Cash Flow Hedging and Liquidity Choices*

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Abstract

Using unique, hand-collected data, this paper investigates how corporations combine the use of derivative hedging, cash holdings, and bank lines of credit to manage cash flow risks. Consistent with a precautionary saving motive, we find that (i) cash flow hedging derivatives and/or lines of credit serve as substitutes for cash, and (ii) the sensitivity of cash to cash flow volatility is significantly lower for firms that use either derivative hedging, lines of credit, or both. We highlight an important and largely unexplored interaction between cash flow hedging and the use of credit lines: Hedging pushes firms to substitute cash for lines of credit, since it reduces the risk of violating financial covenants. We also investigate the determinants of cash flow hedging. The use of cash flow hedging is highly related to industry, and is concentrated in industries exposed to foreign currency and commodity price risks. We also show that the relation between hedging, cash, and lines of credit is mainly concentrated in financially constrained firms. Overall, our findings shed new light on the joint determination of corporate policies to manage cash flow risks.

JEL classification: G30; G31; G32

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Introduction

The uncertainty of cash flows and the risk of adverse cash flow shocks are central concerns in virtually all corporate finance decisions. When capital markets are not frictionless, insufficient cash flows might force companies to underinvest, cut dividends, or become financially distressed. Therefore, not surprisingly, shareholders and managers tend to be very concerned about the detrimental impact of cash flow risk on firm value.[1]

What can managers do to address cash flow risks? One alternative is to make use of hedging instruments, such as options, futures and swaps. Another is to amass precautionary liquid resources in the form of cash reserves or bank lines of credit. However, these choices are neither independent nor mutually exclusive. In equilibrium, firms choose the optimal mixture of hedging, cash, and lines of credit simultaneously. It is therefore important to study these alternatives together.

The purpose of this paper is twofold. We start by investigating how firms shape their overall hedging and liquidity policies. We then study the choice between the various instruments available to them. To this end, we look at firms' hedging strategies, cash holdings, and bank lines of credit jointly, and provide a unified empirical investigation of the relationship between the three. Our findings suggest that the decision to use each of these instruments is affected by the use of the others. Firms tend to substitute cash with either cash flow hedging, lines of credit, or both. Furthermore, firms that use cash flow hedging tend to rely more on lines of credit. Due to the joint determination of the hedging and liquidity policies in equilibrium, we also estimate a simultaneous equation model and find consistent results.

We also find that the ability to use cash flow hedging is largely related to the industry:

[1] See for instance Rawls and Smithson (1990), Bodnar, Hyat, and Marston (1998), Graham and Harvey (2001), and Lins, Servaes, and Tufano (2007).

Cash flow hedging is concentrated in industries that are exposed to foreign currency and commodity price risks. One possible explanation is that derivatives are more readily available to hedges these types of risks. Our results also indicate that cash flow hedging makes it easier for companies to use credit lines in lieu of cash because it decreases the likelihood of violating cash-flow based covenants. Taken together, our results highlight the inter-dependence between cash flow hedging and liquidity choices, and provide a new, more comprehensive look into corporate risk management. Before further developing our argument, we briefly discuss how previous literature studied these three policies in isolation.

Previous literature considered corporate risk management and corporate liquidity policies separately. Theoretical work on risk management emphasizes the importance to hedge against adverse cash flow shocks that might force firms to (i) forgo valuable investment opportunities due to costly external financing, (ii) violate debt covenants or miss principal/coupon payments and suffer deadweight costs, and (iii) lose customers, suppliers and employees.[2] Consistently, the empirical literature on corporate hedging finds that derivatives are associated with a reduction in risk (e.g., Guay (1999), Jin and Jorion (2006), and Bartram, Brown, and Conrad (2008)). The overall effect on firm value is, however, unclear (e.g., Gutay and Kothari (2003), Adam and Fernando (2006), and Bartram, Brown, and Conrad (2008)).

In terms of liquidity policies, the predominant approach to understanding corporate cash reserves is the precautionary saving motive, which was introduced by Keynes (1936). Under this view, firms maintain cash reserves as a safety cushion, to protect themselves against the deadweight costs associated with adverse cash flow shocks. Consistent with the precautionary

[2] There is a large literature on corporate hedging motives, including: limiting deadweight losses of bankruptcy (Smith and Stulz (1985)); Convexity of taxes and managerial risk-aversion (Graham and Smith (1999), Stulz (1984), Smith and Stulz (1985)); Underinvestment costs (Froot, Scharfstein, and Stein (1993)); Information asymmetry (DeMarzo and Duffie (1991, 1995)); Ex-post (after debt issuance) risk-management motivation (Purnanandam (2008)).

saving theory, the evidence presented in the cash literature suggests that firms with riskier cash flows hold more cash, and that cash plays an important role when market frictions might force firms to forego valuable future investments (e.g., Almeida, Campello, and Weisbach (2004), and Opler, Pinkowitz, Stulz, and Williamson (1999)). Moreover, Duchin, Ozbas, and Sensoy (2009) provide ex-post evidence on the benefits of holding cash, showing that cash-rich companies cut investment less than cash-poor companies amid the subprime mortgage credit crisis that began in 2007.[3]

The theoretical literature on bank lines of credit (e.g., Boot, Thakor, and Udell (1987), Holmstrom and Tirole (1998), and Martin and Santomero (1997)) argues that similar to cash reserves, lines of credit should play an important liquidity role. However, as Sufi (2009) points out, the *contingent* lines of credit that exist in the marketplace are distinct from the *committed* lines of credit described in the theoretical literature. Accordingly, his main finding suggests that companies prefer lines of credit over cash when their cash flows are high, because low expected cash flows might trigger the violation of cash flow based financial covenants on the line of credit, which in turn costs the company its access to (a portion of) the line of credit.

Although, as we show, the firm's uses of derivative hedging, lines of credit, and cash holdings are related, there is virtually no work studying all three together. This paper tries to bridge this gap by investigating the interplay between these three choices. In particular, we ask two main questions: (i) What is the relation between hedging, cash, and lines of credit? (ii) What governs the choice between them? If, as some theories suggest, all three play similar roles, they should all act as substitutes to one another. This, however, is unlikely to be true for a number of reasons.

[3] Further consistent with this view, Bates, Kahle, and Stulz (2008) find that the secular increase in corporate cash holdings over the past two decades was accompanied by the increase in idiosyncratic risk documented by Campbell, Lettau, Malkiel, and Xu (2001) and Irvine and Pontiff (2009).

First, as Sufi (2009) argues, unlike cash, access to bank lines of credit depends on the firm's cash flows. But since future cash flows are affected by the decision (or ability) of the firm to hedge cash flow risk, access to lines of credit is also affected by the company's use of derivatives. This implies a nontrivial connection between liquidity policies and hedging strategies. Second, derivative hedging is limited in its scope and effect on firm value (e.g., Gutay and Kothari (2003)). Therefore, there might be cases in which hedging policies are complemented by the use of liquid assets.

To investigate these issues, we use unique, hand-collected data on the derivative hedging practices of all industrial companies in the S&P 500 index, from 2002 to 2007.[4] We take advantage of SFAS No. 133, which went into effect in 2001, and required companies for the first time to distinguish between cash flow hedges and fair value hedges. This allows us to focus on the portion of a company's hedging policy that is more directly related to its liquidity choices, namely the hedging of financial cash flow risks.[5]

Our results reveal two effects. First, we find a significant *negative* relation between cash holdings and either derivative hedging, bank lines of credit, or both. The magnitudes are economically significant: Cash holdings decrease by 13.4 percent given a one standard deviation increase in the use of cash flow hedging, and by 19.5 percent after a one standard deviation increase in lines of credit. The combined effect of simultaneous one standard deviation increases in both cash flow hedging and lines of credit corresponds to a 30.8 percent decrease in cash

[4] Our sample is a significant improvement relative to previous studies of derivative hedging that examine either smaller samples (see e.g., Geczy, Minton, and Schrand (1997), Graham and Rogers (2002), Guay (1999), Guay and Kothari (2003), Haushalter (2000), Jin and Jorion (2006), Nance, Smith, and Smithson (1993), Tufano (1996)) or use samples that are only based on a yes/no hedging indicator (see e.g., Mian (1996), Bartram, Brown, and Fehle (2007), Bartram, Brown, and Conrad (2008)).

[5] In our sample, fair value hedging is mostly comprised of swaps from fixed-rate debt 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.

reserves. Second, we find a significant *positive* relation between derivative hedging and the use of bank lines of credit. An increase of one standard deviation in cash flow derivative hedging corresponds to an increase of 9.8 percent in the amount of lines of credit as a proportion of total liquid assets. Next, we analyze each of these two effects in greater detail.

Our first effect suggests that cash flow derivative hedging and lines of credit are both substitutes for cash. Consistent with a precautionary motive-based interpretation of substitutability, we also find that the sensitivity of cash holdings to cash flow volatility is lower when companies also use derivative hedging and/or bank lines of credit. The use of lines of credit seems to have the strongest effect on the sensitivity of cash holdings to cash flow volatility: this sensitivity is only half of that observed for companies without credit lines. In companies that use both lines of credit and cash flow derivative hedging, the sensitivity of cash holdings to cash flow volatility is about 84 percent smaller than that found for companies using neither. Taken together, these findings provide direct evidence of substitution between *precautionary* cash savings and derivative hedging and/or bank lines of credit.

Furthermore, these findings suggest that the decomposition of total hedging resolves the perhaps puzzling lack of relation between derivative hedging and cash holdings found in prior studies (e.g., Opler, Pinkowitz, Stulz and Williamson (1999).) As in these studies, we find no significant relation between cash and *total hedging*.[6] We do, however, find a strong negative relation between cash and *cash flow hedging*.

Yet, our findings portray a more complicated picture than simple substitution between derivative hedging, cash holdings, and bank lines of credit. In fact, we find a positive relation between cash flow derivative hedging and lines of credit. To understand this finding, we focus on

[6] Two exceptions are Hausalter, 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 (2007), who find a negative relation between the use of derivatives and the quick ratio.

the effect of cash flow hedging on the choice between cash holdings and lines of credit. We follow Sufi (2009), and define 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 findings suggest that companies that use derivatives to hedge their cash flow risks prefer lines of credit over cash holdings. These results continue to hold in a simultaneous equation model, which takes into account the joint determination of liquidity and hedging policies in equilibrium. The magnitudes are nontrivial: An increase of one standard deviation in cash flow derivative hedging increases the bank liquidity ratio by almost 10 percent.

This evidence suggests that cash flow hedging affects the firm's liquidity choice in favor of bank lines of credit. There is, however, a large dispersion in the way companies choose their cash flow hedging policies. We find strong industry clustering in the use of cash flow hedging. About 18.5 percent of the variation in firm-level cash flow hedging can be explained by their industry. That is, even after controlling for firm-level characteristics, including dummies for the 48 Fama-French industries increase the adjusted R^2 from 5.2 to 23.7 percent. Which industries are more likely to hedge? Our findings suggest that these are industries more exposed to foreign currency and commodity price risks, where cash flow hedging is more feasible.

Next, we investigate why lines of credit and derivative hedging go hand in hand. We find a significantly stronger relation between cash flow derivative hedging and bank liquidity ratios for firms whose lines of credit come with some cash flow based financial covenant. This evidence provides an explanation to the positive relation between cash flow derivative hedging and lines of credit. Hedging reduces the likelihood of triggering a violation of a cash flow based covenant on the line of credit, which might cost the company its access to (a portion of) its line of credit. Thus, companies that rely on lines of credit for liquidity, tend to engage in cash flow

derivative hedging to overcome the inherent lack of commitment associated with lines of credit due to their contingency on cash flows through financial covenants.

Finally, we look into firm attributes that affect its joint liquidity and risk management policy. Our line of investigation draws upon the insight of Modigliani and Miller (1958), who show that in frictionless financial markets, risk management and precautionary savings become redundant. The reason is that firms can overcome adverse cash flow shocks by tapping external financial markets without incurring any deadweight costs. This implies that the relation between derivative hedging, cash holdings, and bank lines of credit should be mainly observed in companies whose frictions are relatively more important, i.e., more financially constrained firms. We employ various measures of financial constraints used by recent studies such as Almeida, Campello, and Weisbach (2004) and Whited and Wu (2006) to distinguish between constrained and unconstrained firms. Consistent with our hypothesis, the results show a significantly stronger relation between cash holdings, cash flow derivative hedging, and bank lines of credit in financially constrained firms, and little to no relation in unconstrained firms.

The paper proceeds as follows. Section 1 describes our sample construction. Section 2 presents evidence about the relation between derivative hedging, cash holdings, and bank lines of credit in the context of cash flow risk management. Section 3 takes a closer look at cash flow derivative hedging and its effect on the firm's liquidity policy. Section 4 considers firm attributes that affect its joint liquidity and risk management policy and also includes robustness tests. Section 5 concludes.

1. Sample Construction

Our sample comes from three data sources. The first is a unique, hand-collected data set on the hedging practices of a large sample of U.S. industrial firms. Disclosure of derivative hedging is governed by the 1998 Financial Reporting Release (FRR) No. 48 of the U.S. 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).[7]

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*. While 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.[8] 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).[9]

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

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[7] 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.

[8] 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.

[9] 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.

about the use of derivatives, and as a result the format of disclosure varies from company to company.[10] 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 industry analyses and robustness tests, we expanded the data to include all industrial S&P 1500 companies for the last two years of our sample. Next, we describe the data collection process.

The first 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 second stage, we read all paragraphs surrounding the keywords and examine (a) whether we can identify the total notional amount of derivatives used by the company, and (b) 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 (a) and (b). 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).[11]

Otherwise, our data collection procedure is conservative. When we can observe the total notional amount of hedges, but we 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

[10] 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.

[11] 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 value hedges.

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 that they use. For example, suppose that company A reports that it uses forwards as cash flow hedges, but does not disclose their notional amount. In this case, the variables *total hedge* and *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 to one.

We also assign missing values to observations where the notional amount of the 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 is collected. In particular, for each firm-year in our 2002-2007 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. In addition, for each firm-year, we collect information on whether the firm had a financial covenant on any of its active revolving credit facilities that year (a "yes/no" variable), and also the number of financial covenants that the firm had on any of its active revolving credit facilities that year.

Lastly, our company-level accounting data comes from the Compustat's annual files. We collect data on firms' total assets, cash holdings, sales, cash flows, capital expenditures, short-term and long-term debt, dividends, stock repurchases, and investment opportunities (using Tobin's Q).[12] In Table XI, we detail the construction of the various variables used throughout the paper.

Table I provides summary statistics for the 2002–2007 sample. The average notional amount of derivative hedging is 7.9% of firm assets, while 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 enough information on cash flow hedging. The majority of firms in our sample use derivative hedging: 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: 71.5% of the firms have access to a line of credit, and the average amount of credit is 13.1% of firm assets. This number is comparable in magnitude to average cash holdings in our sample, equal to 14.3% of firm assets.

2. The Relation Between Hedging, Cash, and Lines of Credit

2.1 Nonparametric Evidence

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

Panel A of Table II presents results in which we compute the sample-wide correlations

[12] Tobin's Q is 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).

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 percent level. However, the correlation between derivative hedging and bank lines of credit is positive.

Panel B presents results in which we double-sort firms into bins based on whether or not they use cash flow derivative hedging or lines of credit, and compare annual average cash holdings across bins for each year over the period 2002-2007. Both derivative hedging and lines of credit seem to affect cash holdings: In virtually all cases, there is a monotonic decline in annual cash holdings as we move from companies that do not use derivative 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 31.8% of their assets in cash, compared to 21.9% 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 B shows, the differences between firms that use neither hedging nor lines of credit to and firms that use both are all statistically significant at the 1 percent level.

In Panel C, 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 C 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 percent level or better. The largest effect is found in 2007: cash flow derivative hedging is associated with an increase of almost 70 percent 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. This preliminary evidence is also consistent with a positive relation between cash flow hedging and lines of credit. Next, we investigate these patterns in more detail by using multivariate regressions and controlling for other firm and industry level effects.

2.2 Regression Evidence

To study the relation between derivative hedging, cash holdings, and bank lines of credit, we estimate panel regressions explaining firm-level cash holdings. Independent variables include derivative hedging and bank lines of credit, as well as a set of control variables that follow previous empirical studies of cash holdings (e.g., Opler, Pinkowitz, Stulz, and Williamson (1999), Almeida, Campello, and Weisbach (2004), and Dittmar and Mahrt-Smith (2007)). In particular, our controls include: cash flow, net working capital (excluding cash), industry cash flow volatility, debt, capital expenditure, payout, R&D expenditure, Tobin's Q, age, and size. (see Table XI for variable definitions.) One important caveat is that these regressions do not control for the endogeneity of the hedging and liquidity choices. We deal with this issue explicitly in Table VI using a simultaneous equation approach.

The first five columns of Table III report the cash regression results. Column (1) shows that bank lines of credit are inversely related to cash holdings. The estimates in Column (1) imply that a one standard deviation increase in the amount of lines of credit, corresponds to 19.5 percent less cash.[13] This is consistent with the view that credit lines can serve as a substitute for

[13] This number is obtained by multiplying the regression coefficient on lines of credit (-0.18) by their standard deviation (15.9%), and dividing the result by average cash holdings (14.7%). Throughout the sample, we use a similar approach to compute the percentage effect of a one standard deviation change in other independent variables.

cash. We find no significant relation between overall derivative hedging and corporate cash holdings. The coefficient on *total hedge* in Column (2) 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, Pinkowitz, Stulz and Williamson (1999) examined derivative hedging among the S&P 500 companies in 1994, and found no relation between derivatives and cash.

However, in what follows, we do find a strong negative relation between cash and *cash flow* hedging, which represents the portion of derivative hedging designated to manage cash flow risk. Thus, one major advantage of our data collection process is that it allows us to distinguish between *cash flow* hedging and non-cash-flow hedging (*fair value* hedging). In Column (3), we decompose derivative hedging into cash flow hedging and fair value hedging, and find a significant inverse relation between cash holdings and cash flow hedging, but not fair value hedging. The magnitude of the effects is nontrivial: An increase of one standard deviation in cash flow hedging reduces corporate cash by 13.4 percent.

The regression in Column (4) includes both lines of credit and derivative hedging. It shows that both are inversely related to cash holdings simultaneously. Note that the magnitudes of the effects are virtually unchanged compared to Columns (1) and (3), suggesting that these are different (linear) effects. Column (4) implies that the combined effect of a one standard deviation increase in both cash flow hedging and lines of credit decreases cash holdings by 30.8 percent. In Column (5), we verify that the same results hold when we use dummies instead of amounts for bank lines of credit and for derivative hedging. The results in Column (5) imply that firms that use both lines of credit and derivative hedging hold 32.6 percent less cash than companies that do not use them.

Finally, to test the relation between bank lines of credit and derivative hedging, we estimate, in the last column of Table III, regressions of bank lines of credit. Again, the relation between bank lines of credit and cash holdings is negative, whereas the relation between bank lines of credit and derivative hedging is positive. Specifically, we find that an increase of one standard deviation in derivative hedging corresponds to a 18.4 percent increase in bank lines of credit. As before, the effects are concentrated in cash flow derivative hedging: The coefficient on fair value hedging is insignificant.

2.3 The Cash-flow-volatility sensitivity of cash

The evidence presented so far suggests that both cash flow hedging and bank lines of credit serve as a substitute for cash. This, however, does not necessarily imply substitution in the context of cash flow risk management. For example, firms might be using lines of credit to substitute cash required for working capital purposes. In Lins, Servaes, and Tufano (2007), for example, CFOs of 204 firms (18 in the U.S) report in a survey that they use only 40% of their cash for strategic reasons rather than day-to-day operations. In what follows, we study a more direct link between substitution and cash flow risk.

To test whether firms substitute between cash, derivative hedging, and bank lines of credit to manage cash flow risks, we look at the sensitivity of cash to cash flow volatility. It is defined as the regression coefficient of firm-level cash regressions on industry-level cash flow volatility. This coefficient captures the importance of cash flow volatility as a determinant of cash holdings. If corporations use cash flow derivative hedging and bank lines of credit as alternatives to cash holdings in managing cash flow risk, we would expect cash flow volatility to play a less significant role in explaining cash holdings in companies that use derivative hedging and bank lines of credit.

Table IV presents estimates from regressions of firm-level cash holdings, estimated separately for companies that use: (i) derivative hedging, (ii) bank lines of credit, (iii) neither, or (iv) both. We first estimate the univariate relation between cash holdings and cash flow volatility in a univariate setting (Panel A). We then include the firm-level controls of Table III in Panel B.

Panel A shows that the cash-flow-sensitivity of cash is significantly lower in companies that use derivative hedging or bank lines of credit. In terms of magnitudes, the cash-flow-volatility sensitivity of cash drops by 43.5 (67.9) percent, when companies use derivative hedging (bank lines of credit). These differences are statistically significant at the 5 percent level. Furthermore, consistent with precautionary cash holdings, the cash-flow-volatility sensitivity of cash is the highest when firms are using neither cash flow derivative hedging nor bank lines of credit, and is the lowest when they use both. In fact, the sensitivity when neither is used is about 4.6 times higher than when both cash flow derivatives and lines of credit are used.

Panel B shows similar results when controlling for other determinants of cash holdings. In particular, Panel B shows that the cash-flow-volatility sensitivity of cash of companies using neither cash flow hedging nor lines of credit is 6.3 times higher than when both are used. Furthermore, the sensitivity is statistically significant at the 1 percent level when companies use neither cash flow derivative hedging nor bank lines of credit, and is insignificant at the 10 percent level when they use both.

Overall, the results in Tables III and IV show that corporations use derivative hedging and/or bank lines of credit as substitutes for cash, specifically to manage their cash flow risks. This last point follows from two effects: (i) substitution between cash holdings and cash flow (but not fair value) derivative hedging, and (ii) lower cash-flow-volatility sensitivity of cash in companies that use derivative hedging and/or bank lines of credit.

In the next section, we take a closer look at the inter-dependence between cash flow derivative hedging and bank lines of credit. We start by examining the decision to hedge and its effect on firms' liquidity policy choices.

3. Derivative Hedging and the Choice of Liquidity Policy

3.1 Derivative hedging, liquidity, and industry affiliation

The findings of the previous section portray a more complicated picture than simple substitution between derivative hedging, cash holdings, and bank lines of credit to address corporate cash flow risks. While both cash flow derivative hedging and lines of credit can serve as substitutes for cash, we find a positive relation between cash flow derivative hedging and the use of lines of credit. To understand why, this section focuses on cash flow derivative hedging and its relation to corporate liquidity, namely the choice between cash holdings and lines of credit.

To measure how cash flow hedging affects the degree to which credit lines substitute cash, we follow Sufi (2009) and look into the firm's *bank liquidity ratio*. This measure is defined as the ratio between the company's available lines of credit to its overall liquidity resources (i.e., the sum of lines of credit and cash). We examine how cash flow hedging affects this ratio in Table V. The first two columns in Table V report estimates from panel regressions explaining firm-level bank liquidity ratios with derivative hedging and a set of control variables that follows Sufi (2009).[14]

The results suggest that companies that use derivatives to hedge their cash flow risks tend to substitute more cash with lines of credit. We start by estimating the overall effect of total

[14] Note that by considering the effect of cash flow hedging on the liquidity ratio, we examine how cash and lines of credit change together, relative to each other, in response to a change in cash flow hedging. This is different from Table III, where we examine the marginal effect of hedging or lines of credit on cash, holding other variables constant.

hedging on the liquidity ratio. Perhaps not surprisingly, Column (1) shows a non-significant relation, even at the 10 percent level, between the liquidity ratio and *total* hedging. As before, the effects become significant once we isolate the *cash flow* hedging component. In this case (Column (2)), we find that the coefficient on cash flow hedging is larger and highly significant. Specifically, a one standard deviation increase in cash flow hedging is associated with an increase of 9.8 percent in the liquidity ratio.

The above results imply a positive correlation between a company's usage of cash flow derivative hedging and its tendency to prefer bank lines of credit over cash holdings for liquidity provision. However, these results do not control for the simultaneity of the company's hedging and liquidity policies. Thus, in Table VI, we estimate a simultaneous equation model of the liquidity ratio and cash flow hedging regressions. Consistent with Columns (1) and (2) of table V, the results in Column (1) of Table VI reveal a positive effect of cash flow hedging on the liquidity ratio, significant at the 1 percent level. On the other hand, Column (2) of Table VI shows a smaller effect, barely significant at the 10 percent level, of the liquidity ratio on cash flow hedging.

These results suggest that once we account for the simultaneous determination of liquidity and hedging policies, the use of cash flow hedging pushes firms to choose bank lines of credit in lieu of cash. The weak effect of the liquidity ratio on cash flow hedging in Column (2) suggests that this effect might be causal: Cash flow hedging affects liquidity choices but not vice versa. Finally, Columns (3) and (4) show that these effects are insignificant when total hedging, rather than cash flow hedging, is considered. This is consistent with previous findings and highlights the importance of isolating cash flow hedging from total hedging.

That cash flow hedging affects the company's liquidity choice highlights the importance

of understanding why some firms tend to use more cash flow derivative hedging than others. To this end, 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 limiting deadweight losses of bankruptcy (Smith and Stulz (1985), Purnanandam (2008)), tax advantages arising from the convexity of taxes in the presence of risk-averse managers (Graham and Smith (1999), Stulz (1984), Smith and Stulz (1985)), limiting underinvestment costs (Froot, Scharfstein, and Stein (1993)), and reducing the costs of information asymmetry (DeMarzo and Duffie (1991, 1995)).

Thus, these models suggest that it is optimal for all firms to hedge. Why, then, some companies do not hedge? While this question is not the main focus of our paper, we provide some initial evidence that hedging is heavily clustered by industry, which suggests that the nature of a company's business might be a key determinant of its ability to hedge. We later identify industry-level attributes that affect hedging.

Columns (3) and (4) of Table V show that the decision to use cash flow derivative hedging is significantly related to the firm's industry. In Column (3), we estimate panel regressions explaining cash flow hedging with the same set of control variables as in Columns (1) and (2). These variables collectively explain about 5.2 percent of the variation in firm-level cash flow hedging. In Column (4), we augment the previous specification with fixed effects for the Fama-French 48 industries. Strikingly, this model explains 23.7 percent of the variation in cash flow hedging, an increase of roughly 18.5 percentage points. Furthermore, an F-test on the joint significance of the industry fixed-effects strongly rejects the null hypothesis that they are collectively equal to 0. Interestingly, in unreported results, we do not find a similar industry effect on firms' fair value hedging. This is further consistent with fair value hedging being

mainly driven by investor demand rather than cash flow risk management.

These results suggest that industry-affiliation is a first-order determinant of firms' decision to use cash flow derivative hedging. In Table VII, we investigate why some industries show heavier usage of cash flow hedging. Based on our hand-collected hedging data for all industrial firms in the S&P 1500 index over the 2006-2007 period, we calculate the percentage of companies that use cash flow hedging for each of the 48 Fama-French industries. To be included in our sample, an industry is required to have more than 3 companies with non-missing data on the decision to use cash flow hedging. We then regress this percentage on industry-level measures of exposure to foreign currency risk and commodity price risk, and a set of industry-level controls similar to those in Table V.

The results in Columns (1) through (4) of Table VII indicate that both risks are positively and significantly related to industry usage of cash flow hedging at the 1 percent level. Furthermore, the inclusion of both exposures together increases the R^2 from 43.5% (Column 1) to 60% (Column 4). Overall, these findings suggest that the decision to hedge is largely a function of the company's core business, and companies tend to hedge their cash flow risks when hedging is plausible given their risk exposure.

In a final step, we examine whether a firm's line of business explains its choice between lines of credit and derivative hedging through its impact on its cash flow derivative hedging. To this end, we examine the effect of the propensity to hedge on liquidity ratios. Columns (5) and (6) of Table V report estimates from liquidity-ratio regressions with and without the industry propensity to use cash flow hedging. The results suggest that industry-level propensity to hedge significantly affects liquidity rations: The propensity to hedge is statistically significant at the 1 percent level and its inclusion increases the regression's R^2 from 23.2% to 26.4%.

Taken together, these results suggest that the choice between bank lines of credit and cash holdings can be explained by a firm's line of business. We conclude that a firm's line of business determines, to a large extent, whether it can hedge its cash flow or not, and this affects its liquidity choice, namely whether it uses bank lines of credit or cash.

3.2 Derivative Hedging and Financial Covenants

Next, we investigate why lines of credit and cash flow derivative hedging go hand in hand. Our hypothesis is that cash flow derivative hedging is positively related to the usage of bank lines of credit because it reduces the risk of losing access to a line of credit due to violations of cash flow based financial covenants. To test this hypothesis, we collect data on financial covenants on the lines of credit of the companies in our sample. We then test whether the positive relation between cash flow derivative hedging and bank lines of credit is more pronounced for companies whose lines of credit are accompanied by cash flow based financial covenants.

The results in Table VIII support this hypothesis. Table VIII reports the results from panel regressions explaining firm-level bank liquidity ratios, estimated separately for companies with and without covenants on their lines of credit (as reported by DealScan). Columns (1) and (2) study hedging amounts scaled by assets, while columns (3) and (4) study the decision to hedge.

The results in Table VIII imply that the relation between bank liquidity ratios and cash flow hedging (decision, amount) is primarily concentrated in companies with covenants reported on their lines of credit. In fact, this relation is statistically insignificant for companies without covenants (Columns (1) and (3)) and highly statistically significant at the 1 percent level for companies with covenants (Columns (2) and (4)). Furthermore, the magnitudes of the effects for companies with covenants are nontrivial: For instance, a one standard deviation increase in the

amount of cash flow hedging corresponds to an increase of 7.4 percent in the bank liquidity ratio.

Taken together, these results suggest that derivative hedging is positively related to the use of lines of credit because it serves to reduce the likelihood of triggering a violation of cash flow based covenants, which might cost the company its access to (a portion of) its lines of credit. Thus, companies that rely on lines of credit for liquidity are also companies that tend to engage in derivative cash flow hedging, possibly to overcome the inherent lack of commitment associated with lines of credit due to their contingency on cash flows through financial covenants.

4. Financial Constraints and Robustness

4.1 Financial Constraints

As pointed out in Modigliani and Miller (1958), cash holdings do not affect firm value in frictionless capital markets, since they have a zero net present value. This rationale naturally extends to other liquidity instruments such as bank lines of credit. As noted by Froot, Scharfstein, and Stein (1993), the same applies to corporate risk management. Thus, derivative hedging is irrelevant to firm value when companies can access external financial markets without frictions. Therefore, we hypothesize that hedging and liquidity are significantly more important for firms that face greater frictions, namely financially constrained firms. This implies that the effects we document in this paper should be stronger for financially constrained firms.

Thus, we should mainly observe substitution between cash and hedging or lines of credit in financially constrained firms. Similarly, inter-dependence between hedging and lines of credit should be more concentrated in financially constrained firms. Unconstrained firms that can tap external capital markets with little or no deadweight costs have little reason to adjust their cash

holdings, cash flow hedging, and bank lines of credit to one another. In fact, such firms have little precautionary demand for liquidity, and therefore their liquidity policy should not be sensitive to derivative hedging.

To examine the impact of financial constraints, we adopt a similar approach to the one in Almeida, Campello and Weisbach (2004). We first divide the sample into financially constrained firms and financially unconstrained firms and then study the effects in each sample. We use four different measures of financial constraints: (i) the financial constrains index of Whited and Wu (2006), (ii) the size of the firm (Gilchrist and Himmelberg (1995)), (iii) bond ratings, and (iv) the firm's payout ratio (Fazzari, Petersen, and Hubbard (1988)). For (i), (ii), and (iv), the annual median value of each measure is used as the cutoff point between unconstrained and constrained firms. For bond ratings, we consider a firm unconstrained if it has an investment-grade S&P bond rating.

Panel A of Table IX presents results from panel regressions explaining firm-level cash holdings estimated separately for subsamples of firms formed on the basis of financing constraints. Consistent across financing constraints measures, we find a significantly stronger negative relation between cash holdings and bank lines of credit for financially constrained firms. In fact, the relation is statistically insignificant even at the 10 percent level for unconstrained firms in 2 out of the 4 cases. Focusing on the White and Wu index, for example, we find that a one standard deviation increase in lines of credit amounts is associated with 22.9 percent decrease in cash holdings for constrained firms, compared to only a 4 percent decrease when firms are unconstrained. Also note that the differences between constrained and unconstrained firms are all statistically significant at the 5 percent level or better. Thus, consistent with our hypothesis, Panel A suggests that the substitution between cash and cash flow

hedging or bank lines of credit is significantly stronger in financially constrained firms.

Panel B of Table IX compares the effect of cash flow hedging on firms' liquidity ratios between financially constrained and unconstrained firms. Once again, our hypothesis implies that hedging should have a significantly stronger positive effect on liquidity ratios in constrained firms than in unconstrained firms. We find empirical support for this hypothesis based on the first 2 measures of financial constraints in Table VII, namely the Whited and Wu index and firm size. For example, based on the Whited and Wu (2006) index of financial constraints, a one standard deviation increase in cash flow hedging is associated with a increase of 14.3 percent in the liquidity ratios of financially constrained firms, but with only a 4.6 percent increase for unconstrained firms. The latter, is also only significant at the 10 percent level. These results do not hold when we use bond ratings or firm payout to measure financial constraints.

Overall, we find that the substitution between cash and cash flow hedging or bank lines of credit is significantly stronger in financially constrained firms. We also find that the relation between hedging and firms' liquidity choice is largely concentrated in financially constrained firms. These results are in line with our hypothesis that the inter-dependence between cash flow derivative hedging, cash holdings, and bank lines of credit, should be more important for financially constrained firms.

4.2 Robustness

In this section, we perform a series of robustness tests. One source of concern is that our sample is biased towards large, successful companies that comprise the S&P 500 index, and therefore unrepresentative of the universe of U.S. industrial public firms. To deal with this issue, we hand-collect 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. We use a similar data collection process to the one we used for our S&P 500 sample (see Section 1 above).

The first 2 columns of Table X estimate our main regressions of firm-level cash holdings and lines of credit for all S&P 1500 industrial companies over the period 2006-2007. To show robustness, we maximize our sample size by using dummy variables to measure corporate usage of lines of credit and derivative hedging. However, the results are qualitatively similar if we use amounts instead. The results suggest that the negative relation between cash holdings and cash flow derivative hedging or bank lines of credit continues to hold for all industrial S&P 1500 companies. The positive relation between bank lines of credit and cash flow derivative hedging also continues to hold for all industrial S&P 1500 companies. As Columns (1) and (2) of Table X show, these relations are all highly statistically significant at the 1 percent 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. To deal with this concern, the remainder of Table X estimates our main regressions separately across the different years in our sample. Once again, to maximize sample size, we use dummies to measure lines of credit and derivative hedging. For brevity, we only report regression results in 2002, 2004, and 2006. These results are similar for other years.

Across all annual regressions, cash flow hedging is inversely related to cash holdings at the 5 percent level or better. Similarly, lines of credit are also inversely related to cash holdings at the 1 percent level. Note that the magnitudes of the effects are generally similar to the effects found in Column (5) of Table III. We also find that the positive relation between lines of credit

and hedging continues to hold across the different years. It is statistically significant in 2004 and 2006 at the 5 percent significance level or better, and insignificant at conventional levels in 2002.

5. Concluding Remarks

Using a unique hand-collected sample of U.S. industrial firms, this paper provides a unified empirical investigation of how corporations use derivative hedging, cash holdings, and bank lines of credit, together, to manage cash flow risks.

We find that cash holdings are inversely related to derivative hedging and bank lines of credit, and that derivative hedging is positively related to bank lines of credit. Further, consistent with a precautionary-motive-based interpretation of substitutability, we also find that the sensitivity of cash holdings to cash flow volatility is lower when companies also use derivative hedging and/or bank lines of credit. Our results also resolve the perhaps puzzling lack of empirical relation between corporate derivative hedging and cash policies reported in previous studies.

We then take a closer look at the inter-dependence between derivative hedging and corporate liquidity policy, namely the choice between cash holdings and bank lines of credit. We find that firms that use derivatives to hedge their cash flow risks prefer lines of credit over cash holdings, and confirm robustness and causality via a simultaneous equation approach. The decision to use cash flow derivative hedging is highly correlated with the firm's industry affiliation, which in turn implies that liquidity ratios are correlated with industry. Industry propensity to use cash flow hedging is highly correlated with its exposure to foreign currency risk and commodity price risk.

We also investigate why lines of credit and derivative hedging go hand in hand. Our results suggest that companies that use cash flow derivative hedging prefer lines of credit over cash if their lines of credit come with a cash flow based financial covenant. Therefore, companies that rely on lines of credit for liquidity tend to also engage in derivative cash flow hedging, possibly to overcome the inherent lack of commitment associated with lines of credit due to their contingency on cash flows through financial covenants.

Finally, consistent with Modigliani and Miller (1958), our results show significant inter-dependence between cash holdings, cash flow derivative hedging, and bank lines of credit for financially constrained firms, and little to no relation for unconstrained firms.

Overall, our findings portray a nontrivial picture of the way corporations use derivative hedging, cash holdings, and bank lines of credit, together, to manage their cash flow risk. These findings suggest that liquidity and risk-management policies should be studied jointly, rather than in isolation, as has been the case until now.

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Table I: Summary Statistics

This table reports summary statistics for the various variables employed in this study. The sample consists of industrial firms (non-financial and non-utility) from the S&P 500 Index for the period of 2002 to 2007. Hedging data is hand-collected from companies' annual filings with the SEC. Data on lines of credit and covenants 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 XI.

	Mean	Median	Std Dev	N
Hedging Variables				
Total hedge	0.079	0.043	0.114	1359
Cash flow hedge	0.021	0.000	0.047	1160
Fair value hedge	0.022	0.000	0.041	1474
Total hedge dummy	0.819	1.000	0.385	2080
Cash flow hedge dummy	0.560	1.000	0.496	1699
Fair value hedge dummy	0.477	0.000	0.500	1708
Credit Lines				
Line of credit amount	0.131	0.090	0.158	2088
Line of credit dummy	0.715	1.000	0.452	2088
Liquidity Ratio	0.459	0.516	0.361	2088
Covenant dummy	0.519	1.000	0.500	2088
Number of covenants	1.695	1.000	2.343	2088
Accounting Variables				
Cash	0.143	0.085	0.157	2088
Cash flow	0.103	0.106	0.111	2088
Net working capital	0.020	0.013	0.116	1993
Cash flow volatility	0.213	0.192	0.114	2088
R&D	0.031	0.008	0.050	2088
CAPEX	0.049	0.037	0.044	2088
Debt	0.220	0.209	0.155	2088
Payout	0.069	0.039	0.112	2088
Tobin's Q	1.931	1.695	0.828	2082
Size	9.008	8.885	1.186	2088
EBITDA	0.159	0.151	0.088	2080
Tangibles	0.790	0.829	0.181	2041
Sales Volatility	0.315	0.319	0.086	2088
Age	3.095	3.332	0.489	2088
Net Worth	0.308	0.331	0.196	2079

Table II: Nonparametric Evidence

This table presents nonparametric evidence on the relation between derivative hedging, cash, and bank lines of credit. The sample and variable descriptions are in Table XI. Panel A presents the overall sample correlation across hedging, cash, and lines of credit. Panel B presents the average cash holdings (as a fraction of assets) for different types of companies, classified by their use of cash flow hedging and/or lines of credit. Similarly, Panel C 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 dummy	Lines of credit amount	Lines of credit dummy
Total hedge	1.000					
Total hedge dummy	0.457	1.000				
Cash flow hedge	0.553	0.317	1.000			
Cash flow hedge dummy	0.406	0.534	0.594	1.000		
Line of credit amount	0.111	0.149	0.155	0.187	1.000	
Line of credit dummy	0.112	0.197	0.108	0.185	0.521	1.000
Cash	−0.068	−0.251	−0.128	−0.233	−0.242	−0.492

Panel B - Average Cash Holdings in Subsamples

	Lines of Credit?				Difference Yes,Yes − No,No	
	No		Yes			
Derivative Hedging?	No	Yes	No	Yes	Diff	P-value
2002	0.300	0.154	0.108	0.070	−0.230	< 0.001
2003	0.294	0.206	0.113	0.076	−0.218	< 0.001
2004	0.318	0.219	0.126	0.089	−0.229	< 0.001
2005	0.288	0.242	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 C - Lines of Credit in Subsamples

	Derivative Hedging?		Difference Yes − No	
	No	Yes	Diff	P-value
2002	0.122	0.136	0.018	0.359
2003	0.095	0.109	0.009	0.538
2004	0.130	0.158	0.023	0.150
2005	0.117	0.200	0.069	< 0.001
2006	0.138	0.221	0.059	0.005
2007	0.133	0.225	0.076	< 0.001

Table III: The Relation between Cash, Hedging and Lines of Credit

This table presents estimates from panel regressions of firm-level cash holdings (Columns (1) to (5)) and lines of credit (Column (6)). In Column (5), *Line of credit amount*, *Cash flow hedge* and *Fair value hedge* represent dummy variables (instead of proportion of assets) corresponding to the use of credit lines, cash flow hedging and fair value hedging, respectively. *Cash* is the residual of a regression of *Cash* on *Cash flow hedge* and *Fair value hedge*. The sample and all other variables are detailed in Table XI. All regressions include year dummies (not reported). Robust standard errors clustered at firm level are in parentheses. $*$, $**$, $***$ represent significance at the 10%, 5% and 1% level, respectively.

	Cash Holdings					Lines of Credit
	(1)	(2)	(3)	(4)	(5)	(6)
Line of credit amount	−0.180***			−0.181***	−0.070***	
	(0.036)			(0.044)	(0.013)	
Total hedge		−0.070				
		(0.053)				
Cash flow hedge			−0.448***	−0.356***	−0.029***	0.503**
			(0.124)	(0.113)	(0.010)	(0.209)
Fair value hedge			−0.096	−0.111	−0.004	0.086
			(0.118)	(0.111)	(0.009)	(0.186)
Cash						−0.346***
						(0.062)
Cash flow volatility	0.133***	0.159**	0.087	0.102*	0.084*	0.113
	(0.045)	(0.061)	(0.065)	(0.058)	(0.047)	(0.123)
Cash flow	−0.060	−0.059	−0.042	−0.024	−0.056	0.083**
	(0.049)	(0.083)	(0.079)	(0.072)	(0.050)	(0.040)
Net working capital	−0.277***	−0.312***	−0.299***	−0.293***	−0.215***	−0.072
	(0.052)	(0.068)	(0.077)	(0.071)	(0.057)	(0.061)
R&D	0.776***	0.801***	1.026***	0.910***	0.940***	−0.285*
	(0.157)	(0.181)	(0.188)	(0.173)	(0.149)	(0.162)
CAPEX	−0.415***	−0.491***	−0.465***	−0.470***	−0.336***	−0.190
	(0.089)	(0.144)	(0.141)	(0.143)	(0.086)	(0.207)
Debt	−0.184***	−0.245***	−0.185***	−0.127***	−0.150***	0.253***
	(0.039)	(0.048)	(0.048)	(0.046)	(0.039)	(0.077)
Payout	0.008	−0.018	−0.042	−0.034	−0.015	0.028
	(0.049)	(0.079)	(0.077)	(0.059)	(0.048)	(0.102)
Tobin's Q	0.053***	0.051***	0.055***	0.056***	0.056***	0.021*
	(0.008)	(0.011)	(0.012)	(0.011)	(0.009)	(0.012)
Size	−0.033***	−0.030***	−0.031***	−0.039***	−0.020***	−0.053***
	(0.005)	(0.006)	(0.007)	(0.007)	(0.006)	(0.008)
Age	−0.008	−0.017	−0.016	−0.012	−0.002	0.016
	(0.011)	(0.015)	(0.015)	(0.014)	(0.012)	(0.019)
Adjusted R-squared	0.572	0.550	0.581	0.607	0.610	0.250
Observations	1,987	1,337	1,061	1,061	1,597	1,061

Table IV: The Sensitivity of Cash Holdings to Cash Flow Volatility

This table presents estimates from panel regressions explaining firm-level cash holdings. The sample and all variables are defined in Table XI. In Panel A, cash holdings are regressed on the industry cash flow volatility alone. Panel B reports the results controlling for other firm characteristics. Each column represents a different sub-sample, which include firms depending on their use of cash flow hedging (*CF Heging?*) and/or lines of credit (*Lines of Credit?*). All regressions include year dummies (not reported). Robust standard errors clustered at firm level are in parentheses. $*$, $**$, $***$ represent significance at the 10%, 5% and 1% level, respectively.

Panel A - Cash Flow Volatility

Sample Description	CF Hedging?		Lines of Credit?		Neither	Both
	No	Yes	No	Yes		
Cash flow volatility	0.620***	0.350***	0.781***	0.251***	0.963***	0.207***
	(0.122)	(0.067)	(0.151)	(0.044)	(0.223)	(0.050)
R-squared	0.146	0.097	0.145	0.094	0.178	0.075
Observations	747	952	595	1,493	296	744

Panel B - Controlling for other Characteristics

Sample Description	CF Hedging?		Lines of Credit?		Neither	Both
	No	Yes	No	Yes		
Cash flow volatility	0.086	0.017	0.250**	0.123***	0.362***	0.057
	(0.076)	(0.051)	(0.096)	(0.040)	(0.126)	(0.048)
Cash flow	−0.003	−0.145***	−0.034	−0.054	0.068	−0.143
	(0.077)	(0.026)	(0.053)	(0.074)	(0.052)	(0.101)
Net working capital	−0.409***	−0.116**	−0.341***	−0.127***	−0.427***	−0.053
	(0.073)	(0.057)	(0.090)	(0.044)	(0.095)	(0.057)
R&D	0.986***	1.147***	0.852***	0.539***	0.909***	0.733***
	(0.208)	(0.182)	(0.186)	(0.158)	(0.212)	(0.182)
CAPEX	−0.440**	−0.210***	−0.696***	−0.244***	−0.744**	−0.151**
	(0.194)	(0.068)	(0.185)	(0.064)	(0.345)	(0.064)
Debt	−0.190***	−0.172***	−0.135**	−0.198***	−0.069	−0.164***
	(0.052)	(0.051)	(0.061)	(0.033)	(0.069)	(0.048)
Payout	−0.023	0.056	−0.044	0.079*	−0.055	0.143***
	(0.081)	(0.059)	(0.065)	(0.041)	(0.062)	(0.048)
Tobin's Q	0.053***	0.052***	0.069***	0.028***	0.055***	0.031**
	(0.014)	(0.012)	(0.011)	(0.009)	(0.015)	(0.014)
Size	−0.041***	−0.008	−0.045***	−0.012***	−0.067***	−0.008
	(0.009)	(0.006)	(0.011)	(0.004)	(0.015)	(0.005)
Age	−0.017	−0.003	−0.006	0.002	−0.038	0.004
	(0.020)	(0.012)	(0.023)	(0.011)	(0.031)	(0.012)
R-squared	0.597	0.532	0.617	0.365	0.679	0.345
Observations	746	930	574	1,413	295	727

Table V: Liquidity Ratios and Industry Effects

This table presents the results of panel regressions of cash flow hedging and liquidity ratios. In Columns (1) and (2), 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). In Columns (3) and (4), the dependent variable is the amount of cash flow hedging over total assets. In Column (4), industry fixed effects are included. *F-stat* is the F-statistic for the null that all industry fixed effects are simultaneously zero. In Columns (5) and (6) we look at the effect of the *Propensity to Hedge* variable on the *Liquidity Ratio*. The *Propensity to Hedge* variable is constructed by averaging the estimated probability of cash flow hedging across all firms in the same industry. The sample and all other variables are described in Table XI. *Lag* represents one-year lagged variables. All regressions include year dummies (not reported). Robust standard errors clustered at firm level are in parentheses. $*$, $**$, $***$ represent significance at the 10%, 5% and 1% level, respectively.

	Liquidity Ratio		CF Hedge		Liquidity Ratio	
	(1)	(2)	(3)	(4)	(5)	(6)
Total hedge	0.095					
	(0.131)					
Cash flow hedge		0.918**				
		(0.435)				
Fair value hedge		−0.158				
		(0.442)				
Propensity to Hedge						0.219***
						(0.082)
EBITDA (Lag)	1.698***	1.690***	0.068**	0.066*	1.597***	1.668***
	(0.176)	(0.193)	(0.034)	(0.035)	(0.174)	(0.178)
Tangibles (Lag)	−0.439***	−0.381***	−0.045***	−0.029**	−0.417***	−0.367***
	(0.108)	(0.121)	(0.013)	(0.013)	(0.101)	(0.104)
Size (Lag)	−0.017	−0.012	−0.002	−0.001	−0.039**	−0.043***
	(0.018)	(0.023)	(0.003)	(0.003)	(0.016)	(0.016)
Tobin's Q (Lag)	−0.185***	−0.167***	−0.005	−0.008*	−0.206***	−0.215***
	(0.020)	(0.025)	(0.004)	(0.004)	(0.021)	(0.020)
Age (Lag)	0.059	0.075*	−0.008	−0.010	0.030	0.034
	(0.037)	(0.041)	(0.008)	(0.009)	(0.037)	(0.037)
Sales Vol (Lag)	−0.522**	−0.338	−0.025	−0.317*	−0.429**	−0.345*
	(0.211)	(0.257)	(0.038)	(0.188)	(0.196)	(0.203)
Net Worth (Lag)	−0.130*	−0.064	−0.015	−0.010	−0.112*	−0.128**
	(0.070)	(0.075)	(0.014)	(0.013)	(0.064)	(0.065)
Industry FE	No	No	No	Yes	No	No
F-stat (H0: Ind FE = 0)				121.39		
Adjusted R-squared	0.271	0.248	0.052	0.237	0.232	0.264
Observations	1,289	1,018	1,093	1,093	1,607	1,486

Table VI: Simultaneous Equation Estimation

This table presents estimates from simultaneous equation models of liquidity ratio and hedging:

$$\begin{cases} \text{Liq Ratio} & = \alpha_1 + \beta_1 \text{Hedge} \quad + Z_1\gamma_1 + \varepsilon_1 \\ \text{Hedge} & = \alpha_2 + \beta_2 \text{Liq Ratio} + Z_2\gamma_2 + \varepsilon_2 \end{cases}$$

where *Hedge* is taken to be either *Cash Flow Hedge* (Columns (1) and (2)) or *Total Hedge* (Columns (3) and (4)), Z_1 corresponds to the set of regressors in Column (5) of Table V, and Z_2 corresponds to the set of regressors in Panel B of Table IV. This system of equations is estimated using Two-Stage Least Squares (2SLS). In the first stage, the endogenous variables *Liq Ratio* and *Hedge* are regressed on all exogenous variables, i.e., Z_1 and Z_2. In the second stage, the predicted values from the first stage are used as instruments for the endogenous variables (represented by an $*$). All regressions include year and industry dummies (not reported). Although not reported, the regressions in Columns (1) and (3) include the Z_1 regressors described above. Similarly, the variables in Z_2 are also include in the regressions of Columns (2) and (4). For the second stage regressions, robust standard errors clustered at firm level are in parentheses. $*$, $**$, $***$ represent significance at the 10%, 5% and 1% level, respectively.

	Liq Ratio (1)	CF Hedge (2)	Liq Ratio (3)	Tot Hedge (4)
*Cash flow hedge**	5.705***			
	(1.539)			
*Liquidity Ratio**		0.046*		0.016
		(0.026)		(0.045)
*Total hedge**			0.024	
			(0.805)	
R-squared	0.407	0.285	0.253	0.204
Observations	1,078	1,078	1,078	1,027

Table VII: Industry Determinants of Cash Flow Hedging

This table presents industry-level regressions of the proportion of firms using cash flow hedging. The dependent variable is the percentage of firms using these instruments in each of the Fama and French 48 industries. The sample consists of all non-financial and non-utilities companies in the S&P 1500, from 2006 to 2007. All industry controls are computed using the medians (over the entire Compustat universe) of the corresponding firm firm level variables. These firm level variables are described in Table XI. All regressions include dummies for the year 2007 (not reported). $*$, $**$, $***$ represent significance at the 10%, 5% and 1% level, respectively.

	(1)	(2)	(3)	(4)
PPI Sensitivity		1.841***		1.660***
		(0.411)		(0.411)
Foreign Income			0.436***	0.304**
			(0.164)	(0.150)
EBITDA (Lag)	1.052**	0.903*	1.075**	0.934**
	(0.525)	(0.461)	(0.502)	(0.451)
Tangibles (Lag)	−0.040	0.034	−0.048	0.021
	(0.195)	(0.172)	(0.186)	(0.168)
Size (Lag)	0.010	−6.996*	−3.407	−8.685**
	(3.758)	(3.646)	(3.812)	(3.656)
Tobin's Q (Lag)	0.178	0.036	0.116	0.007
	(0.140)	(0.127)	(0.135)	(0.124)
Age (Lag)	0.034	0.030	0.094	0.072
	(0.100)	(0.087)	(0.098)	(0.088)
Sales Vol (Lag)	−1.717***	−1.447***	−1.646***	−1.424***
	(0.376)	(0.335)	(0.360)	(0.327)
Net Worth (Lag)	−0.024	−0.044	−0.145	−0.126
	(0.327)	(0.287)	(0.316)	(0.283)
R-squared	0.435	0.573	0.493	0.600
Observations	72	72	72	72

Table VIII: Covenants

This table presents the results of panel regressions of Liquidity Ratios, defined as the ratio of outstanding lines of credit to total liquidity (i.e., the sum of outstanding lines of credit and cash reserves). Regressions are run on either the amount of derivatives hedging (*LR on Hedge Amounts*) or dummies variables representing the use of derivatives hedging (*LR on Hedge Dummies*). The sample and all other variables are described in Table XI. *Lag* represents one-year lagged variables. All regressions include year dummies (not reported). Robust standard errors clustered at firm level are in parentheses. $*$, $**$, $***$ represent significance at the 10%, 5% and 1% level, respectively.

	LR on Hedge Amounts		LR on Hegde Dummies	
	No Covenant	Covenant	No Covenant	Covenant
Cash flow hedge	−0.397	0.854***		
	(0.982)	(0.232)		
Fair value hedge	−0.191	−0.427		
	(0.452)	(0.441)		
Cash flow hedge dummy			0.058	0.126***
			(0.040)	(0.030)
Fair value hedge dummy			0.057	−0.024
			(0.041)	(0.030)
EBITDA (Lag)	2.191***	0.725***	0.985***	0.894***
	(0.475)	(0.272)	(0.329)	(0.248)
Tangibles (Lag)	−0.243	−0.309***	−0.283**	−0.277***
	(0.193)	(0.086)	(0.132)	(0.075)
Size (Lag)	−0.042	−0.018	−0.067***	−0.014
	(0.034)	(0.019)	(0.019)	(0.017)
Tobin's Q (Lag)	−0.232***	−0.079**	−0.197***	−0.100***
	(0.037)	(0.034)	(0.036)	(0.032)
Age (Lag)	−0.055	0.082**	−0.069	0.051
	(0.080)	(0.038)	(0.054)	(0.035)
Sales Vol (Lag)	−0.087	−0.305	−0.001	−0.402**
	(0.325)	(0.206)	(0.237)	(0.195)
Net Worth (Lag)	−0.244	−0.035	0.067	0.006
	(0.155)	(0.083)	(0.101)	(0.074)
R-squared	0.240	0.200	0.269	0.219
Observations	232	467	445	649

Table IX: Financial Constraints

This table shows the results of panel regressions of cash holdings and liquidity ratios for different subsamples. The sample and all variables included in this table are defined in Table XI. In Panel A, the dependent variable is cash holdings over assets. All regressions in this panel include the same controls as in Column (4) of Table III, although we only report the relevant coefficients. In Panel B, the dependent variable is the 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). All regressions in this panel include the same controls as in Column (2) of Table V, but we only report the relevant coefficients. Each column represents a different subsample, in which firms are classified based on the following variables: *Firm Assets*, *Whited-Wu Index*, *Bond Ratings*, and *Payout*. With the exception of *Bond Ratings*, *High* or *Big* (*Low* or *Small*) represent values above (below) the median. For *Bond Ratings*, *High* represents investment grade S&P bond ratings. All regressions include year dummies (not reported). Robust standard errors clustered at firm level are in parentheses. $*$, $**$, $***$ represent significance at the 10%, 5% and 1% level, respectively.

Panel A - Cash Holdings

	Whited-Wu Index		Firm Assets		Bond Ratings		Firm Payout	
	Low	High	Big	Small	High	Low	High	Low
Line of credit amount	−0.028	−0.230***	−0.025	−0.214***	−0.073***	−0.179**	−0.089**	−0.229***
	(0.049)	(0.057)	(0.053)	(0.055)	(0.024)	(0.072)	(0.042)	(0.052)
Cash flow hedge	−0.062	−0.540***	−0.167	−0.351**	−0.236***	−0.362*	−0.232*	−0.319***
	(0.095)	(0.130)	(0.119)	(0.154)	(0.067)	(0.213)	(0.133)	(0.122)
Fair value hedge	0.044	−0.245*	0.100	−0.298*	0.126	−0.439*	0.016	−0.156
	(0.156)	(0.147)	(0.113)	(0.161)	(0.087)	(0.236)	(0.138)	(0.154)
R-squared	0.461	0.618	0.501	0.615	0.387	0.604	0.618	0.684
Observations	379	675	417	644	651	410	447	473

Panel B - Liquidity Ratio

	Whited-Wu Index		Firm Assets		Bond Ratings		Firm Payout	
	Low	High	Big	Small	High	Low	High	Low
Cash flow hedge	0.460	1.291***	−0.031	1.039***	0.790	0.632	1.133***	0.823
	(0.604)	(0.452)	(0.795)	(0.365)	(0.544)	(0.474)	(0.411)	(0.658)
Fair value hedge	−0.435	0.086	−0.497	0.148	−0.402	0.037	−1.035**	0.882*
	(0.722)	(0.432)	(0.720)	(0.439)	(0.510)	(0.589)	(0.516)	(0.533)
R-squared	0.125	0.378	0.160	0.415	0.156	0.337	0.277	0.275
Observations	375	643	410	608	640	378	435	449

Table X: Robustness

This table shows the results of cash holdings (*Cash*) and lines of credit (*Credit Lines*) regressions for different sub-samples. The sample and variables are described in Table XI. *S&P 1500 (2006-07)* includes all industrial firms in the S&P 1500 for the years of 2006 and 2007. *S&P 500 (Y)* includes only the observations for the year *Y*. Year dummies are only included in the regressions using the S&P 1500 sample, but are not reported. Robust standard errors clustered at firm level are in parentheses. $*$, $**$, $***$ represent significance at the 10%, 5% and 1% level, respectively.

Sample (Year)	S&P 1500 (2006-07)		S&P 500 (2002)		S&P 500 (2004)		S&P 500 (2006)	
	Credit Lines	Cash	Credit Lines	Cash	Credit Lines	Cash	Credit Lines	Cash
Line of credit dummy		−0.030***		−0.063***		−0.061***		−0.085***
		(0.008)		(0.018)		(0.016)		(0.016)
Cash flow hedge dummy	0.027***	−0.031***	0.028	−0.039**	0.036**	−0.040***	0.074***	−0.027**
	(0.010)	(0.007)	(0.021)	(0.015)	(0.017)	(0.014)	(0.020)	(0.011)
Fair value hedge dummy	0.022	0.002	0.029	−0.013	0.022	−0.010	0.055**	0.010
	(0.016)	(0.007)	(0.023)	(0.014)	(0.019)	(0.015)	(0.027)	(0.011)
Cash	−0.077***		−0.277***		−0.269***		−0.492***	
	(0.024)		(0.079)		(0.080)		(0.095)	
Cash flow volatility	−0.013	0.028	0.018	0.069	0.038	0.099	0.241*	0.085*
	(0.049)	(0.032)	(0.085)	(0.082)	(0.093)	(0.062)	(0.142)	(0.050)
Cash flow	−0.050	−0.013	0.050	−0.037	0.266**	−0.119	−0.172	−0.087
	(0.035)	(0.051)	(0.033)	(0.050)	(0.121)	(0.153)	(0.198)	(0.159)
Net working capital	−0.052*	−0.296***	−0.054	−0.274***	−0.039	−0.208**	−0.084	−0.192***
	(0.028)	(0.032)	(0.062)	(0.086)	(0.076)	(0.090)	(0.095)	(0.055)
R&D	−0.147**	1.080***	−0.081	0.882***	−0.315*	1.186***	−0.342	0.795***
	(0.074)	(0.117)	(0.166)	(0.233)	(0.185)	(0.199)	(0.221)	(0.159)
CAPEX	−0.092	−0.450***	0.115	−0.549***	−0.132	−0.276**	−0.161	−0.308**
	(0.064)	(0.063)	(0.436)	(0.152)	(0.196)	(0.109)	(0.190)	(0.123)
Debt	0.085**	−0.210***	0.252**	−0.096	0.153**	−0.162***	0.278**	−0.230***
	(0.039)	(0.026)	(0.109)	(0.058)	(0.066)	(0.062)	(0.108)	(0.045)
Payout	0.044	0.014	−0.154	−0.454**	0.220*	−0.057	0.085	−0.005
	(0.046)	(0.045)	(0.201)	(0.179)	(0.118)	(0.110)	(0.169)	(0.074)
Tobin's Q	0.032***	0.041***	0.033	0.070***	−0.006	0.066***	0.051***	0.046***
	(0.008)	(0.007)	(0.021)	(0.018)	(0.013)	(0.011)	(0.018)	(0.018)
Size	0.019***	−0.017***	−0.050***	−0.019***	−0.044***	−0.010	−0.061***	−0.024***
	(0.003)	(0.003)	(0.010)	(0.007)	(0.007)	(0.008)	(0.010)	(0.007)
Age	0.025**	−0.008	−0.001	0.003	−0.015	−0.001	0.041*	−0.007
	(0.011)	(0.008)	(0.022)	(0.017)	(0.019)	(0.015)	(0.025)	(0.014)
R-squared	0.160	0.520	0.228	0.598	0.280	0.652	0.342	0.644
Observations	1,847	1,847	266	266	270	270	269	269

Table XI: Variable Definitions

The sample consists of non-financial and non-utility firms from the S&P 500 Index for 2002-2007. Hedging data is hand-collected from companies' annual filings with the SEC. Data on lines of credit is taken from DealScan. Data on cash and other accounting figures are taken from Compustat annual files.

NOTE: Compustat variable names are in parenthesis.

Age	is the number of years since the firm first appeared on Compustat with non-missing book assets.
CAPEX	is capital expenditure (capx) over book assets (at).
Cash flow hedge dummy	is an indicator set to 1 if the firm reported a positive notional amount of cash flow derivative hedging, and 0 otherwise.
Cash flow hedge	represents the total (identifiable) notional amount of cash flow derivative hedging over book assets (at).
Cash flow volatility	is the industry's equal-weighted average cash flow volatility over the prior 10 years.
Cash flow	is the sum of income before extraordinary items (ib) and depreciation and amortization (dp), over book assets (at).
Cash	is cash and short-term investments (che) over book assets (at).
Covenant dummy	is an indicator set to 1 if the company has a financial covenant on any of its active revolving credit facilities according to DealScan, and 0 otherwise.
Debt	is the sum of debt in current liabilities (dlc) and long-term debt (dltt), over book assets (at).
EBITDA	is earnings before interest, taxes, depreciation and amortization (ebitda) over book assets (at).
Fair value hedge dummy	indicator set to 1 if the firm reported a positive notional amount of fair value derivative hedging, and 0 otherwise.
Fair value hedge	is the total (identifiable) notional amount of fair value derivative hedging over book assets (at).
Foreign Income	is a measure of the relative importance of foreign income across all firms in each industry (as a fraction of assets.)
Line of credit amount	is 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	is an indicator set to 1 if the firm should have access to a revolving credit facility according to DealScan, and 0 otherwise.
Liquidity Ratio	is 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 Worth	is defined as book assets (at) minus cash (che) minus total liabilities (lt), all divided by book assets (at).

Table XI Variable Definitions, Continued

Net working capital	is current assets (act) minus current liabilities (lct) minus cash (che), over book assets (at).
Number of covenants	is the total number of financial covenants that the company has on any of its active revolving credit facilities, according to DealScan.
PPI Sensitivity	is a measure of the sensitivity of EBIT to the Producer Price Index (PPI) across all firms in each industry. This is calculated based on quarterly data by regressing EBIT on PPI by firm.
Payout	is the sum of total dividends (dvt) and the purchase of common and preferred stock (prstkc), over book assets (at).
Propensity to Hedge	is constructed by averaging the estimated probability of cash flow hedging across all firms in the same industry.
R&D	is the ratio of R&D expenses (xrd) over book assets (at), set to zero if missing.
Sales Volatility	is the average volatility of firm sales (sale/at) over the past 10 years across all firms in each Fama-French 48 industry.
Size	is the natural logarithm of book assets (at).
Tangibles	is one minus intangible assets (intan) over book assets (at).
Tobin's Q	is the sum of the market value of assets book assets (at) and market value of common equity (csho $\times$ prcc), minus the sum of common equity (ceq) and deferred Taxes (txdb), all over the sum of $0.9\times$book value of assets (at) and $0.1\times$ market value of assets.
Total hedge dummy	is an indicator set to 1 if the firm reported a positive notional amount of derivative hedging, and 0 otherwise.
Total hedge	represents the total (identifiable) notional amount of derivative hedging over book assets (at).