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Cash Flow Hedging and Liquidity Choices*

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Abstract. This article studies the interaction between corporate hedging and liquidity policies. We present a theoretical model that shows how corporate hedging facilitates greater reliance on cost-effective, externally provided liquidity in lieu of internal resources. We test the model's predictions by employing a new empirical approach that separates cash flow hedging from other hedging instruments. Using detailed, hand-collected data, we find that cash flow hedging reduces the firm's precautionary demand for cash and allows it to rely more on bank lines of credit. Furthermore, we find a significant positive effect of cash flow hedging on firm value, where prior evidence is mixed.

JEL Classification: G30, G31, G32

1. Introduction

The uncertainty of cash flows and the risk of adverse cash flow shocks are central concerns in corporate finance and are taken seriously by both managers and shareholders.[1] Theory suggests that corporate risk management can effectively mitigate cash flow risks and consequently affect firms' financing and value (e.g., Froot, Scharfstein, and Stein, 1993; Leland, 1998;

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[1] See, for instance, Rawls and Smithson (1990), Bodnar, Hayt, and Marston (1998), Graham and Harvey (2001), and Lins, Servaes, and Tufano (2010).

Chidambaran, Fernando, and Spindt, 2001). Yet, prior empirical studies offer limited evidence on the financing implications of hedging (e.g., Campello *et al.*, 2011). There is also no conclusive evidence that hedging matters at all for firm performance, with some studies finding significant positive correlations (e.g., Graham and Rogers, 2002; Mackay and Moeller, 2007) and others finding small, mostly insignificant correlations (e.g., Guay and Kothari, 2003; Jin and Jorion, 2006; Bartram, Brown, and Conrad, 2011).

The goal of this article is to shed new light on the financing and value consequences of corporate hedging. Taking advantage of a regulatory change in accounting standards, we identify substantial interconnections between a firm's cash flow derivative hedging and its liquidity policy and show that cash flow derivative hedging has nontrivial value implications.

To motivate our empirical investigation, we model the interaction between the firm's hedging and liquidity policies. In our model, a firm facing present and future investment opportunities chooses the optimal mixture of cash holdings and bank lines of credit to maximize firm value, considering hedging limitations and the uncertainty of future cash flows. Cash holdings mitigate the risk of future underinvestment, but entail a liquidity premium as a result of suboptimal investments today. Bank lines of credit do not entail underinvestment today, but are contingent on cash-flow-based financial covenants. The key implication of our model is that cash flow hedging reduces the likelihood of violating an existing cash-flow-based financial covenant or having a financial covenant in the first place, and therefore allows the firm to rely more on lines of credit in lieu of cash.[2] Cash flow hedging thus increases the value of the firm by reducing the liquidity premium that the use of cash holdings entails. Overall, our model highlights the interaction between corporate hedging and liquidity policies as a means to address cash flow risks. As a result, it emphasizes the importance of studying the firm's choice of hedging, cash holdings, and lines of credit not in isolation, but as interrelated corporate policies.

To test the predictions of the model, our empirical analysis employs a new approach that isolates the portion of derivative hedging that pertains to cash flow risk, that is, *cash flow hedging*. Specifically, we take advantage of the 2001 accounting standard SFAS No. 133, which requires firms, for the first time, to distinguish between cash flow hedging and fair value hedging in the financial statements. To illustrate the distinction, consider an example of a

[2] Cash-flow-based financial covenants are one way through which hedging might affect liquidity choices. More broadly, hedging can reduce the costs of tapping external capital markets (e.g., by reducing bankruptcy costs), thus allowing firms to employ a cost-effective liquidity policy that relies less on internal resources.

company that has previously issued fixed-rate debt. This company is exposed to an interest rate risk. If interest rates go down, the value of its debt goes up, reflecting the loss incurred by committing to pay a higher rate than the market rate. This risk is called fair value risk because it affects the fair value of debt, but has no direct effect on the firm's cash flow stream. On the other hand, if the firm switches to a floating-rate debt instrument, then it is hedged against fair value risk, but becomes exposed to cash flow risk because future interest payments are uncertain. Thus, cash flow hedging captures a firm's derivative use that attempts to hedge against shocks that affect the firm's cash flow stream. In contrast, fair value hedging corresponds to a firm's derivative use aimed at hedging against shocks to the value of its assets and liabilities, irrespective of the realized cash flow stream associated with these assets.

The distinction in SFAS No. 133 between cash flow hedging and fair value hedging is important for our purposes. Cash flow hedging reduces the volatility of the firm's cash flow stream and therefore may mitigate or cancel altogether the cash-flow-based financial covenants, whereas fair value hedging does not. Moreover, the theoretical literature on corporate hedging has mainly focused on cash flow hedging; Smith and Stulz (1985); Froot, Scharfstein, and Stein (1993); Leland (1998); Chidambaran, Fernando, and Spindt (2001); and others, all highlight the value-enhancing implications of actively reducing the volatility of cash flows. Therefore, to test these theories (as well as our model), one needs to identify the portion of derivative hedging that reduces the volatility of cash flows.

Consistent with our model, we find that cash flow hedging reduces the firm's precautionary demand for cash and allows it to rely relatively more on bank lines of credit for liquidity provision. Defining a firm's bank liquidity ratio as the ratio between its available lines of credit and its overall liquidity resources (i.e., lines of credit and cash holdings), our results show a significant positive relation between cash flow hedging and the bank liquidity ratio. We estimate that an increase of one standard deviation in the firm's cash flow hedging is associated with an increase of approximately 10% in the liquidity ratio.

Our model further predicts that cash holdings are negatively related to cash flow hedging, whereas bank lines of credit are positively related to cash flow hedging. To test these two separate effects, we estimate a simultaneous equation model with cash holdings and lines of credit as the two dependent variables. Our estimates reveal a significant *positive* relation between cash flow hedging and lines of credit and a significant *negative* relation between cash holdings and cash flow hedging. These findings suggest that our decomposition of total hedging resolves the puzzling lack of relation between derivative hedging and cash holdings found by Opler *et al.* (1999). As in their study, we find no significant relation between cash and *total hedging*.[3]

Finally, we explore the value implications of cash flow hedging. In our model, the equilibrium value of the firm is positively related to cash flow hedging. Although this implies that firms should fully hedge their cash flow risks, there are various factors that may prevent them from doing so. We investigate the determinants of cash flow hedging and find that the ability to hedge cash flows is strongly related to the firm's industry. We therefore test the value implications of our model by constructing an industry-level instrument for cash flow hedging. Consistent with the model, the results reveal a positive relation between our cash flow hedging industry-level instrument and firm value, using the firm's market-to-book ratio as our value measure (e.g., Fama and French, 1998; Dittmar and Mahrt-Smith, 2007). We estimate that an increase of one standard deviation in instrumented cash flow hedging increases the firm's market-to-book ratio by 4%.

Our article is part of a recent literature on integrated corporate risk management policies. For example, Gamba and Triantis (2011) examine through a dynamic structural model how firms should coordinate their risk management efforts using financial derivatives, cash holdings, and operating flexibility. Their paper concludes that a strategy that combines the different instruments is optimal and that the mix of the instruments is linked to the firm's underlying risk exposures. We complement their work by allowing firms to maintain liquidity through both cash holdings and lines of credit. Our findings show that the choice between cash holdings and lines of credit depends on the firm's derivative hedging policy, thus highlighting another channel through which hedging and liquidity policies are interrelated.

Acharya, Almeida, and Campello (2007) study the tradeoff between cash and debt capacity across firms with different hedging needs. They show that cash holdings are preferable to debt when hedging needs are low and vice versa. Our article complements theirs by considering the joint use of a broader set of policies (cash holdings, lines of credit, and derivative hedging), which are linked to each other through cash flow risks and contractual agreements.

More broadly, our article is also related to the recent works by Bolton, Chen, and Wang (2011, 2012), who study the dynamic properties of investment, financing, and risk management. We complement their work by

[3] Two related papers are Haushalter, Klasa, and Maxwell (2007), who find a substitution relation between cash holdings and the use of currency swaps in a product market (predation risk) context, and Bartram, Brown, and Fehle (2009), who find a negative relation between the use of derivatives and the quick ratio.

providing evidence on the linkages between hedging and liquidity through internal and external financing.

Overall, this article adds to prior literature in a number of ways. First, our hand-collected data on hedging are a considerable improvement relative to previous studies.[4] By taking advantage of SFAS No. 133, we are able to separate, to our knowledge for the first time, cash flow derivative hedging from other types of derivative hedging. The decomposition of derivative hedging allows us to study cash flow hedging, which has been the focus of the theoretical literature on corporate hedging. Second, our article suggests that derivative hedging and liquidity policies are jointly determined, thus emphasizing the importance of studying them together rather than in isolation. Third, our findings provide cleaner estimates, which suggest that consistent with the theory, hedging does matter for firm value.

The article proceeds as follows. Section 2 presents the theoretical model. Section 3 describes the data. Section 4 studies the determinants of cash flow hedging and presents univariate evidence on its relation to liquidity policy. Section 5 investigates the implications of cash flow hedging for corporate liquidity. Section 6 studies the relation between cash flow hedging and firm value. Section 7 gives concluding remarks.

2. Theoretical Model

In this section, we present a simple model to illustrate how cash flow hedging affects liquidity policy and the value of the firm. Specifically, we study how the firm's ability to hedge a fraction of its cash flows affects its choice between cash holdings and bank lines of credit.

In the literature on cash holdings, Keynes' (1936) precautionary savings motive is typically viewed as the main driver for maintaining corporate cash reserves (e.g., Kim, Mauer, and Sherman, 1998; Opler *et al.*, 1999; Almeida, Campello, and Weisbach, 2004; Bates, Kahle, and Stulz, 2009; Duchin, Ozbas, and Sensoy, 2010). Similar arguments underlie the theory of lines of credit, which views them as option-like cash equivalents (e.g., Melnik and Plaut, 1986; Boot, Thakor, and Udell, 1987; Martin and Santomero, 1997; Shockley and Thakor, 1997; Holmstrom and Tirole, 1998).

[4] Previous studies examine either smaller samples (see, e.g., Nance, Smith, and Smithson, 1993; Tufano, 1996; Geczy, Minton, and Schrand, 1997; Guay, 1999; Haushalter, 2000; Graham and Rogers, 2002; Guay and Kothari, 2003; Adam and Fernando, 2006; Brown, Crabb, and Haushalter, 2006; Jin and Jorion, 2006; Mackay and Moeller, 2007), or use samples that are only based on a yes/no hedging indicator (see, e.g., Mian, 1996; Bartram, Brown, and Fehle, 2009; Bartram, Brown, and Conrad, 2011).

A number of papers considered firms' choice between cash holdings and lines of credit. Yun (2009) shows that antitakeover laws push firms to hold more cash relative to lines of credit (and vice versa for internal governance). Sufi (2009) argues that firms prefer lines of credit over cash when they are less likely to violate cash-flow-based financial covenants. Lins, Servaes, and Tufano (2010) find that cash and lines of credit are held for different purposes. Lines of credit are strongly related to a firm's need for external financing to fund future investment opportunities, whereas nonoperational cash is primarily held as a general buffer against future cash shortfalls. Acharya, Almeida, and Campello (2012) show that firms with high asset betas hold more cash in lieu of lines of credit because it is more costly for them to obtain lines of credit from banks. Other papers that highlight the cost efficiency of bank lines of credit relative to cash holdings include Kashyap, Rajan, and Stein (2002) and Gatev and Strahan (2006).

Our model shows that cash flow hedging allows the firm to rely more on bank lines of credit, in lieu of cash holdings, for liquidity provision, and therefore increases firm value. Importantly, we do not assume that cash flow hedging mechanically enhances firm value. Instead, in our specification, hedging is mean-preserving, that is, it does not affect the expected value of future cash flow. Hedging increases firm value due to the discontinuity introduced by financial covenants written on lines of credit. It lowers the likelihood of violating a financial covenant, or equivalently, lowers the likelihood of having a financial covenant in the first place, thus increasing the cost efficiency of the firm's liquidity policy, and as a consequence the firm's overall value.

2.1 SETUP

The time line of the model has three dates: 0, 1, and 2. At Time 0, the firm is an ongoing concern and has a cash flow X_0 from existing assets. Also at Time 0, the firm has the option to invest in a long-term project that requires an investment of I_0 today and pays off $G_0(I_0)$ at Time 2. The firm expects to have access to another investment opportunity at Time 1. If the firm invests I_1 at Time 1, it generates a payoff of $G_1(I_1)$ at Time 2. At Time 1, the firm receives an uncertain cash flow from existing assets, X_1, with a strictly positive probability density function $f(X_1) > 0$, a cumulative density function $F(X_1)$, support $[\underline{X}, \bar{X}]$, and an expected value of $E[X_1] \equiv \bar{X}_1$.

The production functions $G_0(\cdot)$ and $G_1(\cdot)$ are increasing, concave and continuously differentiable. We assume that the discount factor is one, everyone is risk neutral, and the cost of investment goods at Dates 0 and 1 is equal to one. We also assume that the cash flows $G_0(I_0)$ and $G_1(I_1)$ are not verifiable and thus cannot be contracted upon. Therefore, the firm cannot use these cash flows to raise funds from outside investors. It can, however, obtain access to a bank line of credit by using its existing assets as collateral.[5] Risk neutrality implies that the maximal amount of the bank line of credit equals $\bar{X}_1$. Importantly, the line of credit is not entirely committed; it includes a financial covenant that conditions its ex post availability at Time 1 on the realization of the firm's cash flow. If X_1, the cash flow at Time 1, is lower than the prespecified threshold, denoted A, the covenant is violated and the bank is no longer committed to provide the line of credit. Therefore ex ante, at Time 0, the bank will only provide a line of credit if

$$A < \bar{X}_1. \tag{1}$$

In what follows, we assume that Equation (1) is satisfied.

The company pays a proportional commitment fee to gain access to the line of credit. We denote the amount of obtained line of credit by B and the proportional commitment fees paid by the firm to the bank by βB. Without loss of generality, we assume perfect competition across banks. Banks simply break even after the firm repays the drawn down portion of its line of credit at Time 2 using the payoffs generated by its investments. Thus, the only deadweight cost associated with external financing in the form of a bank line of credit is the commitment fee.[6] This specification incorporates the cost efficiency of bank lines of credit highlighted in previous work (e.g., Kashyap, Rajan, and Stein, 2002; Gatev and Strahan, 2006) and more recently in Acharya, Almeida, and Campello (2012). It also takes into account that, as argued by Sufi (2009), the *contingent* lines of credit that exist in the marketplace are distinct from the *committed* lines of credit described in the theoretical literature (e.g., Boot, Thakor, and Udell,1987; Martin and Santomero, 1997; Holmstrom and Tirole, 1998).

2.2 CASH FLOW HEDGING

Next, we introduce the possibility of cash flow hedging. Since the evidence on the value implications of hedging is mixed, we take an agnostic view and assume that hedging is mean-preserving and thus does not change the expected value of cash flows. Furthermore, we recognize that perfect

[5] This idea is in the spirit of Hart and Moore (1995), who argue that the liquidation value of "hard" assets is verifiable by a court. Therefore, creditors can seize those assets if the firm defaults.

[6] This assumption is not crucial for our results. Assuming that the commitment fee is paid in period 1, for example, only if the covenant is violated, yields similar results.

hedging is realistically infeasible and therefore let firms hedge a fraction α of their cash flows, where $0 < \alpha < 1$. Specifically, the firm's Time 1 cash flow is given by: $X_1(\alpha) = \alpha\bar{X}_1 + (1-\alpha)X_1$. Note that hedging does not affect the expected value of cash flow, as:

$$E[X_1(\alpha)] = E\left[\alpha\bar{X}_1 + (1-\alpha)X_1\right] = \alpha\bar{X}_1 + (1-\alpha)\bar{X}_1 = \bar{X}_1 \tag{2}$$

While hedging does not affect the expected value of cash flow, it decreases the probability of violating a financial covenant. Note that: $(X_1(\alpha) < A) = \text{prob}\left(\alpha\bar{X}_1 + (1-\alpha)X_1 < A\right) = \text{prob}\left(X_1 < A - \alpha\bar{X}_1/1-\alpha\right) = F(A - \alpha\bar{X}_1/1-\alpha)$. Equation (1) implies that for every $0 < \alpha < 1$:

$$F\left(\frac{A-\alpha\bar{X}_1}{1-\alpha}\right) < F(A) \tag{3a}$$

Define $A(\alpha) = A - \alpha\bar{X}_1/1-\alpha$. Equation (1) implies that when we differentiate $A(\alpha)$ with respect to α, we get:

$$A'(\alpha) = \frac{A-\bar{X}_1}{(1-\alpha)^2} < 0 \tag{3b}$$

This (and our assumption that the density function is strictly positive) implies that:

$$\frac{d}{d\alpha}F(A(\alpha)) < 0 \tag{4}$$

Equation (4) suggests that as the fraction of cash flow hedging increases, the firm is less likely to violate a financial covenant, even though as Equation (2) implies, the expected value of cash flow, $\bar{X}_1$, is unchanged by the firm's hedging policy. As we show below, this pushes the firm to use more lines of credit in lieu of cash. We note, however, that cash flow hedging is also likely to decrease the likelihood of having a financial covenant in the first place. Our model is consistent with this alternative since from the point of view of the firm, a lower likelihood of having a financial covenant is equivalent to a lower likelihood of violating a financial covenant (it is impossible to violate a nonexistent covenant). Thus, Equation (4) is consistent with a reduction in both the likelihood of violating and the likelihood of having a financial covenant due to cash flow hedging.

In what follows, we model the fraction of cash flow that can be hedged as exogenously determined. That is, we recognize that the firm is less likely to violate a financial covenant when α increases; however, certain risk exposures are not easily hedged using hedging instruments, and firms with such exposures are likely to have a lower fraction of their cash flows hedged. Our empirical findings suggest that a firm's line of business is an important determinant of the ability to hedge.

2.3 SOLUTION

We are now ready to write the expected value of the firm at Time 0:

$$E[V(C,B)] = G_0(X_0 - C) + \int_{\underline{X}}^{A(\alpha)} G_1(X_1 + C)f(X_1)dX_1 + \int_{A(\alpha)}^{\bar{X}} G_1(X_1 + C + B)f(X_1)dX_1 - \beta B \tag{5}$$

The first term in Equation (5) corresponds to the value generated by the investment at Time 0. It highlights the cost associated with cash holdings, C, namely, the "liquidity premium." Every dollar carried from Times 0 to 1 is one less dollar invested in the positive NPV project available at Time 0. The second term in Equation (5) corresponds to the case in which the company violates the financial covenant, that is, the case in which $X_1(\alpha) < A$. In this case, the company can only invest its Time 1 cash flow plus the cash, C, carried to Time 1. The third term corresponds to the case in which the covenant is not violated, and the company can draw its line of credit and invest that amount in addition to its Time 1 cash flow and the cash it carried to Time 1. The final term represents the deadweight costs that the company is required to pay as a commitment fee, regardless of whether or not it violates the covenant. Note that due to the commitment fees, the ex ante optimal choice of a line of credit at Time 0 corresponds to drawing the entire line of credit at Time 1, if the covenant is not violated.

To derive the optimal amount of cash, C^*, and bank line of credit, B^*, we differentiate Equation (5) with respect to C and B and write the two 1st-order conditions, respectively:

$$-G_0'(X_0 - C^*) + \int_{\underline{X}}^{A(\alpha)} G_1'(X_1 + C^*)f(X_1)dX_1 + \int_{A(\alpha)}^{\bar{X}} G_1'(X_1 + C^* + B^*)f(X_1)dX_1 = 0 \tag{6a}$$

$$\int_{A(\alpha)}^{\bar{X}} G_1'(X_1 + C^* + B^*) f(X_1) dX_1 - \beta = 0 \tag{6b}$$

Substituting Equation (6b) into (6a), and then differentiating Equation (6a) and (b) with respect to α yield, respectively:

$$G_0''(X_0 - C^*)\frac{\partial C^*}{\partial \alpha} + \frac{\partial C^*}{\partial \alpha}\int_{\underline{X}}^{A(\alpha)} G_1''(X_1 + C^*) f(X_1) dX_1 + A'(\alpha)G_1'(A(\alpha) + C^*) f(A(\alpha)) = 0 \tag{7a}$$

$$\left(\frac{\partial C^*}{\partial \alpha} + \frac{\partial B^*}{\partial \alpha}\right)\int_{A(\alpha)}^{\bar{X}} G_1''(X_1 + C^* + B^*) f(X_1) dX_1 - A'(\alpha)G_1'(A(\alpha) + C^* + B^*) f(A(\alpha)) = 0 \tag{7b}$$

Next, we introduce the following notation:

$$I_- \equiv \int_{\underline{X}}^{A(\alpha)} G_1''(X_1 + C^*) f(X_1) dX_1;\ I_+ \equiv \int_{A(\alpha)}^{\bar{X}} G_1''(X_1 + C^* + B^*) f(X_1) dX_1$$
$$G_{1-}' \equiv G_1'(A(\alpha) + C^*);\ G_{1+}' \equiv G_1'(A(\alpha) + C^* + B^*);\ G_0'' \equiv G_0''(X_0 - C^*) \tag{8}$$

Solving Equation (7a) and (b) for $\partial C^*/\partial \alpha$ and $\partial B^*/\partial \alpha$ using the notation in Equation (8) gives:

$$\frac{\partial C^*}{\partial \alpha} = \frac{-A'(\alpha) f(A(\alpha)) G_{1-}'}{G_0'' + I_-} \tag{9a}$$

$$\frac{\partial B^*}{\partial \alpha} = \frac{A'(\alpha) f(A(\alpha)) G_{1+}'}{I_+} - \frac{-A'(\alpha) f(A(\alpha)) G_{1-}'}{G_0'' + I_-} \tag{9b}$$

To determine the effect of hedging on the optimal quantity of cash holdings and lines of credit, note that the properties of the production function imply the following for the terms defined in Equation (8):

$$I_- < 0;\ I_+ < 0;\ G_{1-}' > 0;\ G_{1+}' > 0;\ G_0'' < 0$$

These properties, combined with Equation (3b) and our assumption that the density function is strictly positive, imply that:

$$\frac{\partial C^*}{\partial \alpha} < 0,\ \frac{\partial B^*}{\partial \alpha} > 0 \tag{10}$$

Equation (10) suggests that the ability to hedge a greater fraction of cash flow pushes the firm to hold less cash and more lines of credit. Put differently, cash flow hedging leads firms to rely more on lines of credit in lieu of cash. To see this directly, let us define the bank liquidity ratio, that is, the fraction of overall liquidity provided by bank lines of credit, as: $\mathrm{LR}^* = B^*/\mathrm{B}^* + C^*$. It is straightforward to see from Equation (10) that when B^* or C^* are different than zero, we have:

$$\frac{\partial \mathrm{LR}^*}{\partial \alpha} = \frac{1}{(B^* + C^*)^2}\left(\frac{\partial B^*}{\partial \alpha} C^* - \frac{\partial C^*}{\partial \alpha} B^*\right) > 0 \tag{11}$$

Equation (11) suggests that we should observe a positive relation between the ability to hedge cash flows and the bank liquidity ratio. In our empirical investigation, we identify the firm's industry as a substantial determinant of the ability to hedge cash flows. We therefore examine the relation between industry-level instrumented cash flow hedging and the firm's bank liquidity ratio. Consistent with Equation (11), we find a significant positive relation between the two.

We further examine the value implications of our model. A straightforward application of the envelope theorem suggests that as long as B^* or C^* are different from zero, the effect of cash flow hedging on firm value is as follows:

$$\frac{\partial E[V(C^*, B^*)]}{\partial \alpha} = A'(\alpha) f(A(\alpha))[G_1(A(\alpha) + C^*) - G_1(A(\alpha) + C^* + B^*)] > 0 \tag{12}$$

Equation (12) suggests that the ability to hedge cash flow risk enhances firm value by improving the cost efficiency of the firm's liquidity policy. In our empirical investigation, we directly investigate the effect of cash flow hedging on the firm's market-to-book ratio as a measure for value.

Overall, our model identifies an important interaction between cash flow hedging and the decision to use cash holdings vis-à-vis bank lines of credit for liquidity provision. In the model, cash flow hedging facilitates greater reliance on external liquidity provision by reducing the likelihood of violating (or having) cash-flow-based financial covenants. In the next section, we empirically test the implications of our theory.

3. Data

Our sample comes from three data sources. The first is a hand-collected data set on the hedging practices of a large sample of US industrial firms.

Disclosure of derivative hedging is governed by the 1998 Financial Reporting Release (FRR) No. 48 of the US Securities and Exchange Commission, the 2001 SFAS No. 133, "Accounting for Derivative Instruments and Hedging Activities," and its amendments. FRR No. 48 requires companies to give quantitative and qualitative disclosures about their market risks in item 7a of the 10-k report. SFAS No. 133 requires firms, for the first time, to distinguish between cash flow hedging and fair value hedging in the financial statements (item 8 of the 10-k report).

In our analysis, it is important to identify the portion of a company's total hedging that pertains to cash flow risk. We take advantage of SFAS No. 133 to decompose firms' *total hedging* into two components: *cash flow hedging* and *fair value hedging*. Although firms might have some discretion in classifying their use of derivatives, the *accounting* definition of cash flow hedging is a better measure of the *actual* derivatives used to manage cash flow risk than all the derivatives used.[7] Specifically, in our sample, fair value hedging is mostly composed of swaps from fixed- to floating-rate debt. In many cases, companies issue fixed-rate bonds to cater to institutional investors that demand (and are often required) to hold fixed-rate bonds and then convert them to floating-rate bonds using swap contracts on the same day of issuance. It is therefore important to distinguish between cash flow hedges and fair value hedges, because in many cases the latter are not driven by risk but rather by investor demand.

Our sample includes all S&P 500 companies from 2002 (the year after the introduction of SFAS No. 133) to 2007, excluding financial companies (SIC codes between 6000 and 6999) and utilities (SIC codes between 4910 and 4940). We exclude financial companies because they might have different motives to use derivatives and exclude utilities because their cash holdings, derivative hedging, and lines of credit can be subject to regulatory supervision.

SFAS No. 133, its amendments, and FRR No. 48 do not require disclosing the notional amounts of the derivatives used. They also do not impose any standard format of disclosure about the use of derivatives, and

[7] SFAS No. 133 (which can be found at: http://www.fasb.org/st/#fas133) defines, in Paragraph 4a, a fair value hedge as a hedge of the exposure to changes in the fair value of a recognized asset or liability, or of an unrecognized firm commitment. In Paragraph 4b, it defines a cash flow hedge as a hedge of the exposure to variability in the cash flows of a recognized asset or liability, or of a forecasted transaction. SFAS No. 133 also establishes the accounting rules for derivatives that are used for hedging the foreign currency exposure of a net investment in a foreign operation and for derivatives not designated as hedging instruments.

as a result the format of disclosure varies from company to company.[8] These shortcomings of the current regulation force us to construct our sample by hand-collecting the data. Therefore, we limited most of our analysis to S&P 500 industrial firms. However, in some of our robustness tests, we expanded the data to include all industrial S&P 1500 companies for the last 2 years of our sample. Next, we describe the data collection process.

The 1st stage of the process is to search for the following keywords in each company's items 7a and 8 of the 10-k report: "notional," "derivative," "hedge," "forward," "future," and "swap." In the 2nd stage, we read all paragraphs surrounding the keywords and examine (i) whether we can identify the total notional amount of derivatives used by the company and (ii) whether we can identify the notional amounts of cash flow hedges and fair value hedges. In the best-case scenario, we find full information on both (i) and (ii). Then, we are able to extract data not only on the total notional amount of hedges (and the decision to hedge) but also on the notional amounts for cash flow hedges and fair value hedges (and the decision to employ cash flow hedges and fair value hedges).[9]

Otherwise, our data collection procedure is conservative. When we can observe the total notional amount of hedges but cannot separate between cash flow hedges and fair value hedges, we assign missing values to the variables corresponding to the notional amount of cash flow hedges (*cash flow hedge*) and fair value hedges (*fair value hedge*). In these cases, we also assign missing values to the dummy variables representing the existence ("yes"/"no") of either cash flow hedges (*cash flow hedge dummy*) or fair value hedges (*fair value hedge dummy*). Note, however, that in this scenario, the variable that corresponds to the total notional amount of hedges (*total hedge*) is not missing, and the dummy variable that represents the existence ("yes"/"no") of hedges in general (*total hedge dummy*) equals to one ("yes").

There are also cases in which companies do not disclose the notional amount of the derivatives that they report they use. For example, suppose that Company A reports that it uses forward as cash flow hedges, but does not disclose their notional amount. In this case, the variables *total hedge* and

[8] In March 2008, the Financial Accounting Standard Board (FASB) issued SFAS No. 161 "Disclosures About Derivative Instruments and Hedging Activities—an Amendment of FASB Statement No. 133." This statement aims to improve the disclosure about derivatives in the financial statements. Its effective date is for fiscal years beginning after November 15 2008, and therefore it does not affect our sample.

[9] Note that the notional amount of derivatives that are used for hedging the foreign currency exposure of a net investment in a foreign operation and the notional amounts for derivatives not designated as hedging instruments are included in the total notional amount of hedges but not in the notional amounts of fair value or cash flow hedges.

cash flow hedge will be missing. But since we do know that this company is engaged in hedging activity in general and cash flow hedging activity in particular, the variables *total hedge dummy* and *cash flow hedge dummy* will both equal one.

We also assign missing values to observations where the notional amount of derivatives is not disclosed in dollar amounts. For instance, a company can disclose that it uses future contracts on five million barrels of oil as cash flow hedges, but not disclose their dollar notional amount. As before, we assign a value of one for both *total hedge dummy* and *cash flow hedge dummy*, but missing values for *total hedge* and *cash flow hedge*.

Our second data source is DealScan, from which all our data on bank lines of credit are collected. In particular, for each firm-year in our 2002–07 S&P 500 sample, we document whether the firm had access to a revolving credit facility that year (a "yes/no" variable) as well as the total amount of credit (used and unused). These variables are computed across all revolving credit facilities that the firm had access to in that year. Finally, our firm-level accounting data come from Compustat's annual files. We collect data on firms' total assets, cash holdings, sales, cash flows, capital expenditures, short- and long-term debt, dividends, stock repurchases, and investment opportunities (using Tobin's *Q*). In Table VII, we detail the construction of the various variables used throughout the article.

Table I provides summary statistics for the 2002–07 sample. The average notional amount of derivative hedging is 7.9% of firm assets, whereas the average amount of cash flow derivative hedging is 2.1% of firm assets. Note that the average amount of cash flow hedging is substantially smaller than total hedging. This is in great part because, as described above, some firms report their overall hedging positions, but do not provide detailed information on cash flow hedging. In our sample, 81.9% of the firms use some type of derivative hedging and 56.0% use cash flow hedging. The usage of bank lines of credit is also widespread among the companies in our sample: 71.2% of the firms have access to a line of credit, and the average amount of credit is 13.0% of firm assets. This number is comparable in magnitude to average cash holdings in our sample, equal to 14.3% of firm assets.

4. Cash Flow Hedging: Univariate Evidence and Cross-Sectional Determinants

4.1 UNIVARIATE EVIDENCE

Table II presents univariate results on the sample-wide relation between the corporate usage of derivative hedging, cash holdings, and bank lines of

Table I. Summary statistics

This table reports summary statistics for the variables employed in this study. The sample consists of industrial firms (nonfinancial and nonutility) from the S&P 500 index for the period 2002–07. Hedging data are hand-collected from companies' annual filings with the U.S. Securities and Exchange Commission. Data on lines of credit are taken from DealScan. Data on cash and other accounting figures are taken from Compustat annual files. A detailed description of each variable is included in Table VII.

	Mean	Median	Std Dev	*N*
Hedging variables				
Total hedge	0.079	0.043	0.114	1368
Cash flow hedge	0.021	0.000	0.048	1169
Fair value hedge	0.021	0.000	0.041	1483
Total hedge dummy	0.819	1.000	0.385	2092
Cash flow hedge dummy	0.563	1.000	0.496	1710
Fair value hedge dummy	0.475	0.000	0.500	1719
Credit lines				
Line of credit amount	0.130	0.089	0.158	2100
Line of credit dummy	0.712	1.000	0.453	2100
Liquidity ratio	0.457	0.510	0.361	2100
Accounting variables				
Cash	0.143	0.084	0.157	2100
Cash flow	0.102	0.106	0.111	2100
Net working capital	0.020	0.013	0.116	2004
Cash flow volatility	0.213	0.192	0.114	2100
R&D	0.031	0.007	0.050	2100
CAPEX	0.048	0.037	0.044	2100
Debt	0.220	0.209	0.156	2100
Payout	0.070	0.039	0.113	2100
Tobin's *Q*	1.930	1.695	0.828	2085
Size	9.009	8.882	1.187	2100
EBITDA	0.159	0.151	0.088	2092
Tangibles	0.789	0.828	0.182	2053
Industry sales volatility	0.315	0.319	0.086	2100
Age	3.084	3.332	0.514	2100
Net worth	0.309	0.331	0.197	2091

credit. Panel A of Table II presents results in which we compute the sample-wide correlations between our measures of derivative hedging, cash, and lines of credit. Panel A shows that there is a negative correlation between cash holdings and both the existence of and the amounts reported for (i) cash flow hedging and (ii) lines of credit. These correlations are all statistically significant at the 1% level. In contrast, the correlation between derivative hedging and bank lines of credit is positive.

Next, we investigate how the use of liquidity and hedging instruments has changed over our sample period. Panel B reports the annual average use of derivative hedging, lines of credit, and cash holdings. The annual estimates of average derivative hedging are persistent and suggest that the use of total derivative hedging and cash flow derivative hedging did not change significantly over the sample period. In particular, the differences in means from 2002 to 2007 are not statistically significant at conventional levels in all cases

Table II. Univariate results

This table presents univariate results on the relation between derivative hedging, cash, and bank lines of credit. The sample and variable descriptions are in Table VII. Panel A presents the overall sample correlation across hedging, cash, and lines of credit. Panel B reports the average annual usage of derivative hedging, lines of credit, and cash holdings. Panel B also provides difference-in-means estimates from 2002 to 2007 and reports the *t*-statistics in parentheses. Panel C presents the average cash holdings for different types of companies, classified by their use of cash flow hedging and/or lines of credit. Similarly, Panel D shows average lines of credit for companies categorized by their use of cash flow derivatives.

Panel A: Correlation between derivative hedging, cash, and bank lines of credit

	Total hedge	Total hedge dummy	Cash flow hedge	Cash flow hedge dummy	Line of credit amount	Line of credit dummy
Total hedge	1.000					
Total hedge dummy	0.456	1.000				
Cash flow hedge	0.555	0.317	1.000			
Cash flow hedge dummy	0.404	0.537	0.591	1.000		
Line of credit amount	0.110	0.146	0.145	0.179	1.000	
Line of credit dummy	0.109	0.189	0.093	0.170	0.524	1.000
Cash	−0.068	−0.252	−0.132	−0.238	−0.236	−0.478

Panel B: Annual averages of derivative hedging, lines of credit, and cash holdings

Year	Total hedge	Total hedge dummy	Cash flow hedge	Cash flow hedge dummy	Line of credit amount	Line of credit dummy	Cash
2002	0.077	0.793	0.020	0.564	0.114	0.678	0.137
2003	0.082	0.812	0.017	0.544	0.089	0.667	0.148
2004	0.079	0.828	0.017	0.562	0.114	0.699	0.155
2005	0.081	0.835	0.020	0.563	0.144	0.735	0.152
2006	0.072	0.818	0.019	0.537	0.156	0.749	0.138
2007	0.085	0.826	0.031	0.593	0.170	0.764	0.129
Difference	0.008	0.033	0.011	0.029	0.056	0.086	−0.008
(2007–02)	(0.814)	(1.095)	(1.822)	(0.690)	(4.331)	(2.523)	(0.737)

(*continued*)

Table II. (Continued)

Panel C: Average cash holdings in subsamples

	Lines of credit?				Difference Yes, Yes–No, No	
	No		Yes			
Cash flow hedging?	No	Yes	No	Yes	Diff	*p*-value
2002	0.300	0.154	0.108	0.070	−0.230	<0.001
2003	0.294	0.201	0.113	0.076	−0.218	<0.001
2004	0.312	0.215	0.126	0.089	−0.223	<0.001
2005	0.288	0.202	0.140	0.091	−0.197	<0.001
2006	0.296	0.209	0.107	0.082	−0.213	<0.001
2007	0.287	0.196	0.089	0.078	−0.208	<0.001

Panel D: Lines of credit in subsamples

	Cash flow hedging?		Difference Yes–No	
	No	Yes	Diff	*p*-value
2002	0.122	0.140	0.018	0.303
2003	0.095	0.108	0.013	0.591
2004	0.127	0.158	0.031	0.147
2005	0.119	0.187	0.068	0.001
2006	0.138	0.221	0.083	0.005
2007	0.133	0.225	0.092	<0.001

but the average ratio of cash flow hedging to book assets, for which the difference is marginally significant at the 10% level.

In contrast, Panel B shows that the use of lines of credit has significantly increased from the 1st half of our sample period (2002–04) to the 2nd half of the sample period (2005–07). Overall, from 2002 to 2007, the average ratio of lines of credit to book assets has increased by 5.6 percentage points, and the difference is statistically significant at the 1% level. To account for this time trend, in the remainder of Table II (Panels C and D), we investigate the relation between derivative hedging, cash holding, and lines of credit separately for each sample year.[10] As indicated in the results below, the links

[10] Note, however, that the samples in Panels B–D are not identical. Panel B reports the annual averages of each variable across its nonmissing observations; Panels C and D report the annual averages only for observations with nonmissing data on both cash flow hedging and lines of credit.

between the hedging and liquidity instruments persist across the entire sample period.

Panel C presents results in which we double-sort firms into bins based on whether they use cash flow derivative hedging or lines of credit and compare annual average cash holdings across bins for each year over the period 2002–07. Both hedging and lines of credit affect cash holdings: in virtually all cases, there is a monotonic decline in annual cash holdings as we move from firms that do not use hedging and bank lines of credit to companies that use: (i) derivative hedging; (ii) lines of credit; and (iii) both. In 2004, for example, companies that only used cash held 31.2% of their assets in cash, compared to 21.5% if they also used derivative hedging, 12.6% if they also used bank lines of credit, and 8.9% if they used both hedging and lines of credit. As Panel C shows, the differences between firms that use neither hedging nor lines of credit and firms that use both are all statistically significant at the 1% level.

In Panel D, we track the usage of bank lines of credit in companies depending on their usage of cash flow derivative hedging. This allows us to examine directly the relation between derivative hedging and bank lines of credit. Panel D shows that lines of credit are positively related to cash flow derivative hedging. Across all years in our sample, lines of credit are higher for companies with cash flow hedging. From 2005 to 2007, these differences are also significant at the 1% level. The largest effect is found in 2007: cash flow derivative hedging is associated with an increase of almost 70% in the average use of lines of credit.

Overall, Table II provides preliminary evidence suggesting that corporations use both cash flow derivative hedging and bank lines of credit as substitutes for cash. The preliminary evidence is also consistent with a positive relation between cash flow hedging and lines of credit. A major concern with this evidence, however, is that it does not take into account the endogeneity of the hedging and liquidity decisions of the firm. One potential solution to this problem is to make use of the structure imposed by our theory. In what follows, we investigate how the *ability* to hedge cash flows affects the choice between cash holdings and bank lines of credit. The next subsection is therefore devoted to studying the determinants of cash flow hedging; it shows that a firm's industry is an important, potentially exogenous determinant of its ability to hedge its cash flows.

4.2 CROSS-SECTIONAL DETERMINANTS OF CASH FLOW HEDGING

Our identification strategy hinges on the measurement of a firm's ability to hedge its cash flow risk. To investigate its determinants, we explore the cross-sectional variation in the use of cash flow derivatives. Standard models of risk management suggest that when capital markets are not frictionless, companies should benefit from hedging their cash flows. These benefits include, for instance, limiting deadweight losses of bankruptcy (e.g., Smith and Stulz, 1985), tax advantages arising from the convexity of taxes in the presence of risk-averse managers (e.g., Stulz, 1984; Graham and Smith, 1999), limiting underinvestment costs (e.g., Froot, Scharfstein, and Stein, 1993), and reducing the costs of information asymmetry (e.g., DeMarzo and Duffie, 1991, 1995).

These models and others thus suggest that it is optimal for all firms to hedge. Why, then, do some companies not hedge? In Panel A of Table III, we provide evidence suggesting that hedging is significantly affected by industry, which implies that the nature of a company's business might be a key determinant of its ability to hedge.[11] Concretely, we investigate the use of cash flow hedging by year for each of the 12 Fama–French industries, excluding financial firms and utilities, which are not in our sample.

The findings indicate that there are substantial differences in cash flow hedging across industries. For example, over the entire sample period 2002–07, the average use of cash flow hedging in the Energy industry had a notional amount of 0.4% of book assets, compared to an average notional amount of 4.2% of assets in the Chemicals industry and 4.5% of assets in the Consumer Nondurables industry. In unreported results, we also estimate difference-in-means tests for each pair of industries each year. We find that the differences in cash flow hedging across industries are frequently statistically significant at conventional levels.

In Panel B of Table III, we proceed with multivariate regression analysis of the determinants of derivative hedging. Panel B presents the results from panel regressions explaining firm-level hedging amounts using firm-level characteristics that were previously found to explain derivative hedging (e.g., Purnanandam, 2008). To better gauge the importance of the industry in explaining the variation in cash flow hedging practices, we run regressions with and without industry fixed effects.

Consistent with the findings in Panel A, the main takeaway from Panel B is that a firm's industry is a significant determinant of the amount of its hedging, and in particular its cash flow hedging. To see this, note that the firm-level characteristics examined in Column (2) collectively explain 4.7% of the variation in cash flow hedging. This specification does not include

[11] Previous studies have shown that a firm's decision to hedge is strategically related to the hedging practices of its industry competitors (e.g., Nain, 2005; Adam, Dasgupta, and Titman, 2007).

Table III. The determinants of corporate hedging

This table investigates the determinants of derivative hedging. Panel A reports the average cross-sectional average ratio of cash flow hedging to book assets for each of the 12 Fama and French industries. Panel B presents the results of panel regressions of hedging policies on firm characteristics and industry controls. The dependent variables are the total amount of hedging (Columns (1) and (3)), and the amount of cash flow hedging (Columns (2) and (4)), all normalized by total assets. In Columns (1) and (2), firm-level variables are included. Columns (3) and (4) also include industry fixed effects based on three-digit SIC codes. All variables are described in Table VII. *Lag* represents 1-year lag. All regressions include year dummies (data not reported). Robust standard errors clustered at firm level are in parentheses. *, **, and *** represent significance at the 10, 5, and 1% level, respectively.

Panel A: Univariate industry analysis

Fama–French 12 industry code	Industry name	2002	2003	2004	2005	2006	2007	2002–07
1	Consumer Nondurables	0.059	0.046	0.038	0.025	0.028	0.071	0.045
2	Consumer Durables	0.019	0.010	0.011	0.009	0.013	0.011	0.012
3	Manufacturing	0.031	0.020	0.019	0.030	0.031	0.052	0.031
4	Energy	0.003	0.012	0.004	0.003	0.003	0.001	0.004
5	Chemicals	0.034	0.031	0.034	0.048	0.051	0.053	0.042
6	Business Equipment	0.016	0.023	0.028	0.021	0.021	0.028	0.023
7	Telecommunications	0.012	0.002	0.007	0.000	0.020	0.027	0.011
8	Utilities	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9	Wholesale, Retail, and Services	0.006	0.006	0.005	0.005	0.003	0.005	0.005
10	Health	0.032	0.010	0.014	0.019	0.021	0.042	0.023
11	Finance	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12	Other	0.003	0.009	0.010	0.010	0.009	0.031	0.012

Panel B: Regression analysis

	Tot hedge (1)	CF hedge (2)	Tot hedge (3)	CF hedge (4)
Foreign sales	0.145**	0.045	0.114*	0.020
	(0.062)	(0.037)	(0.064)	(0.042)
Sales volatility	0.159	0.061	0.287	0.265
	(0.148)	(0.120)	(0.203)	(0.180)
Size (Lag)	0.011	0.013	0.002	0.012
	(0.020)	(0.019)	(0.027)	(0.026)
EBITDA	0.661***	0.139	0.776***	0.392
	(0.241)	(0.202)	(0.291)	(0.265)
Tobin's Q	−0.044***	−0.032***	−0.049**	−0.028**
	(0.014)	(0.011)	(0.020)	(0.013)
Net worth	−0.103	−0.149*	−0.057	−0.108
	(0.098)	(0.077)	(0.112)	(0.101)
Age	−0.036	0.034	−0.034	0.042
	(0.058)	(0.040)	(0.072)	(0.049)
R&D	0.215	−0.223**	0.312	−0.297*
	(0.162)	(0.109)	(0.192)	(0.157)
Leverage	0.006	0.000	0.004	0.000
	(0.004)	(0.000)	(0.003)	(0.000)
Inst ownership	0.017	0.344	0.225	0.151
	(0.357)	(0.305)	(0.358)	(0.331)
Industry FE	No	No	Yes	Yes
Adjusted R^2	0.027	0.047	0.318	0.241
Observations	1,127	1,441	1,123	1,438

industry fixed effects. The inclusion of industry fixed effects in Column (4) increases the adjusted R^2 more than five times to 24.1%. Furthermore, an F-test on the joint significance of the industry fixed effects strongly rejects the null hypothesis that they are collectively equal to zero.

These results suggest that industry is a 1st-order determinant of firms' usage of cash flow derivative hedging. Intuitively, they are consistent with the notion that cash flows from certain lines of businesses are more naturally hedged with derivatives instruments than others. This implies that the firm's industry may serve as a potentially exogenous determinant of its use of cash flow hedging derivatives. Therefore, in what follows, we use the predicted values from the regressions in Panel B of Table III as instruments designed to capture the ability to hedge. We call these variables *Hedge propensity*.[12] In the remainder of the article, we use these instruments to investigate the implications of cash flow hedging for the firm's liquidity policy and value. We start by analyzing how cash flow hedging affects the choice between cash holdings and lines of credit.

5. Cash Flow Hedging and the Liquidity Policy

5.1 THE BANK LIQUIDITY RATIO

To study the relation between derivative hedging and corporate liquidity policy, Table IV estimates panel regressions explaining firm-level bank liquidity ratios. As discussed in the previous section, we use an instrumental variable (IV) approach to address endogeneity and make better inferences on the causal effects of hedging on liquidity policy. Our proxy for the firm's ability to hedge is constructed from the 1st-stage regressions given in Panel B of Table III. We instrument total hedging, cash flow hedging, and fair value hedging based on the overall predicted value from these regressions. We first estimate the regressions using total hedge and then break it down into cash flow hedge and fair value hedge.

Following Sufi (2009), the bank liquidity ratio is defined as the ratio of the firm's available lines of credit to its overall liquidity resources (i.e., the sum of lines of credit and cash). Our control variables are based on Sufi (2009) and include EBITDA, tangible assets, size, Tobin's Q, age, the volatility of industry sales, and net worth, all lagged. All variables are defined in Table VII.

[12] Specifically, the general specification for the regressions in Panel B of Table III takes the form: Hedging $= \alpha + \beta$ Controls $+ \gamma$ Industry Fixed Effects $+ \varepsilon$. *Total hedge propensity* is then equal to $\hat{\alpha} + \hat{\beta}$ Controls $+ \hat{\gamma}$ Industry Fixed Effects. The corresponding variables for cash flow hedging and fair value hedging are defined similarly.

Table IV. Hedging instruments and liquidity policies

This table presents the results of panel regressions explaining firm-level bank liquidity ratios. The dependent variable is liquidity ratio, defined as the ratio of outstanding lines of credit to total liquidity (i.e., the sum of outstanding lines of credit and cash reserves). The variables of interest are the hedging propensities. They, as well as the sample and all other variables, are described in Table VII. Lag represents 1-year lagged variables. The regressions include year dummies (data not reported). Robust standard errors clustered at firm level are in parentheses. *, **, and *** represent significance at the 10, 5, and 1% level, respectively.

	Liquidity ratio	
	(1)	(2)
Total hedge propensity	0.127	
	(0.231)	
CF hedge propensity		2.266***
		(0.724)
FV hedge propensity		−0.209
		(1.025)
EBITDA (Lag)	1.503***	1.470***
	(0.161)	(0.160)
Tangibles (Lag)	−0.393***	−0.336***
	(0.092)	(0.095)
Size (Lag)	−0.031**	−0.026*
	(0.014)	(0.013)
Tobin's Q (Lag)	−0.201***	−0.198***
	(0.018)	(0.018)
Age (Lag)	0.022	0.038
	(0.033)	(0.032)
Industry sales vol (Lag)	−0.599***	−0.625***
	(0.174)	(0.176)
Net worth (Lag)	−0.122**	−0.117**
	(0.060)	(0.059)
Adjusted R^2	0.239	0.249
Observations	1,966	1,966

The results in Table IV collectively suggest that cash flow hedging corresponds to a tendency to substitute more cash with lines of credit, whereas total hedging and fair value hedging are not significantly related to the firm's liquidity choice. Next, we discuss each of these results separately.

In Column (1) of Table IV, we estimate the effect of *total* hedging on the liquidity ratio. We find that total hedging is not significantly related to the liquidity ratio. Although total hedging does not seem to affect the choice between cash and lines of credit, we next show that *cash flow* hedging strongly predicts the liquidity ratio. In other words, the proportion of derivative hedging designed to reduce cash flow risk seems to induce firms to rely more on cost-effective lines of credit relative to cash.

In Column (2), we decompose total hedging into its cash flow and fair value components. Our theory predicts that cash flow hedging is positively related to the liquidity ratio. Accordingly, we find a strong and highly significant effect. The coefficient of 2.27 on *CF hedge propensity* indicates that a one standard deviation increase in the firm's instrumented cash flow hedge is associated with an 8.6% increase in the liquidity ratio.

Finally, note that Column (2) also shows that fair value hedging is not significantly related to the bank liquidity ratio. This emphasizes the importance of separating between cash flow and fair value hedging when studying the effects of hedging on corporate policies. Strikingly, failure to separate cash flow hedging from fair value hedging prevents identifying the effect of cash flow hedging on the firm's liquidity policy, as is evident from Column (1).

One source of concern is that our sample is biased toward large firms in the S&P 500 index, and therefore unrepresentative of the universe of US industrial public firms. To deal with this issue, we hand-collected detailed derivative hedging information on the entire universe of S&P 1500 industrial companies from their 10-k statements for the last 2 years of our sample, 2006 and 2007. In unreported results, we find that the positive relation between the bank liquidity ratio and cash flow hedging continues to hold for all industrial S&P 1500 companies, and this relation is highly statistically significant at the 1% level.

Another source of concern is that our statistical significance is overstated due to the imperfect controls for clustering across time and companies, especially due to the relatively constant composition of our sample of companies across the years (92.5% of firms in our sample appear in every year during the sample period). To deal with this concern, in unreported results we estimated our main regressions separately across the different years in our sample. The findings suggest that cash flow hedging continues to be positively and significantly related to the liquidity ratio in each individual year.

Overall, the results suggest that cash flow hedging has an important effect, both economically and statistically, on corporate liquidity policy. They also suggest that it is vital to separate cash flow hedging from fair value hedging, as fair value hedging is not systematically related to the firm's liquidity policy, and therefore has a confounding effect on the relation between total hedging and corporate liquidity. In the next subsection, we further examine the separate effects of cash flow hedging on cash holdings and lines of credit. Our model suggests that it should affect both.

5.2 SIMULTANEOUS EQUATION MODEL OF CASH HOLDINGS AND LINES OF CREDIT

The results of the previous subsection imply a positive relation between cash flow hedging and the bank liquidity ratio. However, this relation does not necessarily imply that firms adjust both cash reserves and lines of credit to their cash flow hedging. For instance, an increase in lines of credit will lead to an increase in the liquidity ratio for a constant level of cash holdings. Our model predicts that both cash holdings and lines of credit will be affected by cash flow hedging. To test this directly, we estimate a system of two simultaneous equations, with cash holdings and bank lines of credit as the dependent variables. We then analyze how our hedging instruments affect each one of these variables.

Specifically, Table V estimates the following simultaneous equation model of the cash holdings (Cash) and bank lines of credit (Credit) regressions:

$$\begin{cases} \text{Cash} = \alpha_1 + \gamma_1 \text{Credit} + \beta_1 \text{Hedge} + \delta_1' Z_1 + \varepsilon_1 \\ \text{Credit} = \alpha_2 + \gamma_2 \text{Cash} + \beta_2 \text{Hedge} + \delta_2' Z_2 + \varepsilon_2 \end{cases}$$

The system of equations is estimated using two-stage least squares. In the 1st stage, the endogenous variables (Cash and Credit) are each regressed on our hedging instruments (denoted in the system of equations by Hedge) and a vector of explanatory variables suggested by previous studies (denoted in the system of equations by Z_1 and Z_2). For bank lines of credit, we again follow Sufi (2009) and include EBITDA, tangible assets, size, Tobin's Q, firm age, the volatility of industry sales, and net worth, all lagged. For cash, we follow previous empirical studies (e.g., Bates, Kahle, and Stulz, 2009) and regress cash holdings on cash flow volatility, cash flow, net working capital, R&D expenditure, capital expenditure, debt, payout, Tobin's Q, size, and firm age. All variables are defined in Table VII. In the 2nd stage, the predicted values from the 1st stage are used as instruments for the endogenous variables.

Columns (1) and (2) estimate this system of equations using the total hedging instrument. Similar to our results for the liquidity ratio, we find no significant relation between overall derivative hedging and corporate cash holdings. The coefficient on *total hedge* in Column (1) is statistically insignificant. This result is consistent with previous literature that finds little empirical support for a relation between corporate derivative hedging and cash policies. For instance, Opler *et al.* (1999) examined derivative hedging among the S&P 500 companies in 1994 and found no relation between derivatives and cash. In Column (2), we find only a weak relation between total hedging and bank lines of credit, marginally significant at the 10% level.

Table V. Hedging instruments and liquidity policies (simultaneous equation estimation)

This table presents estimates from simultaneous equation models of cash and credit on our hedging instruments.

$$\begin{cases} \text{Cash} = \alpha_1 + \gamma_1 \text{Credit} + \beta_1 \text{Hedge} + \delta_1' Z_1 + \varepsilon_1 \\ \text{Credit} = \alpha_2 + \gamma_2 \text{Cash} + \beta_2 \text{Hedge} + \delta_2' Z_2 + \varepsilon_2 \end{cases}$$

This system of equations is estimated using 2SLS. In the first stage, the endogenous variables Cash and Credit are each regressed on our hedging instruments (Hedge) and a vector of explanatory variables suggested by previous studies (Z_1 and Z_2). In the 2nd stage, the predicted values from the first stage are used as instruments for the endogenous variables (represented by a dagger symbol). All regressions include year dummies (data not reported). The sample and variables are described in Table VII. For the 2nd stage regressions, robust standard errors clustered at firm level are in parentheses. *, **, and *** represent significance at the 10, 5, and 1% level, respectively.

	Cash (1)	Credit (2)	Cash (3)	Credit (4)
Total hedge propensity	−0.006	0.166*		
	(0.054)	(0.089)		
CF hedge propensity			−0.734***	0.787**
			(0.225)	(0.343)
FV hedge propensity			0.258	−0.429
			(0.252)	(0.343)
Credit lines†	−0.999***		−0.935***	
	(0.164)		(0.162)	
Cash†		−0.489***		−0.495***
		(0.073)		(0.070)
Cash flow volatility	0.043		0.054	
	(0.040)		(0.040)	
Cash flow	−0.049		−0.047	
	(0.070)		(0.070)	
Net working capital	−0.212***		−0.212***	
	(0.048)		(0.048)	
R&D	0.457**		0.490***	
	(0.177)		(0.175)	
CAPEX	−0.375***		−0.409***	
	(0.081)		(0.080)	
Debt	0.008		−0.001	
	(0.048)		(0.046)	
Payout	0.019		0.019	
	(0.039)		(0.038)	
Size (Lag)	−0.052***	−0.035***	−0.052***	−0.035***
	(0.007)	(0.004)	(0.007)	(0.004)
Tobin's *Q* (Lag)	0.037***	−0.003	0.037***	−0.001
	(0.007)	(0.009)	(0.007)	(0.009)
Age (Lag)	0.002	−0.004	−0.005	0.004
	(0.011)	(0.014)	(0.011)	(0.013)
EBITDA (Lag)		0.196***		0.193**
		(0.075)		(0.075)
Tangibles (Lag)		−0.060*		−0.050
		(0.032)		(0.033)
Industry sales vol (Lag)		−0.000		−0.021
		(0.059)		(0.059)
Net worth (Lag)		−0.151***		−0.163***
		(0.031)		(0.031)
R^2	0.554	0.234	0.562	0.238
Observations	1,938	1,952	1,938	1,952

In contrast, Columns (3) and (4) document a strong negative relation between cash and cash flow hedging and a strong positive relation between lines of credit and cash flow hedging. Fair value hedging, on the other hand, is not significantly related to either cash holdings or bank lines of credit. The magnitude of the cash flow hedging effects is nontrivial: the significant coefficient of −0.73 implies that an increase of one standard deviation in cash flow hedging reduces corporate cash by 9.6%. In Column (4), we show that cash flow hedging is associated with an increase in the use of lines of credit. The coefficient of 0.79, significant at the 5% level, corresponds to an increase of 11.0% in lines of credit for an increase of one standard deviation in cash flow hedging.

Taken together, the results in Table V imply a significant effect of cash flow hedging on both the firm's cash holdings and bank lines of credit positions, consistent with the predictions from our model.

6. The Value Implications of Cash Flow Hedging

In this section, we study the effect of cash flow hedging on firm value. The real effects of corporate hedging remain the centerpiece, largely unsettled, of the academic literature on corporate risk management. From a theoretical standpoint, the firm has no incentive to engage in hedging when capital markets are frictionless, because investors can hedge on their own. The theoretical literature on corporate hedging relaxes the assumptions in Modigliani and Miller (1958) and shows that corporate hedging enhances firm value when markets are not frictionless.

Specifically, this literature identifies various channels through which hedging can increase firm value: limiting the deadweight losses of bankruptcy (e.g., Smith and Stulz, 1985); convexity of taxes and managerial risk aversion (e.g., Stulz, 1984; Smith and Stulz, 1985; Graham and Smith, 1999); reducing underinvestment costs (e.g., Bessembinder, 1991; Froot, Scharfstein, and Stein, 1993); information asymmetry (e.g., DeMarzo and Duffie, 1991, 1995); increasing the value of the debt tax shield (e.g., Leland, 1998); and overcoming the asset substitution problem (e.g., Chidambaran, Fernando, and Spindt, 2001).[13]

Contrary to the theoretical literature, the empirical evidence on the implications of hedging for firm value is mixed. Allayannis and Weston (2001), for

[13] Far less common are theoretical settings in which corporate hedging can decrease firm value. For instance, Tufano (1998) illustrates that, by adding manager–shareholder agency costs to the Froot, Scharfstein, and Stein (1993) model, hedging may allow managers to destroy value.

example, find a positive relation between the use of foreign currency derivatives and Tobin's *Q*. Another example is the study by Graham and Rogers (2002), which indicates that firms use derivative hedging to increase debt capacity, which leads, in turn, to an average increase of 1.1% in firm value due to the tax benefits of debt. Campello *et al.* (2011) show that hedging enhances corporate value by lowering the cost of borrowing and mitigating investment restrictions. Carter, Rogers, and Simkins (2006) and Mackay and Moeller (2007) are additional studies that find that hedging creates value.

On the other hand, Brown (2001), for example, reports that it is difficult to determine if hedging increases firm value. Guay and Kothari (2003) find that the cash flow implications of derivative hedging are modest, and consequently, its effect on firm value is small. Jin and Jorion (2006) use a similar empirical approach to that in Allayannis and Weston (2001) and, contrary to them, find insignificant effects of hedging on Tobin's *Q*. Other examples include the study by Magee (2009), who concludes that currency hedging has no effect on firm value, and more recently, Bartram, Brown, and Conrad (2011), who study an international sample of nonfinancial firms and find that the market value of derivatives usage is unclear.[14]

Our empirical approach extends the existing literature in two ways. First, it emphasizes the importance of separating between cash flow derivative hedging and fair value derivative hedging. Second, it addresses the endogeneity of corporate hedging by relying on industry instruments of hedging, motivated by our findings that hedging is heavily clustered by industry. The underlying assumption is that the ability to hedge cash flow risk is heavily dependent on the nature of the firm's business.

To test the value implications of hedging, in Table VI, we estimate panel regressions explaining firms' market to book ratios. This methodology is based on Fama and French (1998) and our implementation follows closely that in Dittmar and Mahrt-Smith (2007). We directly test the theoretical predictions of our model, which suggests that a greater ability to hedge

[14] An additional related issue is that derivatives may be used for purposes other than hedging. For instance, the surveys by Dolde (1993), Bodnar, Hayt, and Marston (1998), and Glaum (2002), and the studies of Hentschel and Kothari (2001), Adam and Fernando (2006), and Brown, Crabb, and Haushalter (2006) identify nonhedging, speculative uses of derivatives that do not enhance firm value. However, there is also alternative evidence suggesting that derivative use is consistent with theory. For example, Nance, Smith, and Smithson (1993), Mian (1996), Tufano (1996), Geczy, Minton, and Schrand (1997), Haushalter (2000), and Graham and Rogers (2002) report that derivative usage is consistent with at least some of the theoretical models mentioned before. Furthermore, Guay (1999), Bartram, Brown, and Conrad (2011), and others find that the use of derivatives reduces risk.

Table VI. Value regressions

This table shows the results for value regressions, in which the dependent variable is the ratio of the firm's market value to assets (computed as in Dittmar and Mahrt-Smith (2007)). The variables of interest are the hedging propensities, defined in Table V. Δ2 represents 2-year future changes ($X(t+2)-X(t)$) and Δ*L*2 represents 2-year lagged changes ($X(t)-X(t-2)$). Robust standard errors clustered at firm level are in parentheses. *, **, and *** represent significance at the 10, 5, and 1% level, respectively.

	(1)	(2)
Total hedge propensity	0.902	
	(0.781)	
CF hedge propensity		4.321***
		(1.536)
FV hedge propensity		−0.637
		(1.383)
Earnings before EI	10.080***	10.040***
	(0.963)	(0.953)
Δ2 Earnings before EI	3.255***	3.304***
	(0.476)	(0.468)
Δ*L*2 earnings before EI	−2.176***	−2.173***
	(0.508)	(0.505)
Δ2 assets	−0.041	−0.055
	(0.108)	(0.108)
Δ*L*2 assets	0.126	0.157
	(0.198)	(0.198)
R&D	4.895***	5.108***
	(1.118)	(1.068)
Δ2 R&D	12.450***	12.630***
	(3.080)	(3.051)
Δ*L*2 R&D	1.426	1.021
	(2.167)	(2.166)
Interest exp	−26.560***	−26.390***
	(5.426)	(5.298)
Δ2 interest exp	−3.717	−3.552
	(4.972)	(4.916)
Δ*L*2 interest exp	3.394	2.445
	(6.395)	(6.321)
Dividends	3.962	5.043*
	(2.614)	(2.577)
Δ2 dividends	12.490***	12.940***
	(4.731)	(4.705)
Δ*L*2 dividends	7.795	6.755
	(5.811)	(5.675)
Δ2 Tobin's *Q*	−0.095**	−0.099**
	(0.038)	(0.039)
R^2	0.601	0.603
Observations	1,337	1,337

Table VII. Variable definitions

The sample consists of nonfinancial and nonutility firms from the S&P 500 Index for the period 2002–07. Hedging data are hand-collected from companies' annual filings with the U.S. Securities and Exchange Commission. Data on lines of credit are taken from DealScan. Data on cash and other accounting figures are taken from Compustat annual files. *Note*: Compustat variable names are in parentheses.

Age	The number of years since the firm first appeared on Compustat with nonmissing book assets.
CAPEX	Capital expenditure (capx) over book assets (at).
Cash	Cash and short-term investments (che) over book assets (at).
Cash flow	The sum of income before extraordinary items (ib) and depreciation, and amortization (dp), over book assets (at).
Cash flow hedge	The total (identifiable) notional amount of cash flow derivative hedging over book assets (at).
Cash flow hedge dummy	An indicator set to one if the firm reported a positive notional amount of cash flow derivative hedging, and zero otherwise.
CF hedge propensity	Computed using predicted values from the regression estimates in Column (4) of Table III, Panel B.
Cash flow volatility	The industry's equal-weighted average cash flow volatility over the prior 10 years.
Debt	The sum of debt in current liabilities (dlc) and long-term debt (dltt), over book assets (at).
Dividends	The sum of common and preferred dividends (dvp + dvc).
Earnings before EI	The sum of income before extraordinary items (ib), interest expenses (xint), income taxes (txdi), and investment tax credit (itci).
EBITDA	The earnings before interest, taxes, depreciation, and amortization (ebitda) over book assets (at).
Fair value hedge	The total (identifiable) notional amount of fair value derivative hedging over book assets (at).
Fair value hedge dummy	An indicator set to one if the firm reported a positive notional amount of fair value derivative hedging, and zero otherwise.
FV hedge propensity	Computed using predicted values from regression estimates of fair value hedging on the controls in Table III, Panel B.
Foreign sales	The ratio of foreign sales (from Compustat geographical segments) to total sales of the firm (at).
Industry sales volatility	The average volatility of firm sales (sale/at) over the past 10 years across all firms in each Fama–French 48 industry.
Inst ownership	Measures the percentage institutional ownership in the firm.
Interest Exp	Interest expenses (xint).
Leverage	The sum of long-term debt (dltt) and debt in current liabilities (dlc) over common equity (ceq).
Line of credit amount	The total amount of credit (used and unused), across all revolving credit facilities, that the firm should have access to (according to DealScan) over book assets (at).
Line of credit dummy	An indicator set to one if the firm should have access to a revolving credit facility according to DealScan, and zero otherwise.
Liquidity ratio	Defined as the ratio of outstanding lines of credit to total liquidity (i.e., the sum of outstanding lines of credit and cash reserves).
Net working capital	Current assets (act) minus current liabilities (lct) minus cash (che), over book assets (at).
Net worth	Defined as book assets (at) minus cash (che) minus total liabilities (lt), all divided by book assets (at).
Payout	The sum of total dividends (dvt) and the purchase of common and preferred stock (prstkc), over book assets (at).
PPE	Corresponds to Plan, Plant and Equipment (ppent) divided by total assets (at).
R&D	The ratio of R&D expenses (xrd) over book assets (at), set to zero if missing.
Sales volatility	The 10-year standard deviation of sales (sale) over total assets (at).
Size	The natural logarithm of book assets (at).
Tangible assets	One minus intangible assets (intan) over book assets (at).
Tobin's Q	Computed as in Kaplan and Zingales (1997), and outliers are handled by bounding Q above at 10, following the alternative measure of Baker, Stein, and Wurgler (2003). Specifically, it is the sum of the book value of assets (at) and market value of common equity (csho × prcc), minus the sum of common equity (ceq) and deferred Taxes (txdb), all over the book value of assets (at).
Total hedge	The total (identifiable) notional amount of derivative hedging over book assets (at).
Total hedge dummy	An indicator set to one if the firm reported a positive notional amount of derivative hedging, and zero otherwise.
Total hedge propensity	Computed using predicted values from the regression estimates in Column (3) of Table III, Panel B.

cash flow risks enhances firm value as it reduces the liquidity premium borne by the firm (Equation (12)). Note, however, that cash flow hedging might affect other financial policies as well. Our tests of the value of cash flow hedging cannot separate between the liquidity policy effect and other effects. Although these tests are able to pin down the overall value effects of cash flow hedging, a promising avenue for future research is to identify additional channels through which hedging affects corporate policies, as well as quantifying their relative importance for the value of the firm.

Table VI reports the results of the value regressions with the market-to-book ratio as the dependent variable. Column (1) reports the results for the total hedging instrument. Consistent with our previous findings, it shows no significant relation between total hedging and firm value. These results are also consistent with the mixed evidence found in previous studies of the value of corporate hedging. Next, in Column (2), we separate total hedging into cash flow hedging and fair value hedging. The results are striking: cash flow hedging has a strong positive effect on firm value, significant at the 1% level. The estimate of 4.32 indicates that a one standard deviation increase in the cash flow hedging instrument corresponds to an increase of approximately 4% in the firm's market-to-book ratio. Importantly, we do not find a similar effect for fair value hedging. This result is consistent with previous theoretical literature on corporate derivative hedging that focuses on the hedging of cash flow risks. Furthermore, most of the fair value hedging in our sample consists of swaps from fixed- to floating-rate debt, driven by investor demand rather than by risk management considerations. This might also explain why we do not find a relation between fair value hedging and firm value.

Taken together, the results in this section imply a robust, positive effect of cash flow hedging on firm value. We do not find a similar effect for either total hedging or fair value hedging. This is consistent with the theoretical literature on corporate hedging, which focuses on the motives and implications of cash flow risk management. It also suggests that fair value hedging, considered by previous studies as part of the firm's hedging policy, might have a confounding effect on the relation between hedging and firm value. This may explain why in contrast to the theoretical predictions, previous empirical studies failed to find a robust relation between corporate hedging and firm value.

7. Concluding Remarks

This article sheds new light on the implications of corporate derivative hedging. It highlights the importance of identifying specific mechanisms through which derivative hedging affects corporate financing policies and, as a result, firm value. It provides a unified theoretical and empirical study of how corporations combine the use of derivative hedging, cash holdings, and bank lines of credit to manage cash flow risks. In doing so, it emphasizes the importance of separating between cash flow hedging and fair value hedging.

Our model shows that cash flow hedging has an effect on the firm's liquidity choice of cash holdings vis-à-vis bank lines of credit. It suggests that cash flow hedging facilitates reliance on externally provided, cost-effective liquidity resources that enhance the efficiency of the firm's liquidity policy and as a result its value. Importantly, the model assumes that cash flow hedging is mean-preserving, and therefore does not generate a mechanical positive relation between hedging and firm value. Overall, the model highlights the interaction between corporate hedging and liquidity policies as means to address cash flow risks.

We test the implications of our model by employing a new empirical approach that isolates the effects of cash flow hedging. Specifically, we take advantage of the 2001 accounting standard SFAS No. 133, which requires firms, for the first time, to distinguish between cash flow hedging and fair value hedging in the financial statements. We hand-collect detailed data on corporate hedging and use an instrumental variable procedure to identify the causal effect of cash flow hedging on the firm's liquidity policy and as a result its value. We find that cash flow hedging reduces the firm's precautionary demand for cash and allows it to rely more on bank of lines credit, relative to cash reserves, for liquidity provision. Furthermore, we are able to identify a significant positive value effect of cash flow hedging.

Overall, our results suggest that corporate hedging and liquidity policies should be studied together. It should be noted that cash flow hedging might affect other financial policies, and that our value tests cannot separate between the liquidity policy effects and other potential effects. A promising avenue for future research would be to expand on the value effects we document and identify additional channels through which hedging affects corporate policies.

References

Acharya, V., Almeida, H., and Campello, M. (2007) Is cash a negative debt? A hedging perspective on corporate financial policies, *Journal of Financial Intermediation* **16**, 515–554.

Acharya, V., Almeida, H., and Campello, M. (2012) Aggregate risk and the choice between cash and lines of credit, *Journal of Finance*, forthcoming.

Adam, T., Dasgupta, S., and Titman, S. (2007) Financial constraints, competition, and hedging in industry equilibrium, *Journal of Finance* **62**, 2445–2473.

Adam, T. and Fernando, C. (2006) Hedging, speculation, and shareholder value, *Journal of Financial Economics* **81**, 283–309.

Allayannis, G. and Weston, J. (2001) The use of foreign currency derivatives and firm market value, *Review of Financial Studies* **14**, 243–276.

Almeida, H., Campello, M., and Weisbach, M. (2004) The cash flow sensitivity of cash, *Journal of Finance* **59**, 1777–1804.

Baker, M., Stein, J., and Wurgler, J. (2003) When does the market matter? Stock prices and the investment of equity-dependent firms, *Quarterly Journal of Economics* **118**, 969–1006.

Bartram, S., Brown, G., and Conrad, J. (2011) The effects of derivatives on firm risk and value, *Journal of Financial and Quantitative Analysis* **46**, 967–999.

Bartram, S., Brown, G., and Fehle, F. (2009) International evidence on financial derivative usage, *Financial Management* **38**, 185–206.

Bates, T., Kahle, K., and Stulz, R. (2009) Why do U.S. firms hold so much more cash than they used to?, *Journal of Finance* **64**, 1985–2021.

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

Bodnar, G., Hayt, G., and Marston, R. (1998) Wharton survey of financial risk management by US non-financial firms, *Financial Management* **27**, 70–91.

Bolton, P., Chen, H., and Wang, N. (2011) A unified theory of Tobin's q, corporate investment, financing, and risk management, *Journal of Finance* **66**, 1545–1578.

Bolton, P., Chen, H., and Wang, N. (2012) Market timing, investment, and risk management, *Journal of Financial Economics*, forthcoming.

Boot, A., Thakor, A., and Udell, G. (1987) Competition, risk neutrality, and loan commitments, *Journal of Banking and Finance* **11**, 449–471.

Brown, G. (2001) Managing foreign exchange risk with derivatives, *Journal of Financial Economics* **60**, 401–448.

Brown, G., Crabb, P., and Haushalter, D. (2006) Are firms successful at selective hedging? *Journal of Business* **79**, 2925–2949.

Campello, M., Lin, C., Ma, Y., and Zou, H. (2011) The real and financial implications of corporate hedging, *Journal of Finance* **66**, 1613–1645.

Carter, D., Rogers, D., and Simkins, B. (2006) Does fuel hedging make economic sense? The case of the US airline industry, *Financial Management* **35**, 53–86.

Chidambaran, N.K., Fernando, C., and Spindt, P. (2001) Credit Enhancement through financial engineering: Freeport-McMoran's gold-denominated depositary shares, *Journal of Financial Economics* **60**, 487–528.

DeMarzo, P. and Duffie, D. (1991) Corporate financial hedging with proprietary information, *Journal of Economic Theory* **53**, 261–286.

DeMarzo, P. and Duffie, D. (1995) Corporate incentives for hedging and hedge accounting, *Review of Financial Studies* **8**, 743–771.

Dittmar, A. and Mahrt-Smith, J. (2007) Corporate governance and the value of cash holdings, *Journal of Financial Economics* **83**, 599–634.

Dolde, W. (1993) The trajectory of corporate financial risk management, *Journal of Applied Corporate Finance* **6**, 33–41.

Duchin, R., Ozbas, O., and Sensoy, B. (2010) Costly external finance, corporate investment, and the subprime mortgage credit crisis, *Journal of Financial Economics* **97**, 418–435.

Fama, E. and French, K. (1998) Value versus growth: The international evidence, *Journal of Finance* **53**, 1975–1999.

Froot, K., Scharfstein, D., and Stein, J. (1993) Risk management: Coordinating corporate investments and financing policies, *Journal of Finance* **48**, 1629–1658.
Gamba, A. and Triantis, A. (2011) Corporate Risk Management: Integrating liquidity, hedging, and operating policies, Unpublished working paper, Warwick University, University of Maryland.
Gatev, E. and Strahan, P. (2006) Banks' advantage in hedging liquidity risk: Theory and evidence from the commercial paper market, *Journal of Finance* **61**, 867–892.
Geczy, C., Minton, B., and Schrand, C. (1997) Why firms use currency derivatives, *Journal of Finance* **52**, 1323–1354.
Glaum, M. (2002) The determinants of exchange-risk management: Evidence from German non-financial corporations, *Journal of Applied Corporate Finance* **14**, 108–121.
Graham, J. and Harvey, C. (2001) The theory and practice of corporate finance: Evidence from the field, *Journal of Financial Economics* **60**, 187–243.
Graham, J. and Rogers, D. (2002) Do firms hedge in response to tax incentives? *Journal of Finance* **57**, 815–839.
Graham, J. and Smith, C. (1999) Tax incentives to hedge, *Journal of Finance* **54**, 2241–2262.
Guay, W. (1999) The impact of derivatives on firm risk: An empirical examination of new derivative users, *Journal of Accounting and Economics* **26**, 319–362.
Guay, W. and Kothari, S.P. (2003) How much do firms hedge with derivatives? *Journal of Financial Economics* **70**, 423–461.
Hart, O. and Moore, J. (1995) Debt and seniority: An analysis of the role of hard claims in constraining management, *American Economic Review* **85**, 567–585.
Haushalter, D. (2000) Financing policy, basis risk, and corporate hedging: Evidence from oil and gas producers, *Journal of Finance* **55**, 107–152.
Haushalter, D., Klasa, S., and Maxwell, W. (2007) The influence of product market dynamics on a firm's cash holdings and hedging behavior, *Journal of Financial Economics* **84**, 797–825.
Hentschel, L. and Kothari, S.P. (2001) Are corporations reducing or taking risks with derivatives? *Journal of Financial and Quantitative Analysis* **36**, 93–118.
Holmstrom, B. and Tirole, J. (1998) Private and public supply of liquidity, *Journal of Political Economy* **106**, 1–40.
Jin, Y. and Jorion, P. (2006) Firm value and hedging: Evidence from U.S. oil and gas producers, *Journal of Finance* **61**, 893–919.
Kaplan, S. and Zingales, L. (1997) Do investment-cash flow sensitivities provide useful measures of financing constraints, *Quarterly Journal of Economics* **112**, 169–215.
Kashyap, A., Rajan, R., and Stein, J. (2002) Banks as liquidity providers: An explanation for the coexistence of lending and deposit-taking, *Journal of Finance* **57**, 33–73.
Keynes, J. (1936) *The General Theory of Employment, Interest and Money*, Harcourt Brace, London.
Kim, C.S., Mauer, D., and Sherman, A. (1998) The determinants of corporate liquidity: Theory and evidence, *Journal of Financial and Quantitative Analysis* **33**, 335–359.
Leland, H. (1998) Agency costs, risk management, and capital structure, *Journal of Finance* **53**, 1213–1243.
Lins, K., Servaes, H., and Tufano, P. (2010) What drives corporate liquidity? An international survey of strategic cash and lines of credit, *Journal of Financial Economics* **98**, 160–176.
Mackay, P. and Moeller, S. (2007) The value of corporate risk management, *Journal of Finance* **62**, 1379–1419.

Magee, S. (2009) Foreign currency hedging and firm value: A dynamic panel approach, Unpublished working paper, Macquarie University.

Martin, S. and Santomero, A. (1997) Investment opportunities and corporate demand for lines of credit, *Journal of Banking and Finance* **21**, 1331–1350.

Melnik, A. and Plaut, S. (1986) Loan commitment contracts, terms of lending, and credit allocation, *Journal of Finance* **41**, 425–435.

Mian, S. (1996) Evidence on corporate hedging policies, *Journal of Financial and Quantitative Analysis* **31**, 419–439.

Nain, A. (2005) The strategic motives for corporate risk management, Unpublished working paper, University of Michigan.

Modigliani, F. and Miller, M. (1958) The cost of capital, corporation finance and the theory of investment, *American Economic Review* **48**, 261–297.

Nance, D., Smith, C., and Smithson, C. (1993) On the determinants of corporate hedging, *Journal of Finance* **48**, 267–284.

Opler, T., Pinkowitz, L., Stulz, R., and Williamson, R. (1999) The determinants and implications of corporate cash holdings, *Journal of Financial Economics* **52**, 3–46.

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

Rawls, W. and Smithson, C. (1990) Strategic risk management, *Continental Bank Journal of Applied Corporate Finance* **1**, 6–18.

Shockley, R. and Thakor, A. (1997) Bank loan commitment contracts: Data, theory and tests, *Journal of Money, Credit, and Banking* **29**, 517–534.

Smith, C. and Stulz, R. (1985) The determinants of firms' hedging policies, *Journal of Financial and Quantitative Analysis* **28**, 391–405.

Stulz, R. (1984) Optimal hedging policies, *Journal of Financial and Quantitative Analysis* **19**, 127–140.

Sufi, A. (2009) Bank lines of credit in corporate finance: An empirical analysis, *Review of Financial Studies* **22**, 1057–1088.

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

Tufano, P. (1998) Agency costs of corporate risk management, *Financial Management* **27**, 67–77.

Yun, H. (2009) The choice of corporate liquidity and corporate governance, *Review of Financial Studies* **22**, 1447–1475.