed depositors require a risk free rate of return of 0.[5] Deposit finance is limited by a fractional reserve requirement which must be satisfied at the beginning of each period:

$$R_t \geq \varphi D_t$$

Combining these two equations yields:

$$L_t \leq \frac{1 - \varphi}{\varphi} R_t + E_t$$

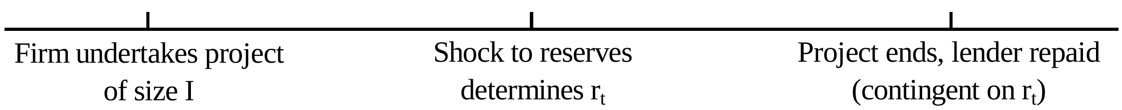
In words, bank lending must be financed by either deposits or non-deposit finance. Deposits in turn are limited by the level of bank reserves. The key point of Stein (1998) is that when raising

[5] The simplest way of motivating this is to assume consumers have access to a riskless storage technology. The assumption that deposit rates are exogenous is not at all crucial. The key price in the analysis that follows is the *wedge* between deposit and lending rates. In a more realistic setup we could assume imperfect substitutability between money and bonds, in which case shocks to bank reserves will affect the interest rate on both deposits and loans. But the key result, that a reduction in reserves tightens bank credit constraints and raises intermediation spreads, will remain, as the model in Stein (1998) shows.

non-deposit finance (E_t) is costly, monetary policy shocks which drain reserves from the banking system (a reduction in R_t) will reduce lending by banks and raise intermediation spreads. This is the bank lending channel of monetary policy.

In Stein, raising external funds is possible, but is costly because of adverse selection. Here, I make a starker assumption: that no additional non-deposit finance can be raised between periods. Non-deposit finance at date 1 will thus be equal to non-deposit finance at date 0 plus any profits from lending to firms at date 0.

The timing of the model is the same as before, except that at the end of $t-1$, there is a random monetary policy shock, which determines the level of reserves in the following period R_t and next period's interest rate on bank loans to firms r_t. Importantly, the value of R_t is revealed *before* the firm repays the lender in period $t-1$, so the date $t-1$ contract can be made contingent on r_t.



The relationship between R_t and r_t is determined by the market clearing condition

$$\int I_{t,i} - A_{t,i} di \leq \frac{1-\varphi}{\varphi} R_t + E_t. \tag{3}$$

A fall in R_t reduces the total amount of loanable funds available for borrowing, and thus reduces investment. Since investment is decreasing in the cost of funds for all firms, this means a negative shock to R_t is matched by an increase in the market clearing interest rate r_t. See Lemma 1 below.[6]

Lemma 1: $cov(R_t, r_t) < 0$.

Proof, see Appendix A.3.■

Below, I solve the firm's problem allowing the repayment from the bank to the firm at the end of $t-1$ to be contingent on the realization of r_t. I restrict contracts to be one of two types: a fixed rate loan with interest rate δ_f, and a floating rate loan where the interest rate is $\delta_v + r_t$.

I focus on the shock to reserves at the end of period 0. Because firms and lenders are risk neutral and date 1 is the terminal period, both parties will be indifferent to the realization of r_2. Firms *do* care whether the date 0 contract is contingent on r_1, because internal funds at the end of date 0 are used to help finance the project at date 1.

Before solving the firm's choice between fixed and variable rate debt, I solve for interest rate charged by banks at date 0 on both types of loans.

[6] As shown in the proof of Lemma 1 in the Appendix, $cov(R_t, r_t) < 0$ regardless of whether debt contracts between banks and firms at date $t-1$ are made contingent on the realization of r_t. Making the repayment to the lender contingent on r_t shifts funds between banks and firms, but does not affect $A_t + E_t$ (the total amount of total non-deposit funds available for investment by firms).

4.1 Pricing fixed and variable rate debt

Since banks are risk-neutral and can choose freely the quantities of fixed or variable rate loans they offer, the equilibrium expected rate of return on the two types of loans must be equal.

The expected return on a fixed rate loan is the product of $1+\delta_f$ (the rate of return in period 0), and $\mathbf{E}[1+r_1]$ (the expected rate of return in period 1).

The expected return on a variable rate loan is $\mathbf{E}[(1+\delta_v+r_1)(1+r_1)]$. Note that the date 0 return $1+\delta_v+r_1$ and date 1 return $1+r_1$ appear together inside the expectation operator. This highlights the key benefit of variable rate debt. Variable rate loans produce a high rate of return exactly in the states of nature where the date 1 rate of return on bank capital is high. In other words, variable rate lending provide a hedge against shocks to loanable funds.

Setting these two expected rates of return equal, using the fact that $E(ab) = E(a)E(b) + cov(a, b)$ and rearranging yields an expression for the interest rate premium on fixed rate debt relative to floating rate debt:

$$\delta_f - (\delta_v + \bar{r}_1) = \frac{\sigma^2}{1+\bar{r}_1} \tag{4}$$

where $\bar{r}_1$ denotes $\mathbf{E}[r_1]$, and σ^2 is the variance of r_1. This premium is strictly positive, and increasing in the volatility of interest rates.

To recapitulate, banks charge an interest rate premium on fixed rate debt, because variable rate debt hedges the bank against shocks to reserves (R_t). When the central bank drains reserves from the banking system, banks are able to raise less deposit finance, this is however offset partially by higher interest payments on previously issued variable rate loans.

Finally, having determined the spread between fixed and variable rate debt, the interest rate on fixed rate debt (δ_f) is pinned down by the market clearing condition (3) at date 0, and is obviously decreasing in the supply of loanable funds ($E_0 + R_0$) relative to demand ($\int I_{t,i} - A_{t,i} di$). If there are excess loanable funds, $\delta_f = 0$, ensuring that banks earn a net expected rate of return of zero on lending to firms.

4.2 Solving the firm's problem

Recall from the deterministic model that the value of the firm at the beginning of date 1 is an increasing function of A_1 and a decreasing function of r: ie $V = V(A_1, r)$ where $V_{A_1} > 0$ and $V_r < 0$. The firm's problem at date 0 is to choose between fixed or variable rate debt to maximize the expected value of the firm:

$$\max_{type\ \in\ (f,v)} \mathbf{E}V(A_1, r_1)$$

subject to:

$$A_1 = A_0 + R_0 - (1+\delta_f)(I_0 - A_0) \qquad [lender\ IR : type = fixed]$$

$$A_1 = A_0 + R_0 - (1+\delta_v + r_1)(I_0 - A_0) \qquad [lender\ IR : type = variable]$$

Let $\bar{\mu}$ be the maximum premium the firm is willing to pay for insurance against interest rate shocks. In other words, $\bar{\mu}$ is defined by:

$$\mathbf{E}_r V(\tilde{A}, r) = \mathbf{E}_r V(\bar{A} - \bar{\mu}, r) \tag{5}$$

where I use $\tilde{A}$ to denote the date 1 value of the firm's internal funds if it chooses variable rate debt (ie $\tilde{A} = R_0 - (1 + \delta_v + r_1)(I_0 - A_0)$), and where $\bar{A}$ is the expected value of $\tilde{A}$.

An approximation of this premium can be obtained by taking a Taylor series expansion of both sides of equation (5). The maximum interest rate premium ($\bar{\mu}$ divided by the amount borrowed at date 0) the firm is willing to pay is given by:

$$\frac{\bar{\mu}}{I_0 - A_0} \approx \sigma^2 \left[-\frac{1}{2} \frac{V_{AA}}{V_A}(I_0 - A_0) + \frac{V_{rA}}{V_A} \right] \tag{6}$$

Whether the firm chooses fixed rate debt or floating rate debt depends on which of several regions the firm is in. This in turn is a function of the level of internal funds A.

Region 1: Firm requires no external finance at $t = 1$. Since the firm does not borrow, its opportunity cost of funds is 1, rather than r (since any funds not invested in the project are deposited at the riskless rate of return of 0). There are two cases to consider.

- **Region 1A: $p_H f(I_1^*) = 1$.** In this region, the firm simply invests an additional unit of internal funds at the riskless rate of return of zero. So $V_A = 1$, and consequently $V_{AA} = V_{rA} = 0$. From (5) it can be immediately seen that $\bar{\mu} = 0$. This is very intuitive, the firm is not affected at all by volatility in interest rates, since it always invests the same amount, and the cost of financing the project is independent of the realization of r_1.

- **Region 1B:** $1{+}r_1{>}p_H f(I_1^*) > 1$. In this region, the firm invests all its internal funds in the project, but does not have enough funds to sustain $p_H f(I_1^*) =$. In this region $V_{AA} < 0$ because an incremental unit of internal funds is used entirely to increase investment, unlike Region A.1. $V_{rA} = 0$, however, because the firm's cost of funds is 1, not r_1. To the extent that r_1(which represents the financing wedge of banks) is relatively low in practice, the width of region 1B will be small.

Region 2: Firm requires external finance, IC constraint satisfied ($p_H f(I_1^*) = 1 + r_1$). Like region 1A investment is not sensitive to internal funds, so $V_{AA} = 0$. The firm's marginal cost of borrowing is r_1 (that is $V_A = r_1$), thus now V_{rA} is no longer equal to zero, but 1. The per-unit fixed rate premium reduces to:

$$\frac{\bar{\mu}}{I_0 - A_0} = \frac{\sigma^2}{1 + \bar{r}} \tag{7}$$

This is exactly the fixed rate premium charged by lenders, leaving the firm indifferent between fixed and floating rate debt. This is no coincidence, in this region, the firm's demand for interest rate risk management is exactly the same as the bank's – in both cases the shadow value of internal funds is r_1, so both prefer to receive funds when r_1 is high.

Region 3: Firm requires external finance, IC constraint not satisfied ($p_H f(I^*) > 1 + r_1$)**.** In this region, both $V_{AA} < 0$ and $V_{Ar} \neq 0$. $V_{AA} > 0$ simply because the firm's production function is concave (so volatility in A_1 reduces the value of the firm because the marginal product of investment is higher when A_1 and I_1 are low)

As shown in Appendix A.7, V_{rA} can be written as:

$$V_{rA} = k\left[p_H f_{II} I_A I_r + (1 - I_A)\right] \tag{8}$$

where $k = \frac{\frac{B}{p_H - p_L}}{\frac{B}{p_H - p_L} + \frac{1+r_1}{p_H} - f_I}$. $k > 1$ since $f_I > \frac{1+r_1}{p_H}$.[7]

The first term in the square brackets $p_H f_{II} I_A I_r$ is always positive. It reflects the fact that higher r_1 means lower investment but a higher marginal product of investment; this magnifies the benefit of the higher investment associated with an incremental increase in internal funds. The second term $1 - I_A$ is positive if an extra unit of internal funds produces less than one extra unit of investment (high interest rates making internal funds more valuable as a substitute for external finance). This condition may or may not be satisfied in practice, so V_{rA} may be positive or negative overall.

Although V_{rA} is not necessarily positive, as the Taylor series expansion shows as the size of the loan at date 0 ($I_0 - A_0$) becomes dominant in determining the fixed rate premium.$\frac{\bar{\mu}}{I_0 - A_0}$.

Lemma 2: In Region 3, the fixed rate premium $\frac{\bar{\mu}}{I_0 - A_0}$ *is monotonically increasing in the size of the loan at date 0* ($I_0 - A_0$)*.* $\frac{\bar{\mu}}{I_0 - A_0}$ *is independent of* $I_0 - A_0$*.in other regions. Thus, the fixed rate premium is highest in Region 3 as long as* $I_0 - A_0$ *is sufficiently large.*

Proof: Follows directly from Equation (6).■

As the size of the loan at date 0 increases, the direct effect of interest shocks on the volatility of internal funds becomes more important than any correlation between shocks to internal funds and future interest rates.

The relationship between these three regions and the firm's willingness to pay a premium for fixed rate debt is displayed graphically in Figure 1. (Figure 1 is drawn assuming that $\bar{r}$ is close to 0, so that region $1B$ is arbitrarily small).

In general, as the 'size' (ie. the amount of internal wealth) of the firm increases, financial constraints ease and the demand for interest rate risk management declines. Firms able to finance the first-best level of investment (region 1) are not willing to pay any positive premium to avoid interest rate risk. Since interest rate risk is 'priced' at $\frac{\sigma^2}{\bar{r}}$, in equilibrium such firms will always

[7]Note that this expression nests the expression for V_{rA} in region 2. In region 2, $f_I = \frac{1+r_1}{p_H}$ (so $k = 1$) and $I_A = 0$. So the expression collapses to $V_{rA} = 1$.

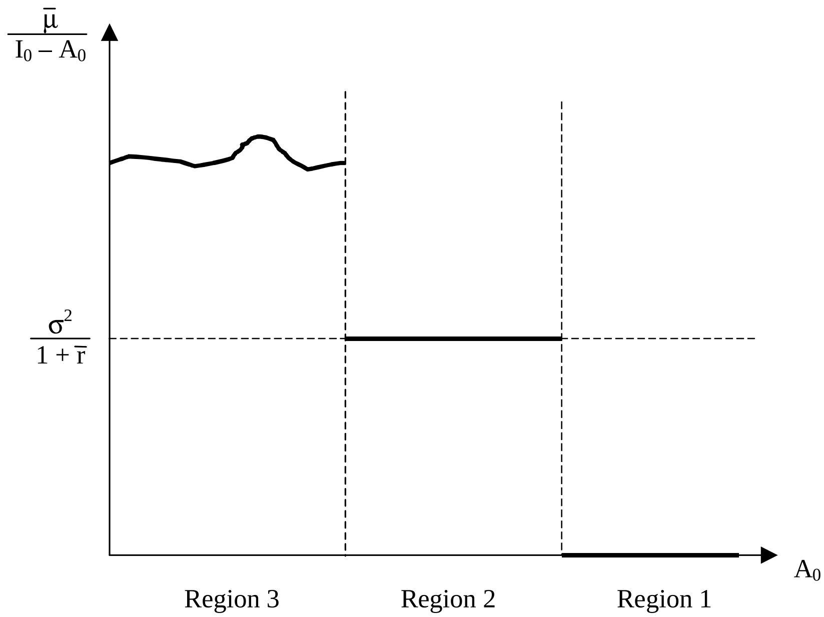


Figure 1:

choose variable rate debt. By contrast, firms in region 1 will always choose fixed rate debt as long as the size of the loan is large enough, as confirmed by Lemma 2. Firms in region 2 have the same 'demand for insurance' as financial institutions, and are thus indifferent between the two types of debt once the premium on fixed rate debt is taken into account.

Note that within region 3, the relationship between $\frac{\bar{\mu}}{I_0 - A_0}$ and A is drawn as being non-monotonic. In general, there is no reason to necessarily think otherwise. For example, momentarily assume that V_{rA} does not vary with A (or that $I_0 - A_0$ is large enough so that V_{rA} is unimportant in determining the firm's demand for insurance). Then, how $\frac{\bar{\mu}}{I_0 - A_0}$ varies with A is determined by the behavior of $-\frac{V_{AA}}{V_A}$ with respect to A.[8] In turn, the shape of $-\frac{V_{AA}}{V_A}$ depends crucially on assumptions about the shape of the firm's production function. Kaplan and Zingales (1997) make a related point when they show in a simple FSS-style framework that investment-cashflow sensitivity is generally not monotonic in the level of firms' internal wealth.

We have established that different classes of firms have different demands for fixed rate debt, and shown that this propensity is, in general, decreasing in the degree of the financial constraints the firm faces. In a slightly more general setting, the willingness to pay for interest rate risk management will be downward sloping within classes of firms as well.

Consider the case where the size of the firm's project at date 1 is unknown at date 0. ie output at date 1 is given by $\theta f(I)$. θ is revealed at the beginning of period 1. In period 0 the firm has a

[8] The direct analog from a consumer insurance problem is that a consumer's willingness to pay for insurance against a lottery of fixed size varies with wealth according to how their coefficient of absolute risk aversion $-\frac{u_{ww}}{u_w}$ varies with wealth.

prior distribution over $\theta : \theta \sim g(\theta)$ where $E(\theta) = 1$. This extension captures the simple idea that firms are somewhat uncertain about their future investment opportunities.

In this case, the firm's demand for fixed rate debt will be determined as a weighted average of the willingness to pay in each region, multiplied by the probability of being in that region:

$$\frac{\bar{\mu}}{I_0 - A_0} = \sum_{i \in \{1a, 1b, 2, 3\}} P_\theta(\text{Region}=i) \times E_\theta \left[\frac{\bar{\mu}}{I_0 - A_0} | \text{Region}=i \right] \tag{9}$$

For higher levels of internal wealth A_0, the probability increases that the firm will be able to finance investment next period entirely from internal funds, without relying on external finance. Even if external finance is required, it is less likely that the firm's IC constraint will bind. Similarly, conditional on internal wealth, a firm with less severe agency problems (lower B) will be more likely to be financially unconstrained next period. This is summarized in Lemma 2 below.

Lemma 3: $\frac{P(\text{Region}=1a)}{P(\text{Region}=1b)}$, $\frac{P(\text{Region}=1b)}{P(\text{Region}=2)}$ *and* $\frac{P(\text{Region}=2)}{P(\text{Region}=3)}$ *are non-decreasing in* A_0 *and non-increasing in* B; *and strictly increasing in* A_0 *and strictly decreasing in* B *as long as* θ *has continuous support over a wide enough range.*

Proof, see Appendix A.5.■

The simple implication of Lemma 2 is that if we compare two firms, the first of whom has more internal funds or less severe moral hazard problems (lower B), the second firm will face financial constraints in more states of the world. The first firm, even if it expects to borrow externally for some realizations of θ, is more likely to be able to use retained earnings and fund the first-best level of investment. Because of a higher weight on states of nature where the firm is indifferent to cash flow shocks, the firm's average demand for fixed rate debt is lower.

The effect of variable project size on the willingness to pay for risk management is depicted in Figure 2. The basic point is that we must average over a range of different project sizes, which smooths out the willingness to pay. For example, looking at the Figure, when project size is deterministic, all firms in region 2 have the same demand for risk management. But when project size is stochastic, a firm who expects to be on the cusp of region 1 on average will have a lower willingness to pay for insurance, because there is a substantial probability the firm will be able to fund the entire project using internal funds, in which case it will be unconcerned about volatility in cash flows.

Even in this setting, it will not necessarily be true that the willingness to pay for fixed rate debt is monotonically decreasing in internal wealth. There are three reasons why. Firstly, depending on assumptions about $f(.)$, it is possible that $\frac{\bar{\mu}}{I_0 - A_0}$ is sometimes upward sloping within region 1. Secondly, unless $\bar{r}$ is close to zero, there will be a 'region 1b' in which the firm does not rely on external finance, but is still willing to pay a positive premium for fixed rate debt. Depending on

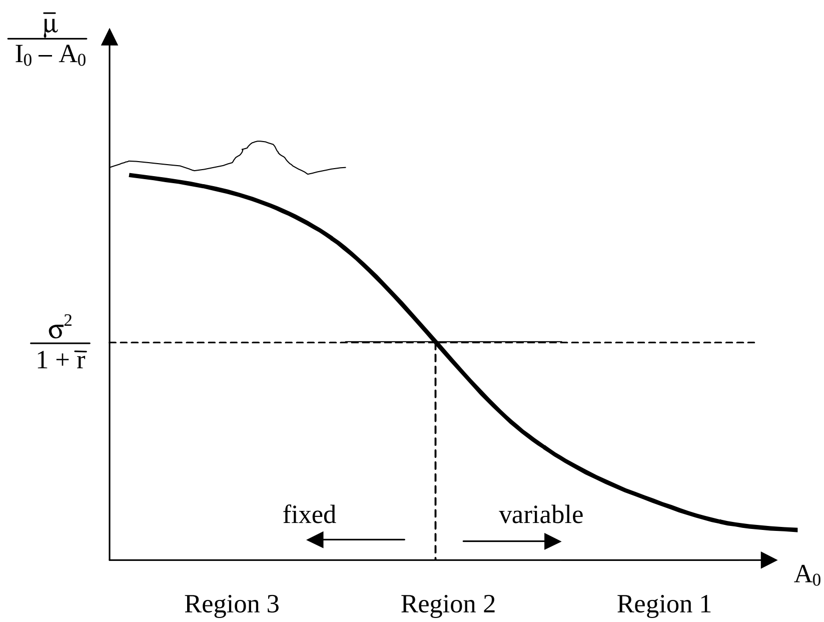


Figure 2:

assumptions this premium may be larger than the willingness to pay in regions 2 or 3. Thirdly, if the loan is small, it is possible that $\frac{\bar{\mu}}{I_0 - A_0}$ is smaller in region 3 than region 2.

However, $\frac{\bar{\mu}}{I_0 - A_0}$ will be downward sloping on average over a broad enough range of internal wealth A, and upward sloping on average over a broad enough range of B. This is stated more precisely in Proposition 1 below.

Proposition 1:

(a) For any level of internal funds A^* there exists $A^{**} > A^*$ such that $\frac{\bar{\mu}_A}{I_0 - A} < \frac{\bar{\mu}_{A^*}}{I_0 - A^*}$ for all $A > A^{**}$.

(b) Holding A constant, for a firm where $B = B^*$ there exists $B^{**} < B^*$ such that $\frac{\bar{\mu}_{B^*}}{I_0 - A} > \frac{\bar{\mu}_B}{I_0 - A}$ for all $B < B^{**}$.

(c) Two special cases where $\frac{\bar{\mu}}{I_0 - A_0}$ is always monotonically decreasing in A_0 and monotonically increasing in B are:

(i) $\bar{r} \approx 0$ and $P(region = 3) \approx 0$.

or

(ii) $\bar{r} \approx 0, -\frac{V_{AA}}{V_A}$ is non-increasing in A, and $I_0 - A_0$ is sufficiently large

Proof: See Appendix A.6. ■

The intuition of Proposition 1 is very simple. The higher is A and the lower is B, the more likely the firm will be able to internally finance the project at date 1. In these states of nature the firm is financially unconstrained, investment is first-best, and the firm is indifferent to interest rate risk. Since $\bar{\mu}$ depends on a weighted average of the willingness to pay in different regions, $\frac{\bar{\mu}}{I-A}$ can always be made arbitrarily small by choosing a high enough A or low enough B. The two special cases exploit the fact that the benefit of risk management is higher in region 2 than region 3a, and always higher in region 1 than region 2 as long as $I_0 - A_0$ is sufficiently large.

Finally, consider a simple extension of the model which takes into account the fact that in practice, interest rates covary with the state of the economy. Assume that the return on the date 0 project is not R_0, but $R_0 + \epsilon$, where ϵ is a function of r_1. Empirically, both nominal and real interest rates are procyclical in the United States, so it seems reasonable to assume $cov(\epsilon, r_1) > 0$.[9]

By taking a Taylor series expansion as before, we can see how introducing this correlation between cash flows and interest rates affects the firm's 'demand for insurance' (the premium on fixed rate debt that makes the firm indifferent between fixed and variable rate debt).[10]

$$\frac{\bar{\mu}}{I_0 - A_0} \approx (1-\alpha)\sigma^2 \left[-\frac{1}{2}\frac{V_{AA}}{V_A}(1-\alpha)(I_0 - A_0) + \frac{V_{rA}}{V_A} \right] \tag{10}$$

where $\alpha = \frac{cov(\epsilon, r_1)}{I_0 - A_0}$. As equation (10) shows, the higher is α and $cov(\epsilon, r)$, the less the firm is willing to pay for insurance against interest rate shocks. The intuition is very simple: when $cov(\epsilon, r) > 0$, the states of nature where repayments on a variable rate loan are high are also the states of nature where the firm is highly profitable, and has a lot of internal funds. In other words, when $cov(\epsilon, r)$ is high, the firm has a natural hedge against interest rate shocks, and has less need for fixed rate debt. FSS show essentially the same result in their setup: if shocks to internal funds are correlated with investment opportunities, firms will attempt to co-ordinate their cash flows and investment opportunities (so that internal funds are high during times when investment opportunities are plentiful).

In empirical work that follows, I test this prediction by estimating α for different industries, and examining whether firms in industries with high α are less likely to use fixed rate debt.

4.3 Final remarks

The model of banks developed here relies heavily on the assumption that banks are not able to costlessly hedge interest rate risk. Although this might seem unrealistic given the large, liquid markets available for such purposes, the literature on the 'bank lending channel' of monetary policy shows, however, that in practice banks are not fully insured against interest rate shocks. Following a monetary contraction, various papers have shown that bank lending falls (Bernanke and Blinder 1992), firms substitute away from bank loans towards commercial paper (Kashyap, Stein and Wilcox, 1993), lending of small banks falls more quickly than lending of large banks

[9] That interest rates covary positively with output is also generally implied by simple monetary rules such as a Taylor rule.

[10] The calculation is exactly the same as in Appendix A.4, except now $\tilde{A}_r$ (the derivative of internal wealth with respect to interest rates when the firm chooses variable rate debt) is $cov(\epsilon, r_1) - (I_0 - A_0)$ instead of just $-(I_0 - A_0)$.

(Kashyap and Stein, 1995), and the lending of banks with smaller buffer stocks of government securities falls more quickly (Gibson 1996, Kashyap and Stein, 2000).

Why banks are not better insured against interest rate risk is an open question. A partial explanation may be that hedging using interest rate swaps involves credit risk, so to the extent that there is adverse selection in the swaps market, hedging using these instruments will be expensive. Such arguments may also help explain the striking fact that only 5 per cent of banks in the United States use derivatives for hedging (Purnanandam 2003).

5 Data and empirical strategy

The model presented above makes four main empirical predictions:

(i) Firms who are more likely to be credit constrained in future periods ie. those who face greater informational problems (high B), or have less internal funds (low A) will be more likely to choose fixed rate debt. [Proposition 1].

(ii) Firms whose cashflows covary more positively with interest rate shocks will be less likely to choose fixed rate debt. [Equation 10].

(iii) The relationship betwen agency costs or internal funds and the propensity to choose fixed rate debt is more likely to be monotonic for larger-sized loans [Lemma 2].

(iv) Credit constrained financial institutions charge a premium on fixed rate loans relative to variable rate loans to compensate them for the interest rate risk of the loan. [Equation 6].

The remainder of this paper tests these predictions using loan-level data drawn from the Federal Reserve Board Survey of Small Business Finance (SBF). The SBF is a cross-sectional survey that contains detailed information on firm characteristics and financing behavior for a sample of US small and medium sized enterprises (defined as firms with less than 500 employees at the end of the reference year).[11] Three surveys have been carried out to date, covering businesses in operation at the end of 1987, 1993 and 1998 respectively.

As well as firm, owner and balance sheet characteristics, the SBF provides detailed information on the firm's most recent loan, including the size of the loan, interest rate paid, category of loan (eg. line of credit, business mortgage etc.), maturity, and what (if any) type of collateral was posted against the loan. Most importantly for the purposes of this paper, the SBF also records whether the loan was issued at a fixed or variable rate of interest.

Table 1 provides information about the total number of firms in each survey, and the number who had applied for and/or been granted external finance. For the 1993 and 1998 surveys, firms were only asked about their most recent loan if they had made a loan application in the past three

[11] For the 1987 survey, the relevant population is the universe of US firms with less than 500 *full time equivalent* employees. For the 1993 and 1998 survey the population is firms with less than 500 *full-time plus part-time* employees. Other things equal, this would tend to make firms in the 1993 and 1998 surveys smaller on average smaller than those in the 1987 survey.

years. Many firms had not applied for credit during that period, others had made loan applications but had always been denied credit. For the 1987 survey, firms provided information about their most recent loan regardless of which year that loan was made. Across all surveys, information on the most recent loan is given for 4673 of the original 11422 firm observations. Of these, 484 of the firms from the 1987 survey had either (i) not provided the year of the loan, (ii) had not stated whether the loan was fixed or floating, or (iii) had not taken out a loan since 1980. Excluding these 484 firms yielded a 'final' sub-sample of 4189 firms.

Tables 2 provides descriptive information about this sub-sample. Since the SBF oversamples large firms and minority-owned firms within the target population, I present averages weighted using the sample weights provided in the SBF, as well as unweighted statistics for comparison. Of the 4189 firms, approximately 70 per cent are corporations. The firms have an average size of 840 thousand dollars ($2.4 million on an unweighted basis), with substantial variation across firms: the largest 1 per cent of firms have assets of $28 million or more, the smallest 1 per cent have assets of $3800 or less.

Relative to other debt contracts, such as household mortgages, the maturity of the loans in the sample is quite short, averaging around 4 years. Most importantly for my purposes, there is substantial variation in firms' choice between fixed and variable rate loans. 51 per cent of loans in the sample were at a fixed rate (58 per cent weighting by the SBF sampling weights), the rest at a variable rate.

Table 3 presents a more detailed breakdown between fixed and variable rate loans, comparing different types of loan and bank loans compared to non-bank loans. There is substantial variation in the proportion of fixed rate loans across different loan types. Importantly though, there is also substantial variation *within* loan types; most categories include substantial proportions of both fixed and variable rate debt. At the extremes, lines of credit are generally (71 per cent) granted at a variable rate, while vehicle mortgages are most likely (88 per cent) to be at a fixed rate. Bank loans are substantially less likely to be issued at fixed rates (44 per cent compared to 76 per cent for non-bank loans).

The first and most basic test is that firms' choices between fixed and variable rate debt are correlated with proxies for financial constraints (ie. high B and low A in the language of the model). Using a binary dependent variable equal to 1 if the firm's most recent loan was at a fixed rate, and 0 if the loan was at a variable rate, I estimate probit regressions of the form:

$$\begin{aligned} \text{P(FIXED=1)} = \; & \Phi(\text{agency costs, cash flows,} \\ & \text{investment opportunities,} \\ & \text{firm, loan and macroeconomic controls},\varepsilon) \end{aligned}$$

I consider three main proxies for agency costs:

1. Size. Small firms are generally thought to face more severe financial constraints than large firms. This result is implied by the theoretical model presented earlier (small firms have less internal funds, worsening moral hazard problems), but there are other reasons to believe it also. Small firms have less ability to access alternative sources of finance, such as public debt and equity markets. And within the class of bank-dependent firms there are substantial economies of scale, both in monitoring by financial intermediaries, and in firm activities that might reduce informational problems (such as the preparation of detailed financial accounts).[12] Consistent with these arguments, Gertler and Gilchrist (1994) argue that financial constraints explain why small manufacturing firms shrink more following monetary contractions, while Perez-Quiros and Timmerman (2000) show that small firms' stock returns are more sensitive to measures of credit market conditions. Also consistent with this view: Petersen and Rajan (1993) using the SBF find that small firms pay a premium on loans from financial institutions.

2. Age. Over time, profitable firms accumulate capital and internal funds to finance investment. Unless the firm's investment opportunities increase proportionately, this implies older firms are likely to face less severe financial constraints than young firms. Hall (1987) and Evans (1987) show that older firms grow more slowly than young firms, consistent with the view that firms' investment opportunities do not increase proportionately with the firm's ability to finance them. Also, the actions of the firm over time can help to reveal private information and build a reputation (Diamond, 1991), and build relationships with financial institutions (Sharpe 1990, Rajan 1992).

3. Banking relationship variables. As well as the age of the firm, the SBF contains variables which directly measure the strength of the firm's banking relationships, namely the length of the relationship with current or primary lenders, and measures of lending concentration (how many banks or lenders the firm borrows from, or the proportion of finance from the firm's primary lender). Using the SBF data, Petersen and Rajan (1994) show that firms with long or concentrated banking relationships rely less on overdue trade credit, a costly alternative form of external finance, suggesting that relationships ameliorate financing problems.

In addition to this set of variables, conditional on future investment opportunities, firms with higher current cash flows will be able to borrow and invest more, and (by the argument made in the model) be more likely to be financially unconstrained in the future. Such firms will have a lower demand for risk management. Conversely, conditional on current cash flows, firms with greater future investment opportunities will have a greater demand for risk management.

I use current profitability scaled by assets as a measure of current cash flows, and sales growth as a proxy for investment opportunities. This interpretation of these variables is subject to some important caveats, however. Sales growth is an imperfect (at best) measure of future investment opportunities. Moreover, current profitability may instead reflect future investment opportunities rather than being a useful proxy for current liquidity. (Kaplan and Zingales, 1997 make this argument as part of their critique of investment-cashflow regressions). Thus, the coefficients on

[12] A simple probit regression using the SBF sample reveals that large firms are much more likely to regularly prepare sets of accounts, and use computer accounting software for financial recordkeeping.

these proxy variables should be interpreted with some caution.

A summary of the main variables of interest and their expected signs is provided below:

Measures of:	**Predicted sign**	**Variables**
Size	-	ln(assets), ln(sales)
Age	-	ln(1+age)
Banking relationships	-	ln(1+relationship length), no. of relationships
Cash flows	-	return on assets (net profit/assets)
Investment opportunities	+	sales growth

I also control for a variety of firm, loan and macroeconomic variables. The set of firm controls includes regional dummies, survey dummies, 1-digit SIC industry dummies, firm leverage (total debt/total assets) and a dummy for whether the firm is incorporated.

The set of macroeconomic controls include the current prime interest rate, the spread between the yield on 10 year government bonds, a corporate bond yield spread (Baa yields minus Aaa yields).

The complete set of loan controls includes dummy variables for the type of lender (bank, non-bank financial institution and non-financial-institution), dummies for the type of loan (line of credit, business mortgage, vehicle loan etc.), dummies for the type of collateral required on the loan, the maturity of the loan, and the size of the loan (scaled by firm size).

Is it necessarily appropriate to include all the loan controls? Many of these controls are clearly endogenous. The argument for not including the loan controls is that, without suitable instruments, the best we can hope for is an estimate of the reduced form effect of agency cost variables on the decision to fix or float. Including loan characteristics (eg. maturity) biases these estimates on the agency cost variables towards zero, because the loan controls are determined by the same factors as the dependent variable.

I thus test the sensitivity of my results to the set of loan controls used. I start with a 'baseline' specification that includes some loan controls for which the problem just outlined is likely to be less important (eg. the type of loan: vehicle loan, operating lease, business mortgage etc.), but exclude others (maturity, size of the loan etc.). I then in turn estimate specifications that include all, then none, of the loan characteristics. Fortunately, as described below, my results are quite robust to the set of loan controls used.

6 Real interest rate volatility

My empirical strategy is based on the assumption that a fixed rate loan reduces the firm's interest rate risk. But is this correct? Interest rates on commercial loans are almost never held fixed in real terms. The interest rate is either tied to an index such as the prime rate, or set at a fixed nominal rate. Since inflation rates fluctuate, a loan with a fixed nominal interest rate may not necessarily be associated with less volatile real interest payments.

To investigate this further, I estimate the variance of $(R_{t+k} - R_t)$ (where R_t denotes the real interest rate at time t) at different horizons, using historical US data from January 1960 until December 1999. This variance is a summary statistic of the extent to which the future real interest rate on a loan is likely to differ from its current rate. (For a loan fixed in real terms, this variance would be zero.) I perform this exercise for the bank prime rate, the Federal funds rate, and a rate fixed in nominal terms, over several different time horizons ($k = 1, 2, 3$ and 5 years).[13] Results are presented in Table 4.

Loans fixed in nominal terms have been associated with smaller fluctuations in real interest rates. Over the entire sample, the variance of the change in the real prime rate over a 1-year period is 3.34, for the Federal funds rate, 4.00. For a fixed nominal interest rate, this variance is only 1.70. The difference is more pronounced over the period since 1982 (after the Volcker disinflation); over this span, the 1-year variance is 0.49 for a fixed nominal rate, but 2.28 for the prime rate and 2.19 for the Federal funds rate. As the table shows, the results are similar at longer horizons up to five years.

Moreover, to the extent that nominal rigidities are important, this comparison is likely to understate the volatility benefits of fixed rate debt. In an environment where wages and prices are fixed in nominal terms, the more relevant measure of volatility may well be the volatility of the nominal rate, rather than the real rate, for interest rate shocks that last a few years or less.

7 Empirical Results

The basic results are presented in Table 5. To make the table easier to read, Table 5 presents just the main coefficient estimates: the complete set of estimates are displayed in Table 14. Coefficients are normalized to show the marginal effect of a change in variable x on the probability of choosing fixed rate debt at the point of means of the data.

Results are presented for a baseline specification (Column 1) as well as a number of alternatives. Column 2 includes two ownership characteristics, whether the owner of the firm also manages the firm, and whether the firm is owned by a single family. Neither are statistically significant, a point discussed in more detail below. Following the discussion in Section 5.2, columns 3 and 4 test how sensitive the results are to the inclusion or exclusion of potentially endogenous loan controls: maturity, dummies for the type of collateral used to secure the loan, the size of the loan, category of loan (eg. line of credit, business mortgage, vehicle loan etc.), and two dummies for the source of the loan (whether the lender was a bank, and whether the lender was not a financial institution).

[13]ie. For the fixed rate, variability in the real interest rate in future periods is due entirely to changes in the inflation rate between t and $t + k$. For the prime rate and the federal funds rate, fluctuations in the real rate may be due to fluctuations in inflation or fluctuations in the nominal rate.

Column 5 excludes loans from before 1985. The reason for doing this is that in 1998 and 1993, firms were only asked about loans made in the previous three years. But in 1987 firms were asked about their most recent loan regardless of which year it was granted. Column 5 checks whether the results are driven by these 'stale' observations from the 1987 sample. Column 6 restricts the sample just to incorporated firms. Since the model discussed earlier assumes limited liability (as do most models in corporate finance), it is important to check that the results are robust to removing partnerships and sole traders from the sample. Column 7 excludes the control for the sales growth of the firm. Although sales growth is often significant, several hundred firms did not report this information, so excluding it allows us to use a larger sample of firms.

Turning to the key agency cost variables, I find that small firms (measured by *log(assets)*) and young firms (measured by *log(1+age)*) are substantially more likely to choose fixed rate loans. My central estimates suggest that at the mean of the data, a doubling of firm size is associated with around a 6-7 percentage point decline in the probability of choosing fixed rate debt, while a doubling of firm age is associated with a decline of around 4 percentage points. The coefficient on firm size is significant at all conventional levels of size (p values < 0.0001), while the coefficient on firm age is generally significant at the 5 per cent level. These results lend prima facie support to the idea that firms who have more difficulty raising external finance are more likely to use fixed rate debt to insure against interest rate shocks.

I also find evidence that firms with lower current cashflows (measured by profits/assets), and firms with greater growth opportunities (measured by sales growth) are more likely to choose fixed rate debt. As discussed above, this too is consistent with costly external finance motivations for risk management, firms with greater growth opportunities have more need for future external finance, while firms with higher current cashflows are more able to finance operations through retained earnings. Two caveats are worth noting, however. Firstly, a good argument can be made that cash flows are really a proxy for investment opportunities (Tobin's q) rather than current liquidity, in which case one might expect the opposite sign on the profitability coefficient. Several papers have made this argument in the context of investment-cashflow sensitivity regressions. Secondly, the results for return on assets in particular are somewhat less robust than for firm age and size; although always correctly signed and generally significant, this variable not is significant in every specification. The critique mentioned above is one possible reason for this, data quality is another. Because many of the firms in the SBF do not produce regular accounting statements except for tax purposes, the quality of accounting information may be somewhat lower than for publicly traded firms.

Table 5 also presents results for three banking relationship variables. 'Number of lenders' measures the breadth of banking relationships (the presumption being that firms who deal with fewer lenders develop stronger relationships, lowering agency costs). The coefficient is never statistically significant. Two variables measure the length of relationships: the length of time the firm has dealt with its primary financial institution, and the length of time the firm dealt with the particular lender who provided the most recent loan. Coefficients on these two variables have opposite signs. The coefficient on 'time with most recent lender' is negative, consistent with a costly external finance view of risk management: firms with short lending relationships face more obstacles obtaining external finance, and thus have a greater incentive to manage internal funds. However, the coefficient is generally not statistically significant, except in Column 4 (1 per cent level) and Column 3 (10 per cent level). Moreover, the coefficient on 'years with primary lender' is positive, not negative as predicted, and always statistically significant.

What explains these results on the 'length of relationship' variables? One possible rationalization is that the finding reflects the implicit insurance contract between the bank and the firm. It is well-known that banks help smooth firms' cost of funds over the interest rate cycle (eg. Berger and Udell, 1991). Perhaps one aspect of this interest rate insurance is the provision of fixed rate loans on favorable terms.

A second possibility is to argue that given the specificity in the relationship between a firm and its primary lender, it is a signal of financial problems if the firm's most recent loan is from a lender other than its primary bank. Under this scenario, a variable like $\ln\left[\frac{\text{years with current lender}}{\text{years with primary lender}}\right]$ is a proxy for financial constraints. Correspondingly, if 'years with current lender' and 'years with primary lender' are included separately, we would predict the first variable will be negatively associated with choosing fixed rate debt, while the second will be positively associated with choosing fixed rate debt.

A final explanation is that, although banking relationship variables are often found to be correlated with access to finance, we have an imperfect understanding of why some firms choose to change their primary lender or to use multiple financial institutions while others do not. Thus, the relationship between relationship length and fixed rate debt may reflect omitted firm characteristics. For example, firms who choose to never to change their primary lender may be more conservative or risk averse, and in turn are also more likely to choose fixed rate debt.

7.1 Cash flows and interest rates

The second implication of the model is that firms should take into account the correlation of interest rate shocks with cashflows when choosing between fixed and variable rate loans. In particular, as equation (10) shows, when $cov(\epsilon, r) > 0$, the states of nature where repayments on a variable rate loan are high are also the states of nature where the firm is highly profitable, and has a lot of internal funds: in other words, the firm has a natural hedge against interest rate shocks. This idea was also expressed succicently by one of the business lenders I surveyed, in response to the question: 'What would you advise a firm are the main disadvantages of a fixed rate loan?':

A variable rate loan tends to follow the overall economy. During good economic times interest rates have a tendency to rise, most businesses will have increased revenues and can afford increased *debt service. During economic downturns interest rates tend to decrease, most businesses need a lower debt service payment to compensate for lack of revenues at this time. Because the debt service on a fixed rate loan does not change it would cause undo* (sic) *stress on the firm during a depressed economic cycle.*

– Survey respondent #4 (business banking manager, midsize bank)

To test this idea, I collected 2-digit SIC industry data for the period 1960-2000, and used it to estimate the following regression:

$$\ln(\frac{y_{it}}{y_t}) = \alpha_{i,0} + \alpha_{i,1}t + \sum_{k=0,1}\beta_{i,k}r_{t-k} + \varepsilon_{it} \tag{11}$$

I regress the output share of 2-digit industry i on a constant, a time trend, and the 12-month riskless interest rate (contemporaneous and lagged one period). I use this regression to produce estimates of how correlated industry cash flows are with interest rates. That is, $\Sigma\beta_i$ is the empirical counterpart to $cov(\epsilon, r)$. I then replace the SIC dummies from the basic probit models with these estimates of $\Sigma\hat{\beta}_i$.

Evidence that the coefficient on $\Sigma\hat{\beta}_i$ is negative would be consistent with the 'natural hedge' view outlined above. A positive coefficient would suggest the opposite: that industries where $cov(\epsilon, r) > 0$ are particularly in need of cash in times when interest rates are high. This could be true if the investment opportunities of such firms increased even more quickly than output and cash flows during booms.[14]

Results from this exercise are presented in Table 6. The coefficient on the estimated $cov(\epsilon, r)$ variable is negative as predicted and significant at either the 5 per cent or 10 per cent level. In other words firms in industries where $cov(\epsilon, r) >> 0$ do in fact hedge less aggressively. The interpretation of the coefficient is as follows: a firm whose share of output increases by 1 per cent when interest rates increase by 1 percentage point (ie $\Sigma\hat{\beta}_i = 0.01$) is around 1.5 percentage points less likely to choose fixed rate debt (compared to a firm whose share of output is independent of interest rate shocks). Moreover, the true estimate is likely to be much larger, since the estimated $\hat{\beta}_i$ are surely a very noisy estimate of how firm cash flows vary with the component of the business cycle measured by interest rates.

7.2 Pricing fixed and variable rate loans

The model also predicts that, assuming bank are credit constrained, fixed rate debt should be relatively expensive, controlling for firm and loan characteristics as well as the state of the yield curve. I am able to test this hypothesis for my sample, since amongst the loan characteristics provided for the most recent loan is the actual interest rate paid on the loan.

[14] A simple way to incorporate this idea into the model would be to change the production function at date 1 to $\theta f(I)$, where θ is stochastic and has the property that $cov(\theta, r) > 0$. In this case, even if $cov(\epsilon, r) > 0$, the firm will still be willing to pay a high premium to avoid interest rate risk as long as $cov(\theta, r) >> cov(\epsilon, r)$.

The null hypothesis is that there should be no premium on fixed rate debt beyond that implied by the yield spread over the life of the loan. In other words, the null is:

$$\delta^f_{t,t+j} - \delta^v_t = spread_{t,t+j} \tag{12}$$

where $\delta^f_{t,t+j}$ denotes the fixed rate for a loan maturing in t periods, δ^v_t denotes the current variable loan rate, and $spread_{t,t+j}$ denotes the yield spread on a government security with maturity j relative to short term government securities.

To test this, I estimate a regression of the interest rate on: (1) a dummy for whether the loan is fixed, (2) a variable set equal to $spread_{t,t+j}$ if the loan is a variable rate loan, and 0 if it is a fixed rate loan, and (3) a set of firm, loan and macroeconomic controls (including a control for the current spot interest rate). Under the null hypothesis embodied in equation (12), the coefficient on variable (1) (the fixed rate dummy) should be equal to zero.

Results for this regression are presented in Table 7. As the table shows, the fixed rate dummy variable is significant and positive in all the specifications. The point estimates suggest a fixed rate loan is associated with a premium of around 40-45 basis points over an equivalent maturity variable-rate loan, after controlling for the shape of the yield curve.

Looking at the rest of the results, I find that large firms pay lower interest rates on their loans, consistent with the idea that firm size is a reasonable measure of agency costs. Young firms also on average pay a higher rate, although this is not statistically significant except in column (3). Petersen and Rajan (1993) estimate a similar regression to this one using the 1987 SBF only. Although they do not use the SBF survey weights, Petersen and Rajan find similar results (most notably, they also find a premium on fixed rate debt of around 40 basis points).

Finally, the last two column split the sample into loans from 1993, and loans from surveys other than 1993. The coefficient on the fixed rate premium is substantially higher for the 1993 sample. One possible explanation for this is since most of the loans from the 1993 survey were taken out during the 'credit crunch' years of 1991-93, banks were more credit constrained during this period and thus required a higher premium to compensate them for interest rate risk.

How does this estimated premium of around 40-45 basis points compare quantitatively to the predictions of the model from Section 4? The model as written predicts a premium of $\frac{\sigma^2}{1+\bar{r}}$ on fixed rate debt. σ^2 represents the variance of the holding period return on a variable rate loan, conditional on interest rates at the beginning of the loan. As a proxy of this, I calculate the variance of $(ff_{t,t+36} - 3\ year_t)$ where $ff_{t,t+36}$ is the 36-month cumulative federal funds rate, and 3 $year_t$ is the cumulative return on holding a 3 year treasury bond over the same 36 month period. I calculate this variance over the post-Volcker period as well as a longer time span (since 1960). These variances are 40 basis points and 57 basis points. $1 + \bar{r} \approx 1.06^3$ over both these periods, so the two estimates of $\frac{\sigma^2}{1+\bar{r}}$ expressed on an annual basis are $\frac{1}{3}\frac{39.6}{1.06^3} = 11$ basis points and $\frac{1}{3}\frac{56.8}{1.06^3}$ =16 basis points respectively.

These estimates are somewhat lower than those from the empirical evidence presented earlier. One factor which would tend to decrease the premium generated by the model is my simplifying assumption that the bank is not able to raise non-deposit finance between periods. In my model, when banks are credit constrained a one-unit increase in bank equity causes a 1 unit increase in lending next period. But in a model like Holmstrom and Tirole (1997) or Stein (1998), when banks are credit constrained a one-unit increase in bank equity causes a $k >> 1$ unit increase in lending, because the additional equity provides pledgeable internal wealth that can be used to raise further external finance. In practice the debt/equity ratios of financial institititions are high (between 10 and 20), so this multiplier effect could be quite large. (σ^2 really represents the variance in the shadow value of bank internal wealth, which is might be lower or higher than the variance of interest rates themselves, depending on assumptions).

Another possibility is that the SBF estimates are too high. The main shortcoming with this regression is the potential for selection bias. Firms choose endogenously whether to take a fixed or variable rate loan. If this choice is correlated with unobserved firm characteristics that also affect the interest rate on the loan (as is almost certainly the case) the coefficient on the fixed rate debt dummy variable will be biased. There is no obvious instrument available: theory suggests that any variable that affects the fixed vs variable decision is also likely to affect the interest rate on the loan.

Subject to this caveat, however, results from the SBF do suggest that, at least in this sample, fixed rate debt is relatively expensive compared to variable rate debt. This finding is also consistent with several responses by business lenders I interviewed, responding to the question "What are the disadvantages of a fixed rate loan relative to a variable rate loan?":

'Fixed rate loans are more expensive. As a Bank we are taking greater risk with a fixed rate loan; therefore, cannot offer as desirable terms for a fixed rate as we can for a variable rate loan'
– Interviewee #5

'Depending on the term of the loan and the general interest rate environment, variable rate loans are much cheaper than fixed rate loans'

'Fewer banks will be willing to do a fixed rate loan versus variable'
– Interviewee #6

'*Interest rates on variable rate loans are lower initially, and probably over the life of the loan (I do not expect interest rates to spike)'*

– Interviewee #2

Also, interviewee #2 also described how his bank made an explicit effort to 'push' clients towards choosing variable rate loans as a method of reducing interest rate risk. Of the other three respondents, interviewee #1 suggested variable rate loans would often be cheaper depending on the interest rate environment, while interviewees #3 and #4 did not report that the interest rates on fixed rate loans were systematically higher than on variable rate loans. None of the survey respondents claimed that fixed rate debt was cheaper on average than variable rate debt.

In future work, I intend to conduct a more robust large-sample test of the hypothesis that bank credit constraints affect the pricing of fixed and variable rate loans, using data from Bank Call Reports and the Federal Reserve Board's Survey of the Terms of Business Lending. For example, one implication of the model is that, cross-sectionally, those banks which previous research has shown are more sensitive to interest rate shocks (small banks and banks with smaller buffer stocks of government securities) should price fixed rate debt more conservatively.

7.3 How robust are the results?

Tables 8, 9 and 10 present various alternative specifications to test the robustness of the results in Table 5. The first part of Table 8 tests for the significance of a number of additional ownership variables: the age, years of business experience, and ownership share of the principal owner, a dummy for whether the owner of the firm also manages the firm, and a dummy for whether the firm is owned by a single family (these last two were also included in the specification in Table 5 column 2). The first three of these ownership variables were only collected in the 1993 and 1998 SBF surveys, and were not reported by all firms, so we are left with a smaller sample than before, between 2000 and 2400 observations depending on the specification.

As the top line of Table 8 shows, this set of ownership variables has little explanatory power in explaining the choice between fixed and variable rate debt. I am never able to reject the null hypothesis that the coefficients on these five variables are jointly equal to zero. None of the individual coefficients are significant either, with the exception of the coefficient on 'principal owner also manages firm', which is significant in Column 3, but insignificant in the other two specifications.

Given that most of the firms in the SBF are small and closely held, this lack of explanatory power is perhaps surprising. It is possible though, that ownership preferences and characteristics are very important, but along dimensions that are not very correlated with the the ownership variables measured in the SBF. A more powerful test would test for the significance of ownership fixed effects using a panel data set (this approach is not possible with the SBF, which is a cross-section). Bertrand and Schoar (2002) using this approach and find that CEO fixed effects are important in explaining financing decisions by publicly traded firms.

The second part of Table 8 restricts the sample to bank loans only. As mentioned earlier, bank loans are less likely to be at a fixed rate than non-bank loans. But the relationship between the fixed-variable choice and firm characteristics is similar to before. The standard errors are somewhat larger, because the sample size is smaller than before. Finally, the last column of Table 8 uses an alternative measure of firm size (log sales instead of log size). The results are essentially identical – the coefficient on log sales is -0.062 and significant at the 1 per cent level.

Table 9 presents model estimates after breaking down the sample by survey year. There are some fairly substantial differences in the coefficient point estimates across surveys. Some, but not all of these differences can be explained by sampling error.[15] Perhaps the most striking feature of the table is that the point estimates and statistical significance of the key agency cost variables is substantially less in the 1998 SBF than in the previous two surveys. For example, point estimates on firm age, firm size, return on assets and sales growth are all smaller in magnitude in 1998 than 1993.

What explains these differences? A speculative but plausible reason is that the financial constraints were much less binding in 1998 than earlier surveys (1993 in particular). Firms in 1998 were in general highly profitable, and did not rank access to finance as an important problem.[16] Interest rate and inflation volatility was low, reducing the probability that an interest rate shock could severely affect a firm's balance sheet. Because of these factors, the consequences of suboptimally choosing variable rather than fixed (or vice versa) were relatively small. Conversely, most loans in the 1993 sample were taken out during the early-90s recession, a recession also associated with a shortage of bank credit (Bernanke and Lown, 1991), which might help explain why the point estimates drawn from this survey are larger and more significant.

Finally, Table 10 divides the sample by type of loan, presenting separate estimates for lines of credit and non-lines of credit. There are reasons to believe the results might look quite different between the two subsamples. Unlike the other types of loan, the interest rate risk of a floating rate line of credit is 'contingent' in the sense that the firm faces risk only to the extent that it subsequently draws down the credit line in the future. Furthermore, most lines of credit are variable rate (71 per cent), while a majority of other loans are fixed.[17] Examining Table 10, the results for lines of credit do look somewhat different than for other loans. The coefficient on firm size is somewhat larger, on firm age and ROA somewhat smaller (and no longer statistically different

[15] To test whether the differences across surveys are due to sampling error, I estimate the model across all years, interacting the main variables of interest (log firm age, log assets, sales growth, return on assets and the banking relationship variables) with survey dummies. I then test for equality across the coefficients on each set of survey-interaction variables. I reject the null of equality at the 10 per cent level for two of the four: log firm age (p = 0.088) and sales growth (p = 0.059).

[16] The most important problem cited by firms in the 1998 survey was a shortage of labor! Reliance on internal finance is also reflected in the small proportion of firms from the 1998 survey who had taken out a recent loan (only 19 per cent of the 'most recent loan' observations come from the 1998 SBF). The strong economy at the time seems like a plausible explanation for this: firms in 1998 were much more profitable (median ROA of 26.6 per cent compared to 14.2 per cent in 1993) and thus more able to fund operations and investment from retained earnings. [The low number of 1998 loan observations also reflects a change in survey design; unlike the previous two surveys data on the most recent loan was not collected in 1998 for firms whose only new loan was the renewal of a pre-existing line of credit. But this is only a partial explanation, since there was a decline in the numbers of all types of loans, not just lines of credit.]

[17] The institutional features of lines of credit make it more difficult to issue such loans at a fixed rate. The main problem with a fixed rate line is that a subsequent change in market rates will affect the wedge between market rates and the cost of funds on the credit line. If rates fall substantially, the credit line becomes very expensive. If rates rise, the firm can potentially exploit an arbitrage opportunity by aggressively drawing on the line of credit and investing the proceeds at the new higher market rate. These scenarios are possible only because, unlike the other types of loan in my sample, credit lines give the firm discretion *ex post* to vary the actual amount borrowed contingent on how interest rates evolve. I thank Allen Berger for bringing these issues to my attention.

from zero). However, I am unable to reject that the null that these differences in coefficient point estimates are due to sampling error.[18]

7.4 Risk aversion

Statistically, the most robust result presented so far is that small firms are more likely to choose fixed rate debt. I interpret this result as evidence that firms are hedging in response to credit constraints: small firms have less access to capital markets and face more severe informational problems, and thus have a greater incentive to smooth fluctuations in internal funds.

But there is another plausible explanation, rooted in the risk aversion of the owner rather than in corporate finance. If the firm is closely held (as most of the firms in the SBF are) and risk aversion is declining in wealth (or firm owners' consumption behaves like a buffer-stock style model), the premium the owner will be willing to pay for insurance against interest rate shocks will also be declining in wealth. If large firms are owned by more wealthy owners, this mechanism could generate a negative correlation between firm size and the probability of choosing fixed rate debt.

I am able to test this hypothesis directly using the 1998 survey, which includes a direct measure of the wealth of the firm's primary owner. If the fixed rate vs variable rate choice is driven by risk aversion and we include both firm size and owner wealth as explanatory variables, only the second of these should be significant.

I use three different model specifications. In each case present estimates from a regression excludes the owner wealth variable, then an otherwise identical specification that includes owner wealth. (Comparing the two shows directly how controlling for wealth affects the coefficient on log assets.) Results from this exercise are shown in Table 11.

The results show that the propensity for small firms to choose fixed rate loans is relatively robust to controlling for owner wealth. However, inferences are somewhat fragile, because of the small number of observations in the 1998 survey relative to 1993 and 1987. The coefficient on log assets in each case is around 30 per cent smaller, but still correctly signed, and with the exception of the third specification, still significant (for the third specification the p value is 0.12). Notably, the coefficient on log wealth *is* negative as predicted, and is significant in two of the three specifications, suggesting that the firm risk management behavior is in part determined by the risk preferences of the owner. Moreover, the size of the elasticities is relatively similar, around 0.03. Given the small number of observations for 1998, these conclusions are somewhat tentative, it would be interesting to re-run this regression once the fourth wave of SBF data is available.

[18] Using the same strategy as for Table 8, I estimate a model which uses all the data but includes an additional set of variables generated by interacting each of the main variables of interest (log firm age, log assets, sales growth, return on assets and the banking relationship variables) with a dummy for line of credit. None of these variables were significant at the 10 per cent level.

7.5 Market timing

Several recent papers have found evidence of 'market timing' in corporate finance decisions. For example, Baker and Wurgler (2002) show that listed firms are more likely to issue equity when market values are high relative to book values or past market values, and that this has a persistent effect on firms' capital structures. Faulkender (2003) finds that the final interest rate exposure of his sample of corporate debt issuances is strongly affected by the shape of the yield curve – firms are much more likely to choose variable rate debt when the yield curve is upward sloping (and thus current interest rates are low relative to expected future rates).

Is there similar evidence in this context? I use two alternative measures of yield spreads to test for the presence of market timing effects. Firstly, in virtually all the regressions presented so far I have included a yield curve spread amongst the macroeconomic controls: the difference between the market yield on a 10 year government security and a 1 year government security during the month the loan was taken out.

Secondly, in specifications where I include all the additional loan controls (maturity, loan size, and so on) I include a variable that measures the yield spread over the life of the loan. The advantage of this variable is that, conditional on the maturity of the loan, it captures the exact interest rate timing decision faced by the firm (the fixed rate will reflect the expected interest rate over the life of the loan, while the corresponding variable rate will reflect instead a current spot rate, such as the Federal funds rate or prime rate). The disadvantage is that the loan maturity (which is endogenous) is required to construct this measure of market timing.

Results using both these measures of market timing are presented in Table 12. Columns 1-3 use just the 10 year yield spread variable. Column 1 exactly reproduces Column 1 of the basic table of regression results (Table 5). The ten year yield spread is negatively signed but not significant in this specification. Although this suggests market timing effects are not important, remember that this specification includes survey dummies, removing most of the time-series variation in the 10 year yield spread. To isolate how important this is, Column 2 replicates Column 1 except the survey fixed effects are dropped. In this specification, the coefficient on the 10 year yield spread is negative and significant at the 10 per cent level. Column 3 includes additional loan controls, when these are added the coefficient becomes significant at the 5 per cent level.

Column 4 takes the specification from Column 2 but replaces the 10 year yield spread with a different yield spread variable (the yield spread measured over the particular maturity of the loan in question). This 'loan yield spread' variable is negative but not statistically significant. Column 5 also uses this variable but includes all the loan characteristics

Thus, the evidence for 'market timing' as defined in this context by Faulkender (2003) is weak at best. As an aside, although evidence of market timing is often viewed as evidence of behavioral or psycological influences on corporate finance decisions, there is a possible rational explanation.

Namely, if the firm is currently very short of cash, it may make sense for the firm to 'backload' interest payments on its debts, so that payments are low immediately, but then higher in the future when the firm has more disposable funds. In other words, it might make sense for such a firm to choose whichever of fixed or variable rate debt minimizes current interest payments.

7.6 Out of sample evidence

One possible criticism of the analysis here is that there is not sufficient cross sectional variation across firms (ie. all the firms in the sample are in some sense 'small' since even the largest have only 500 employees).

At one level this is an advantage, since the firms in the SBF are overwhelmingly reliant on bank debt rather than direct access to capital markets; this substantially simplifies the analysis since we do not need to consider the 'fixed or variable' decision jointly with the firm's decision to borrow from banks or directly from capital markets (or the decision whether or not to use derivatives). As an attempt to deal with the critique, it is, however useful to conduct out-of-sample comparisons: how does the proportion of fixed and variable rate debt in the SBF compare to the proportion of fixed rate debt for much larger firms?

One such source of evidence is Booth and Chua (1995), who examine a sample of large bank loans from Loan Pricing Corporation's Dealscan database. The loans are much larger than those in the SBF with a mean loan size of \$184m, and median loan size of \$36m. Booth and Chua report that almost all the loans in their sample are at a variable rate.

Similar results are reported in Faulkender (2003). 90 per cent of the bank loans in Faulkender's sample were originally issued at a variable rate (a further 19 per cent were subsequently swapped to a fixed rate using interest rate derivatives). By comparison, less than half of the loans in the SBF sample were issued at a fixed rate; the comparison is even more stark if we exclude lines of credit (which are generally floating) from the SBF average.[19]

These comparisons provide some external validation for the regression results presented in this section. Firms in the SBF sample, taken as a whole, are both smaller and more likely to choose fixed rate debt than comparison samples of much larger firms. This is consistent with my in-sample results that larger SBF firms are less likely to choose fixed rate loans. Also, although unfortunately Booth and Chua do not specifically regress firm size or loan size on the propensity to fix, they do report (by different size classes) the proportion of loans that fall into an 'Other' category which

[19] Only 32 per cent of the non-line-of-credit loans in my sample involve a variable interest rate. Even for firms with more than \$1m in assets, the percentage is only 45 per cent. (By comparison, even after taking into account the final exposure those loans that are subsequently swapped to a fixed rate, 71 per cent of Faulkender's (2003) sample consists of variable rate loans).

The institutional features of lines of credit make it more difficult to issue such loans at a fixed rate. Otherwise the firm can exploit arbitrage opportunities when interest rates rise, aggressively drawing on the line of credit and investing the proceeds at the new higher market rate. This is possible because the option-like features of lines of credit; unlike the other types of loan in my sample, lines of credit give the firm discretion *ex post* to vary the actual amount borrowed. I thank Allen Berger for drawing these facts to my attention.

bundles together fixed rate loans as well as some other relatively uncommon loan types. This 'Other' category makes up 43 per cent of the loans in the smallest size category (loans < $250 000), but close to zero per cent of the loans in the largest size category (loans >$500m). Although not the cleanest test, this is suggestive that the propensity to fix is negatively correlated with size *within* Booth and Chua's sample, as well as *between* Booth and Chua's sample and the SBF.

To sum up, all of this evidence suggests that the stylized fact that small firms choose fixed rate debt is not just true for the SBF sample, but also more generally across a broader range of firm sizes.

8 Interviews with business lenders

As mentioned above, to complement the large-sample evidence presented so far, I also conducted a series of interviews with business lending professionals from various banks in the Washington, DC and Boston, MA metro areas.

One motivation for conducting these interviews was to collect additional information not provided in the SBF. For example, the SBF provides no explicit information about whether the firms in the sample make use of derivatives (such as interest rate swaps). In principle this could bias my results – perhaps the large firms in my sample are choosing variable rate loans, but are then swapping them to a fixed rate using interest rate swaps. By asking business lenders what proportion of the firms they deal with make use of derivatives, I can get a sense of how serious a problem this might be. A second purpose was to improve my institutional knowledge, and learn about additional factors bearing on the fixed vs variable rate decision of which I would have been otherwise unaware. A third purpose was simply to learn how consistent my empirical results are with anecdotally reported industry practice. A finding that the two are grossly inconsistent would be a serious cause for concern.

This process of interviews is ongoing research. I have conducted six interviews so far, and intend to conduct about 15-20 in total. I have asked nine questions in each interview, that fall into five main categories. These are listed below, along with a brief summary of the tenor of the responses :

A. What are the advantages and disadvantages of fixed vs variable rate loans; is the 'cost' (the expected total interest expense plus any transactions costs) higher or lower for fixed rate debt? (Q1,Q2,Q4)

All respondents cited the lack of uncertainty about future interest rates as being the main benefit of fixed rate debt. As already discussed in section 8.3, a majority of interviewees reported that fixed rate debt involves higher total interest costs in expectation. Respondents also cited prepayment penalties as being a disadvantage of fixed rate debt (there are generally no prepayment penalties on variable rate loans, but there are on fixed rate loans). Answers to this section also partially seemed to reflect individual respondents views about the future path of interest rates. 4

of the 6 respondents told me that they were sometimes given directives by senior management to favor variable or fixed rate debt.

B. What type of firms are more likely to choose fixed rate debt or variable rate debt, and what proportion of loans are issued at a fixed rate? (Q3).

Respondent #6 cited small firms as being more likely to use fixed rate loans. Respondent #1 did not believe there were many obvious trends, although doctors 'did not care' while construction companies 'love fixed rate loans'. Respondent #2 suggested more risk-averse firms were more likely to choose fixed rate loans. Respondent #4 suggested more conservative firms, as well as those in the non-profit sector (who generally face a fixed budget constraint).

C. What is the average and largest size of the firms you deal with (Q5,Q6)

This ranged from maximum $2.5m (respondent #1), to maximum $20m (respondent #2 and #6)

D. What proportion of the firms you deal with make use of derivatives? (Q9)

4 out of 6 interviewees reported that none of the firms they dealt with used derivatives. Respondent #1 suggested a small proportion do, while respondent #2 estimated 2/50 used derivatives.

E. Generally, how much refinancing is there in the business lending market (Q7)

Respondents generally said that there had been a substantial amount of refinancing in recent years because of the fall in interest rates, but less common in general (especially for shorter maturity loans).than the household mortgage market.

9 Quantitative exercise

As a final exercise, I examine how important (in a quantitative sense) the choice between fixed and variable rate debt is for the firms in my sample. In particular, how important is the decision relative to the magnitude of 'traditional' derivatives-based risk management activities undertaken by large firms?

A natural point of comparison are estimates produced by Guay and Kothari (2003). They calculate the magnitude of the cash flow generated by the average Fortune 500 firms' derivatives portfolio following a 3.6 percentage point change in interest rates. (These cash flow estimates are then scaled by various firm characteristics, such as total assets, interest rate expenses etc.)

To produce comparable estimates for my sample, I calculate the additional interest expense that would be incurred by the firm on its most recent loan following a 3.6 percentage point change in interest rates, assuming the loan was taken at a variable rate. I then scale these by the same firm characteristics as Guay and Kothari. The comparison is shown in Table 13.

In each case, the difference in interest rate sensitivity induced by the firm choosing a variable rather than fixed interest rate on its most recent loan is much larger than the effects of derivatives use by the average Fortune 500 firm. The sensitivity associated with the most recent loan is larger by a factor between 2 and 8 relative to the subsample of Fortune 500 firms that use interest rate derivatives, and even larger again in comparison to the entire Fortune 500.

This simple comparison suggests that the focus of the existing risk management literature on the use of derivatives may be partially misplaced. The risk management margin considered in this paper (fixed vs variable rate loans) appears to be more important empirically than the use of derivatives by even the largest non-financial firms.

10 Conclusions

This paper presents new evidence on corporate risk management by analyzing firms' choices between fixed and variable rate loans. In constrast to other papers in this literature that focus on hedging using deriviatives, I find strong evidence that small, young, privately held firms have the greatest 'demand for risk management'. I also find evidence that firms choices also vary systematically with industry sensitivity to interest rate shocks, and that financial institutions charge a premium on fixed rate debt to compensate them for interest rate risk. Finally, I present evidence from interviews with business lenders consistent with my large sample findings.

The main theoretical contribution of this paper is to analyse interest rate risk management in an environment when both the buyer (the firm) and seller (the bank) are credit constrained. Although both parties are risk neutral, credit market imperfections mean that both have a demand for interest rate risk management, and that insurance against interest rate risk is priced. This introduces a new cost of hedging relative to most papers; whether the firm chooses to insure against particular shocks depends on how credit constrained the firm is relative to the provider of the insurance. In this respect, there is an interesting parallel with Froot (1998), who shows how premiums and the availability of insurance in the reinsurance market are affected by shocks to the capital of reinsurers. The fact that interest rate premiums on fixed rate debt are highest around the credit crunch of the early 1990s is perhaps analogous to Froot's findings that premiums charged by reinsurers increased substantially after Hurricane Andrew. This raises several interesting questions for future research: for example one could test whether the fixed rate premium is higher amongst the types of financial institutions which previous research has shown are more sensitive to periods of tight money.

The theory and evidence in this paper also has implications for literatures on the 'financial accelerator', and the credit channel of monetary policy. My evidence is consistent with the predictions of Krishnamurthy (2003), who shows in a general equilibrium framework that hedging is valued as a way of muting the multiplier effects from shocks to collateral identified by Kiyotaki and Moore (1997). Supportive of the balance sheet channel of monetary policy, Gertler and Gilchrist (1994) show that small manufacturing firms are more affected by tight monetary policy; evidence from this paper that small firms are more likely to use fixed rate debt is thus in one sense consistent with Gertler and Gilchrist's findings (if small firms are more sensitive to tight money they should be more likely to hedge against it). It also however raises a question: if small firms use more fixed rate debt, why they are still more sensitive to contractionary monetary policy.

Finally the model in this paper makes a new prediction about the effect of financial innovation on the effects of monetary policy. Several economists have noted that improved risk management by banks is likely to weaken the importance of the bank lending channel. For example Cecchetti (1996) notes [in a discusion of the relative importance of the balance sheet and bank lending channels] that 'with the introduction of interstate banking and the development of more sophisticated pools of loans, it is only the balance sheet effects that will remain'. The model presented here predicts that, given the interaction between the risk management activities of firms and financial institutions, improved risk management by banks will lead to a transfer of risk away from firms and towards banks (since banks have an improved ability to bear that risk). Thus, financial innovation may weaken both the bank lending *and* balance sheet channels (even if small firms never directly make use of the new hedging instruments). The recent proliferation of more flexible and customized types of business and consumer loans is perhaps evidence of this 'risk sharing' effect in action.

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12 Appendix: Proofs and calculations

I use the notation X_y to signify the partial derivative of X with respect to y evaluated at the optimum, X_{yz} to represent the second derivative of X with respect to y and then z etc. I use bold face (eg. $\mathbf{X}_y$) to represent the total rather than partial derivative.

A.1. Date 1 investment is concave in internal funds:

Suppressing all the time subscripts, I_1^* is defined by:

$$\left[\frac{B}{p_H - p_L} + \frac{1+r}{p_H}\right] I^* = f(I^*) + A\frac{1+r}{p_H} \tag{13}$$

Differentiating with respect to A :

$$\left[\frac{B}{p_H - p_L} + \frac{1+r_1}{p_H} - f_I\right] I_A = \frac{1+r_1}{p_H} \tag{14}$$

Since $f'(I^*)I^* < f(I^*)$, $I^*\left[\frac{B}{p_H-p_L} + \frac{1+r_1}{p_H} - f_I\right] > \left[\frac{B}{p_H-p_L} + \frac{1+r_1}{p_H}\right] I^* - f(I^*) = A\frac{1+r_1}{p_H} > 0$. Thus $I_A > 0$. Taking the second derivative and substituting for $\frac{B}{p_H-p_L} + \frac{1+r_1}{p_H} - f_I$ from (14), we get:

$$I_{AA} = \frac{p_H}{1+r_1} I_A^3 f_{II} < 0 \tag{15}$$

A.2. Date 1 profit is concave in internal funds:

The value of the firm if the project succeeds is given by:

$$V = f(I^*) - \frac{r}{p_H}(I^* - A) \tag{16}$$

The first-order and second-order conditions are:

$$V_A = [f_I - \frac{r}{p_H}]I_A + 1 \tag{17}$$

$$V_{AA} = \underbrace{[f_I - \frac{r_1}{p_H}]}_{>0}\underbrace{I_{AA}}_{<0} + \underbrace{f_{II}}_{<0}\ \underbrace{I_A^2}_{>0} \tag{18}$$

As can be seen from the equation, $V_{AA} = \frac{d^2V}{dA_1^2}$ is unambiguously negative.

A.3. Proof of Lemma 1: $cov(R_1, r_1) < 0$.

The market clearing condition for loanable funds at the beginning of date 1 is:

$$\int_0^1 I_{1,i} - A_{1,i} di = \frac{1-\varphi}{\varphi} R_1 + E_1 \tag{19}$$

Note that $E_1 + \int_0^1 A_{1,i} di = E_0 + A_0 + (R_0 - I_0)$, that is, the sum of the total equity held by banks and firms at the beginning of date 1 is a constant, equal to the sum of date 0 bank and firm equity $(E_0 + A_0)$ plus net returns from the date 0 project $(R_0 - I_0)$. Thus, we can write:

$$\int_0^1 I_{1,i}(\underset{-}{r_1}) di = \frac{1-\varphi}{\varphi} R_1 + [E_0 + A_0 + R_0 - I_0] \tag{20}$$

Therefore a negative shock to R_1 must reduce total investment $\int_0^1 I_{1,i}(r)$. Since I_1 is decreasing in r_1 for all firms, this implies dr_1/dR_1 and thus $cov(r_1, R_1) < 0$. ■

A.4. Taylor series expansion

The premium $\bar{\mu}$ that makes the firm indifferent between fixed and variable rate debt is given by:

$$\mathbf{E}V(\tilde{A}, r) = \mathbf{E}V(\bar{A} - \bar{\mu}, r) \tag{21}$$

where $\tilde{A}$ is the level of internal wealth if the firm chooses a variable rate loan (ie $\tilde{A} = R_0 - (\delta_v + r_1)(I_0 - A_0))$, and $\bar{A}$ is the expected value of $\tilde{A}$.

The second-order Taylor series expansion of the left hand side around $(\bar{A}, \bar{r})$ is:

$$\begin{aligned} V(\tilde{A}, r) &= V(\bar{A}, \bar{r}) + (\tilde{A} - \bar{A})V_A + (r - \bar{r})V_r + (\tilde{A} - \bar{A})(r - \bar{r})V_{rA} \\ &+ \frac{1}{2}(r - \bar{r})^2 V_{rr} + \frac{1}{2}(\tilde{A} - \bar{A})^2 V_{AA} \end{aligned} \tag{22}$$

The Taylor series expansion of the right hand side around $(\bar{A}, \bar{r})$ is:

$$V(\bar{A} - \bar{\mu}, r) - V(\bar{A}, \bar{r}) = -\bar{\mu}V_A + \bar{\mu}^2 V_{AA} + (r - \bar{r})V_r + \frac{1}{2}(r - \bar{r})^2 V_{rr} - \bar{\mu}(r - \bar{r})V_{Ar} \tag{23}$$

Putting these two together and taking the expectation with respect to r:

$$\tilde{A}_r \mathbf{E}(r - \bar{r})^2 V_{rA} + \frac{1}{2}\tilde{A}_r^2 \mathbf{E}(r - \bar{r})^2 V_{AA} = -\bar{\mu}V_A + \bar{\mu}^2 V_{AA} \tag{24}$$

Recalling that $\tilde{A}_r = -(I_0 - A_0)$, denoting the variance of the interest rate $\mathbf{E}(r - \bar{r})^2$ by σ^2, removing the $\bar{\mu}^2$ term (which is vanishingly small) and rearranging, we can rewrite this equation as:

$$\frac{\bar{\mu}}{I_0 - A_0} = \sigma^2 \left[-\frac{1}{2}\frac{V_{AA}}{V_A}(I_0 - A_0) + \frac{V_{rA}}{V_A} \right] \tag{25}$$

which is equation (6) from the main text.

A.5. Proof of Lemma 2.

If a firm with $A = A^*, B = B^*$ is in region i for $\theta = \theta^*$ then a firm where $A = A^*, B > B^*$ or $A = A^*, B > B^*$ is also in region $\geq i$ for $\theta = \theta^*$. (This proves the first part of the Lemma). Moreover assuming firm A^*, B^* is in region $< i$ for some realization of θ and θ has continuous support, there exists θ so that firm A^*, B^* is in region $< i$ but firm $A = A^*, B > B^*$ or $A = A^*, B > B^*$ is in region $\geq i$. This proves the second part of the Lemma. ■

A.6. Proof of Proposition 1.

Denote firm $A^*, B^{*\prime}s$ premium on fixed rate debt by $\bar{\mu}_{A^*,B^*}$. Remember that this premium is given by $\frac{\bar{\mu}}{I_0 - A_0} = \sum_{i \in \{1a,1b,2,3\}} P_\theta(Region{=}i) \times E_\theta \left[\frac{\bar{\mu}}{I_0 - A_0} | Region{=}i \right]$. Using Lemma 2, as $B \to 0$ or $A \to \infty$, $P(region = 1a) \to 1$ and $\frac{\bar{\mu}}{I_0 - A_0} \to 0$. Therefore it is always possible to choose a $B = B^{**}$ small enough, or $A = A^{**}$ large enough so that $\bar{\mu}_{A^*,B} < \bar{\mu}_{A^*,B^*}$ for all $B < B^{**}$ or $\bar{\mu}_{A,B^*} < \bar{\mu}_{A^*,B^*}$ for all $A > A^{**}$. This proves Part (a). Part (b) follows from the facts that (1) as $\bar{r}_1 \to 0$, $P_\theta(Region{=}1b) \to 0$ (2) $\frac{\bar{\mu}}{I_0 - A_0} |Region{=}2 > \frac{\bar{\mu}}{I_0 - A_0} |Region{=}1a$, and (3) when $-\frac{V_{AA}}{V_A}$ is non-increasing in A, $\frac{\bar{\mu}}{I_0 - A_0}$ is non-increasing in A within region 3. ■

A.7. Derivatives

Recall that optimal date 1 investment I_1^* is found implicitly from $\left[\frac{B}{p_H - p_L} + \frac{1+r_1}{p_H}\right] I_1^* = f(I_1^*) + \frac{1+r_1}{p_H} A_1$, and the value of the firm if the project succeeds is given by $V(A_1, r_1) = f(I_1^*) - \frac{1+r_1}{p_H}(I_1^* - A_1)$. For convenience the first, second and cross derivatives of I_1 and $V(A_1, r_1)$ with respect to A_1 and r_1 are summarized in the below tables:

derivative of $\mathbf{V}(\mathbf{A}_1, \mathbf{r}_1)$ w.r.t.	
$\mathbf{A}_1$	$I_A[f_I - \frac{1+r}{p_H}]$
$\mathbf{r}_1$	$I_r \left[f_I - \frac{1+r_1}{p_H}\right] - \frac{I_1 - A_1}{p_H}$
$\mathbf{A}_1\mathbf{A}_1$	$f_{II} I_A^2 + I_{AA} \left[f_I - \frac{1+r_1}{p_H}\right]$
$\mathbf{A}_1\mathbf{r}_1$	$k\left[p_H f_{II} I_A I_r + (1 - I_A)\right]$
$\mathbf{r}_1\mathbf{r}_1$	$f_{II} I_r^2 + \left[f_I - \frac{1+r_1}{p_H}\right] I_{rr} - \frac{2}{p_H} I_r$

where: $k = \frac{\frac{B}{p_H - p_L}}{\frac{B}{p_H - p_L} + \frac{1+r_1}{p_H} - f_I}$. $k > 1$ since $f_I > \frac{(1+r)}{p}$.

derivative of $\mathbf{I}_1$ w.r.t.	
$\mathbf{A}_1$	$\frac{1+r_1}{p_H}\left[\frac{B}{p_H - p_L} + \frac{1+r_1}{p_H} - f_I\right]^{-1}$
$\mathbf{r}_1$	$\frac{A_1 - I_1}{1+r_1} I_A$
$\mathbf{A}_1\mathbf{A}_1$	$\frac{p_H}{1+r_1} f_{II} I_A^3$
$\mathbf{A}_1\mathbf{r}_1$	$\left[f_{II} I_A I_r + \frac{1}{p_H}[1 - I_A]\right] \left[\frac{B}{p_H - p_L} + \frac{1+r_1}{p_H} - f_I\right]^{-1}$
$\mathbf{r}_1\mathbf{r}_1$	$-\left[f_{II} I_r^2 - \frac{2}{p_H} I_r\right] [\frac{B}{p_H - p_L} + \frac{1+r_1}{p_H} - f_I]^{-1}$

Table 1
Sample selection: firms' applications for and receipt of external finance

This table provides descriptive information on the number of firms in each wave of the SBF, and whether they applied for and/or had been granted external finance. The 'final sample' for each survey is the number of firms who met the following criteria (i) received a loan within the timeframe specified, (ii) reported the year the loan was approved, and (iii) reported whether the loan was fixed or floating. Note that for the 1987 survey, no information was reported on the number of firms who sought but had not received finance within particular time periods.

	SBF survey year			
	1987	1993	1998	*TOTAL*
No. firms in original sample	3224	4637	3561	*11422*
No. firms sought external finance	*	2007	962	*
No. firms granted external finance				
within 3 years	1509	1695	796	*4000*
>3 years, since 1980	236			*236*
before 1980	128			*128*
year not identified	309			*309*
TOTAL	*2182*	*1695*	*796*	*4673*
Final sample: fixed vs floating				
finance <3 years ago	1466	1695	796	*3957*
finance >3 years ago, since 1980	232			*232*
TOTAL	*1698*	*1695*	*796*	*4189*

Table 2
Descriptive statistics

The first three columns present summary statistics by survey years for the subsample of firms for whom information is recorded on whether the most recent loan was fixed or floating. The fourth column presents summary statistics for this subsample across all three surveys. The fifth column does the same, but observations are weighted using sampling weights provided with the SBF. The sixth column presents weighted summary statistics for the entire sample of firms across all three surveys (not just those who had taken out a recent loan and recorded whether it was fixed or floating).

	Individual surveys			**Combined**		
	1987	1993	1998	subsample, not weighted	subsample, weighted	all firms, weighted
Number of firms	1698	1695	796	4189	4189	11422
Assets (mean, $000s)	1623	3401	2291	2469	841	468
Assets (median, $000s)	238	650	326	359	159	72
Assets (std. dev., $000s)	4331	9911	6198	7434	3345	2497
Employment (mean, #)	34.2	55.1	36.9	43.2	14.2	8.8
Corporate form (%):						
Sole trader	0.30	0.18	0.26	0.24	0.34	0.45
Partnership	0.08	0.07	0.07	0.07	0.08	0.08
S-corp	0.16	0.28	0.35	0.24	0.22	0.20
C-corp	0.47	0.46	0.33	0.44	0.36	0.28
Firm age (mean, years)	13.1	16.3	13.9	14.6	12.8	13.7
Characteristics of most recent loan:						
Loan is fixed rate (%)	0.53	0.42	0.66	0.51	0.58	0.58
Maturity of loan (years)	4.16	3.29	4.91	3.94	4.07	4.19
Lender is a bank (%)	0.77	0.84	0.73	0.79	0.76	0.26
Loan is line of credit (%)	0.32	0.60	0.32	0.43	0.38	0.13

Table 3
Descriptive statistics: proportions of fixed rate loans by category

The first part of the table presents information on the number of 'most recent loans' of different types, and the source of those loans (bank or non-bank). The 'non-bank' source includes non bank intermediaries such as finance companies, credit unions etc. as well as lenders who were not financial institutions. The second part of the table presents (by source) the proportion of each type of loan for which the interest rate on the loan was fixed, rather than floating.

	Number of observations, by lender type			**Proportion of fixed rate loans, by lender type**		
	Bank	Non-bank	All	Bank	Non-bank	All
New line of credit	1631	176	1807	0.28	0.41	0.29
Capital lease	26	59	85	0.62	0.97	0.86
Business mortgage	404	88	492	0.44	0.63	0.47
Vehicle mortgage	434	275	709	0.84	0.96	0.88
Equipment Loan	410	176	586	0.58	0.86	0.66
Other	412	98	510	0.55	0.66	0.57
All loans	**3317**	**872**	**4189**	**0.44**	**0.76**	**0.51**

Table 4
Variance of real interest rates: alternative loan indexes

Presents calculations of the variance of (R_{t+k} - R_t) (where Rt denotes real interest rate at time t) for: the bank prime rate, the federal funds rate, and a nominal fixed rate. Real interest rates were calculated on an ex post basis (ie. if the realized inflation rate was x per cent, and the prime rate was *y* per cent, then the real prime rate was calculated as *x* - *y*). The first two parts of the table used a smoothed measure of the inflation rate (obtained by applying a two-sided moving average filter with binomial weights) to minimize high-freqency fluctuations in the inflation series caused by measurement error. The last part of the table uses the original unsmoothed inflation data. Sample from 1/1960 to 12/1999. GDP deflator used to construct inflation rate (linearly interpolated to produce monthly data).

	Horizon (k)			
	1 year	2 years	3 years	5 years
Full sample (1960 onwards)				
Fixed rate	1.70	3.80	5.11	6.96
Prime rate	3.34	5.68	7.93	12.22
Federal funds rate	4.00	6.07	7.98	11.84
1982 onwards				
Fixed rate	0.49	0.72	1.07	1.09
Prime rate	2.28	3.42	4.45	5.30
Federal funds rate	2.19	3.72	4.93	5.50
1982 onwards (raw inflation series)				
Fixed rate	0.92	1.07	1.53	1.49
Prime rate	2.71	3.82	4.86	5.74
Federal funds rate	2.59	4.13	5.37	5.97

Table 5

Which firms choose fixed rate loans?

Dependent variable = 1 if the firm's most recent loan is a fixed rate loan, and = 0 if it is a variable rate loan. Probit regression. Coefficients are normalized to display the marginal effect of a change in the RHS variable at the point of sample means. Standard errors in parentheses. For F-tests, table presents the p-value for the null that estimated coefficients are jointly equal to zero.

	(1)	(2) include some ownership variables	(3) include no loan characteristics	(4) include all loan characteristics	(5) Bank loans only	(6) corporations only	(7) no sales growth
Log(book value of assets)	-0.065	-0.067	-0.086	-0.081	-0.066	-0.063	-0.059
	(0.008)***	(0.008)***	(0.009)***	(0.008)***	(0.008)***	(0.011)***	(0.008)***
Log(firm age + 1)	-0.041	-0.041	-0.041	-0.037	-0.041	-0.046	-0.029
	(0.019)**	(0.019)**	(0.019)**	(0.017)**	(0.020)**	(0.025)*	(0.017)*
Profitability & growth opportunities							
Sales growth	0.068	0.068	0.055	0.060	0.058	0.084	
	(0.028)**	(0.028)**	(0.029)*	(0.028)**	(0.028)**	(0.036)**	
Profits/assets	-0.018	-0.019	-0.010	-0.022	-0.019	-0.008	-0.010
	(0.009)*	(0.009)**	(0.011)	(0.009)**	(0.009)**	(0.015)	(0.009)
Lending relationship variables							
No. of fin.institutions firm borrows from	0.003	0.003	-0.002	0.010	-0.001	0.010	0.005
	(0.009)	(0.009)	(0.010)	(0.009)	(0.009)	(0.012)	(0.009)
Log(years with current lender + 1)	-0.021	-0.020	-0.030	-0.067	-0.022	-0.016	-0.022
	(0.017)	(0.017)	(0.018)*	(0.015)***	(0.017)	(0.021)	(0.016)
Log(years with primary lender + 1)	0.048	0.048	0.044	0.092	0.041	0.058	0.049
	(0.019)***	(0.019)**	(0.020)**	(0.017)***	(0.019)**	(0.024)**	(0.017)***
Firm controls	all	all	all	all	all	all	all
Ownership controls	no	some	no	no	no	no	no
Loan controls	some	some	no	all	some	some	some
Macroeconomic controls	all	all	all	all	all	all	all
Pseudo R2	0.224	0.224	0.252	0.102	0.219	0.227	0.214
Number of observations	3546	3546	3422	3546	3334	2454	4064

***, ** and * represents significance at 1%, 5% and 10% levels respectively.

Table 6

Interest rate shocks and industry cash flow shocks

Dependent variable = 1 if the firm's most recent loan is a fixed rate loan, and = 0 if it is a variable rate loan. Probit regression. Coefficients are normalized to display the marginal effect of a change in the RHS variable at the point of sample means. Standard errors in parentheses. For F-tests, table presents the p-value for the null that estimated coefficients are jointly equal to zero.

	(1)	(2) include some ownership variables	(3) include all loan characteristics	(4) exclude loans before 1985	(5) Bank loans only	(6) no sales growth
Industry interest rate sensitivity	-1.521	-1.548	-1.186	-1.340	-1.549	-1.106
(2 digit SIC)	(0.678)**	(0.684)**	(0.703)*	(0.787)*	(0.716)**	(0.672)*
Firm size and age variables						
Log(book value of assets)	-0.068	-0.070	-0.088	-0.066	-0.068	-0.061
	(0.008)***	(0.009)***	(0.009)***	(0.011)***	(0.009)***	(0.008)***
Log(firm age + 1)	-0.037	-0.037	-0.037	-0.048	-0.035	-0.028
	(0.019)*	(0.019)*	(0.019)*	(0.025)*	(0.020)*	(0.017)*
Profitability & growth opportunities						
Sales growth	0.064	0.064	0.051	0.079	0.056	
	(0.028)**	(0.028)**	(0.029)*	(0.037)**	(0.028)**	
Profits/assets	-0.022	-0.022	-0.012	-0.014	-0.022	-0.016
	(0.010)**	(0.010)**	(0.011)	(0.015)	(0.010)**	(0.009)*
Firm controls	all	all	all	all	all	all
Ownership controls	no	some	no	no	no	no
Loan controls	some	some	all	some	some	some
Macroeconomic controls	all	all	all	all	all	all
Pseudo R2	0.222	0.223	0.248	0.224	0.217	0.212
Number of observations	3420	3420	3300	2355	3208	3908

***, ** and * represents significance at 1%, 5% and 10% levels respectively.

Table 7
Is fixed rate debt expensive?

Dependent variable = interest rate on most recent loan in percentage points. Standard errors in parentheses.

	(1)	(2) include all loan characteristics	(3) no sales growth	(4) Observations from 1993 survey only	(5) Observations NOT from 1993 survey
Dummy for fixed rate loan	0.474	0.355	0.364	0.579	0.343
	(0.110)***	(0.107)***	(0.104)***	(0.157)***	(0.148)**
Firm size and age variables					
Log(book value of assets)	-0.279	-0.327	-0.294	-0.259	-0.318
	(0.042)***	(0.045)***	(0.040)***	(0.059)***	(0.059)***
Log(firm age + 1)	-0.073	-0.093	-0.142	-0.111	-0.058
	(0.076)	(0.077)	(0.071)**	(0.152)	(0.088)
Profitability & growth opportunities					
Sales growth	0.320	0.184		0.650	0.268
	(0.164)*	(0.142)		(0.462)	(0.177)
Profits/assets	-0.045	-0.035	-0.017	-0.079	-0.020
	(0.049)	(0.043)	(0.037)	(0.064)	(0.070)
Selected interest rate controls					
Federal funds rate	0.398	0.338	0.427	1.873	0.213
	(0.337)	(0.343)	(0.321)	(1.053)*	(0.315)
Prime rate	-0.038	0.023	-0.070	-1.352	0.052
	(0.295)	(0.299)	(0.283)	(1.015)	(0.277)
Term spread over loan maturity		0.018	-0.015		
		(0.216)	(0.202)		
Term spread: 10 year vs spot rate	0.022	-0.030	-0.019	-0.575	0.149
	(0.101)	(0.105)	(0.101)	(0.293)**	(0.112)
Firm controls	all	all	all	all	all
Ownership controls	no	no	no	no	no
Loan controls	some	all	all	some	some
Macroeconomic controls	all	all	all	all	all
Pseudo R2	0.239	0.254	0.249	0.189	0.203
Number of observations	3011	2933	3406	1330	1681

***, ** and * represents significance at 1%, 5% and 10% levels respectively.

Table 8
Which firms choose fixed rate loans? Additional results

Dependent variable = 1 if the firm's most recent loan is a fixed rate loan, and = 0 if it is a floating rate loan. Probit regression. Coefficients are normalized to display the marginal effect of a change in the RHS variable at the point of sample means. Standard errors in parentheses. For F-tests, table presents the p-value for the null that estimated coefficients are jointly equal to zero.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Additional ownership characteristics			Bank loans only			
		All loan controls	No sales growth		All loan controls	Addit. owner characteristics	Alternative size measure
F-test on ownership variables: P value	0.832	0.578	0.508			0.896	
Firm size and age variables							
Log(book value of assets)	-0.056	-0.078	-0.053	-0.066	-0.090	-0.053	
	(0.011)***	(0.012)***	(0.010)***	(0.010)***	(0.011)***	(0.012)***	
Log(sales)							-0.062
							(0.008)***
Log(firm age + 1)	-0.064	-0.066	-0.043	-0.039	-0.039	-0.084	-0.041
	(0.031)**	(0.032)**	(0.026)*	(0.022)*	(0.022)*	(0.035)**	(0.019)**
Profitability & growth opportunities							
Sales growth	0.079	0.070		0.065	0.044	0.069	0.075
	(0.045)*	(0.048)		(0.033)*	(0.035)	(0.053)	(0.028)***
Profits/assets	-0.019	-0.011	-0.012	-0.021	-0.011	-0.020	0.003
	(0.011)*	(0.012)	(0.010)	(0.010)**	(0.011)	(0.012)*	(0.009)
Lending relationship variables							
No. of fin.institutions firm borrows from	-0.014	-0.018	-0.006	0.004	0.000	-0.014	-0.002
	(0.011)	(0.012)	(0.010)	(0.011)	(0.011)	(0.013)	(0.009)
Log(years with current lender + 1)	0.001	-0.014	-0.007	-0.030	-0.047	-0.007	-0.020
	(0.023)	(0.024)	(0.022)	(0.021)	(0.022)**	(0.028)	(0.017)
Log(years with primary lender + 1)	0.022	0.020	0.029	0.053	0.055	0.033	0.048
	(0.025)	(0.026)	(0.023)	(0.023)**	(0.024)**	(0.031)	(0.019)***
Firm controls	all	all	all	all	all	all	all
Ownership controls	all	all	all	no	no	all	no
Loan controls	some	all	some	some	all	some	some
Macroeconomic controls	all	all	all	all	all	all	all
Pseudo R2	0.200	0.241	0.191	0.177	0.206	0.163	0.221
Number of observations	2080	2027	2465	2834	2743	1699	3546

***, ** and * represents significance at 1%, 5% and 10% levels respectively.

Table 9

Which firms choose fixed rate loans? By survey

Dependent variable = 1 if the firm's most recent loan is a fixed rate loan, and = 0 if it is a floating rate loan. Probit regression. Coefficients are normalized to display the marginal effect of a change in the RHS variable at the point of sample means. Standard errors in parentheses. For F-tests, table presents the p-value for the null that estimated coefficients are jointly equal to zero.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	1987 SBF		1993 SBF		1998 SBF		
		Additional loan controls		Additional loan controls		Additional loan controls	Parsimonious specification
Firm size and age variables							
Log(book value of assets)	-0.087	-0.104	-0.069	-0.095	-0.037	-0.043	-0.038
	(0.015)***	(0.017)***	(0.013)***	(0.015)***	(0.014)***	(0.016)***	(0.013)***
Log(firm age + 1)	-0.021	-0.017	-0.117	-0.094	-0.037	-0.043	-0.039
	(0.027)	(0.027)	(0.042)***	(0.042)**	(0.034)	(0.033)	(0.026)
Profitability & growth opportunities							
Sales growth	0.059	0.047	0.459	0.491	0.031	0.000	
	(0.037)	(0.038)	(0.143)***	(0.138)***	(0.040)	(0.040)	
Profits/assets	-0.015	-0.004	-0.026	-0.015	-0.009	0.006	-0.007
	(0.019)	(0.021)	(0.017)	(0.017)	(0.012)	(0.012)	(0.012)
Lending relationship variables							
No. of fin.institutions firm borrows from	0.044	0.041	-0.027	-0.027	-0.002	-0.007	
	(0.017)**	(0.018)**	(0.017)	(0.017)	(0.013)	(0.013)	
Log(years with current lender + 1)	-0.049	-0.049	-0.028	-0.039	0.018	-0.012	
	(0.026)*	(0.027)*	(0.034)	(0.035)	(0.026)	(0.026)	
Log(years with primary lender + 1)	0.081	0.071	0.049	0.047	-0.018	-0.007	
	(0.029)***	(0.030)**	(0.039)	(0.040)	(0.028)	(0.027)	
Firm controls	all	all	all	all	all	all	some
Ownership controls	no	no	no	no	no	no	no
Loan controls	some	all	some	all	some	all	some
Macroeconomic controls	all	all	all	all	all	all	some
Pseudo R2	0.287	0.305	0.206	0.227	0.221	0.262	0.202
Number of observations	1464	1393	1329	1329	750	698	794

***, ** and * represents significance at 1%, 5% and 10% levels respectively.

Table 10

Which firms choose fixed rate loans? Broken down by type of loan

Dependent variable = 1 if the firm's most recent loan is a fixed rate loan, and = 0 if it is a floating rate loan. Probit regression. Coefficients are normalized to display the marginal effect of a change in the RHS variable at the point of sample means. Standard errors in parentheses. For F-tests, table presents the p-value for the null that estimated coefficients are jointly equal to zero.

	(1)	(2)	(3)	(4)	(5)	(6)
	Lines of credit			Bank loans only		
		Additional loan characteristics	Corporations only		Additional loan characteristics	Corporations only
Firm size and age variables						
Log(book value of assets)	-0.077	-0.090	-0.071	-0.046	-0.063	-0.040
	(0.012)***	(0.014)***	(0.014)***	(0.009)***	(0.010)***	(0.012)***
Log(firm age + 1)	-0.027	-0.031	-0.003	-0.040	-0.040	-0.059
	(0.030)	(0.031)	(0.037)	(0.020)**	(0.020)**	(0.027)**
Profitability & growth opportunities						
Sales growth	0.091	0.084	0.082	0.038	0.024	0.061
	(0.044)**	(0.045)*	(0.055)	(0.029)	(0.029)	(0.037)*
Profits/assets	-0.014	0.002	0.014	-0.018	-0.015	-0.019
	(0.013)	(0.014)	(0.019)	(0.010)*	(0.011)	(0.015)
Lending relationship variables						
No. of fin.institutions firm borrows from	0.014	0.011	0.026	-0.002	-0.004	0.001
	(0.014)	(0.015)	(0.016)	(0.010)	(0.010)	(0.012)
Log(years with current lender + 1)	0.005	0.004	-0.006	-0.027	-0.037	-0.008
	(0.030)	(0.032)	(0.033)	(0.016)*	(0.017)**	(0.020)
Log(years with primary lender + 1)	0.040	0.029	0.032	0.036	0.033	0.051
	(0.032)	(0.034)	(0.037)	(0.018)**	(0.019)*	(0.024)**
Firm controls	all	all	all	all	all	all
Ownership controls	no	no	no	no	no	no
Loan controls	some	all	some	some	all	some
Macroeconomic controls	all	all	all	all	all	all
Pseudo R2	0.115	0.158	0.100	0.176	0.207	0.174
Number of observations	1519	1450	1163	2027	1972	1291

***, ** and * represents significance at 1%, 5% and 10% levels respectively.

Table 11

Do the results reflect owner risk-aversion? (1998 SBF only)

Dependent variable = 1 if the firm's most recent loan is a fixed rate loan, and = 0 if it is a floating rate loan. Probit regression. Coefficients are normalized to display the marginal effect of a change in the RHS variable at the point of sample means. Standard errors in parentheses. For F-tests, table presents the p-value for the null that estimated coefficients are jointly equal to zero.

	(1)	(2)	(3)	(4)	(5)	(6)
	Specification #1		Specification #2		Specification #3	
	excluding owner wealth variable	including owner wealth variable	excluding owner wealth variable	including owner wealth variable	excluding owner wealth variable	including owner wealth variable
Firm size and owner wealth						
Log(book value of assets)	-0.043	-0.030	-0.037	-0.023	-0.038	-0.026
	(0.016)***	(0.018)*	(0.014)***	(0.016)	(0.013)***	(0.015)*
Log(total owner wealth)		-0.026		-0.035		-0.033
		(0.017)		(0.018)**		(0.017)*
Profitability & growth opportunities						
Log(firm age + 1)	-0.043	-0.034	-0.037	-0.025	-0.039	-0.029
	(0.033)	(0.034)	(0.034)	(0.034)	(0.026)	(0.026)
Sales growth	0.000	-0.002	0.031	0.026		
	(0.040)	(0.040)	(0.040)	(0.040)		
Profits/assets	0.006	0.006	-0.009	-0.008	-0.007	-0.006
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Firm controls	all	all	all	all	some	some
Ownership controls	no	no	no	no	no	no
Loan controls	all	all	some	some	some	some
Macroeconomic controls	all	all	all	all	some	some
Pseudo R2	0.262	0.266	0.201	0.209	0.202	0.209
Number of observations	698	698	750	750	794	794

***, ** and * represents significance at 1%, 5% and 10% levels respectively.

Table 12
'Market timing'?

Dependent variable = 1 if the firm's most recent loan is a fixed rate loan, and = 0 if it is a floating rate loan. Probit regression. Coefficients are normalized to display the marginal effect of a change in the RHS variable at the point of sample means. Standard errors in parentheses. For F-tests, table presents the p-value for the null that estimated coefficients are jointly equal to zero.

	(1) Same as column (1) from table 5	(2) No survey dummies	(3) As (2), additional loan characteristics	(4) As (2), alternative spread measure	(5) As (4), additional loan characteristics
Measure of term structure spread					
Term spread: 10 year vs spot rate	-0.012	-0.024	-0.030		
	(0.017)	(0.013)*	(0.014)**		
Term spread over loan maturity				-0.052	-0.014
				(0.033)	(0.037)
Firm size and age variables					
Log(book value of assets)	-0.065	-0.065	-0.086	-0.064	-0.090
	(0.008)***	(0.008)***	(0.009)***	(0.009)***	(0.010)***
Log(firm age + 1)	-0.041	-0.041	-0.041	-0.048	-0.045
	(0.019)**	(0.019)**	(0.019)**	(0.020)**	(0.020)**
Profitability & growth opportunities					
Sales growth	0.068	0.077	0.063	0.091	0.079
	(0.028)**	(0.027)***	(0.028)**	(0.028)***	(0.028)***
Profits/assets	-0.018	-0.018	-0.010	-0.015	-0.005
	(0.009)*	(0.009)*	(0.011)	(0.010)	(0.011)
Firm controls	all	all but surv. dum.	all but surv. dum.	all but surv. dum.	all but surv. dum.
Ownership controls	no	no	no	no	no
Loan controls	some	some	all	some	all
Macroeconomic controls	all	all	all	all	all
Pseudo R2	0.224	0.223	0.251	0.226	0.252
Number of observations	3546	3546	3422	3207	3185

***, ** and * represents significance at 1%, 5% and 10% levels respectively.

Table 13: Cash flows and interest rates

Sensititivity of firm cash flows to a 3.4 percentage point change in interest rates, scaled by various firm characteristics

	Interest rate derivatives, Fortune 500 firms		**Most recent loan, SBF sample**
	All firms	Users only	
mean sensitivity of cash flows to shock, as proportion of:			
Mean interest expense	< 0.039	< 0.069	0.205
Mean assets $x10^{-2}$	< 0.091	< 0.161	0.956
Mean cash flows from operations	< 0.009	< 0.016	0.029
median sensitivity of cash flows to shock, as proportion of:			
Median interest expense	0.0	< 0.046	0.235
Median assets $x10^{-2}$	0.0	< 0.112	0.876
Median cash flows from operations	0.0	< 0.013	0.030