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Corporate Hedging During the Financial Crisis

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Corporate hedging during the financial crisis

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Abstract

We study corporate hedging during the 2007-2008 financial crisis. The crisis provides an ideal setting to study both the interaction of hedging with corporate liquidity policies as well as the value implications of programs that are designed to protect firms from cash-flow shortfalls. We find that hedging programs are fragile. Firms whose lenders suffered losses on their mortgage portfolio were more likely to lose access to over-the-counter derivatives, and this effect was strongest among unrated and below investment grade firms. Affected firms responded by drawing down existing lines of credit, and saving more out of realized cash-flows. Termination of hedging program hurt the most vulnerable firms in our sample, with decreases in value of the order of 11% to 28% occurring in these firms. These value effects are largest among firms that do not have alternative sources of liquidity to draw upon.

JEL: G21, G32

Keywords: Corporate hedging, liquidity risk management, financial crisis, credit lines, cash-flow sensitivity of cash.

I. Introduction

Corporate hedging programs have the potential to add value by reducing the expected tax liability (Smith and Stulz (1985)), by reducing cash-flow shortfalls (Tirole 2006), and ensuring firms can take advantage of profitable investment opportunities (Froot, Sharfstein and Stein 1993). Consistent with these theories, empirical studies have documented the prominence of hedging in practice (Nance, Smith and Smithson 1993) along with the rapid growth of financial innovation (Tufano 2003).

Corporate hedging programs rely on financial counterparties for their implementation and execution. Yet, the 2007-2008 financial crises exposed the fragile nature of these programs as banks' willingness to carry risk decreased following losses on their mortgage portfolios (Mian and Sufi 2010, Gorton and Metrick 2012). These concerns left many firms frozen out of the market for derivatives, forcing them to terminate or reduce their hedging programs (Economist 2009).[2] We use this setting to explore whether and how non-financial corporations substituted alternative forms of liquidity such as cash or lines of credit for the loss of their risk management programs. We also examine the impact of losing a hedging program on firm value.

The financial crisis provides a unique and advantageous setting in which to address these questions. First, hedging programs are designed to protect firms from left-tail events. Yet, the existing literature has focused on the introduction rather than the reduction or termination of corporate hedging programs.[3] The introduction or commencement of these programs typically occurs during periods of positive firm and/or economic growth. Prior findings may thus understate the importance of these programs to firm value.[4] Put differently, in the words of Warren Buffet, "Only when the tide goes out do you discover who has been swimming naked."

[2] "Corporate hedging gets harder: The perils of prudence", http://www.economist.com/node/13881056.

[3] A notable exception is Gilje and Taillard (2017).

[4] This point is made by Bartram, Brown and Conrad (2011).

Second, during the financial crisis external liquidity declined for reasons unrelated to the firm's performance. Specifically, the crisis caused a reduction in external sources of capital for a large segment of industrial firms due to a contraction in the banking sector. Anecdotal evidence suggests that this contraction limited the willingness of banks to supply hedging instruments to their corporate clients, which in turn forced these firms to terminate their hedging programs. We exploit this setting in our empirical design in order to measure the effect of hedging programs on firm liquidity policies and value. Third, new accounting standards enable us to use more precise data to measure the extent of corporate derivative usage. Using information based on mandatory disclosures on derivatives usage required by accounting rules SFAS 133 and SFAS 161, we hand collect derivatives exposures for a random sample of 500 firms that belong to the Standard and Poor's 1500 index (S&P 1500) for the years 2007 to 2011.[5]

We begin by examining which firms' hedging policies were the most affected by lender losses on their mortgage portfolios. Hedging services may require collateral on the part of the firm, and they consume lender risk-capital that can otherwise be used to arrange debt financing for corporate clients.[6] Economic intuition and financial theory suggest that banks' most vulnerable (corporate) customers may have been the ones most affected since these customers represented the greatest credit risk for their lenders. However, lenders may have been loath to ration hedging services for their weakest customers out of fear of precipitating these firms into bankruptcy. We address this question in Figure 1, which shows that there is no relation between the firm's lending syndicate's loan chargeoffs (a measure of bank mortgage portfolio losses) and the firm's hedging activity for investment-grade corporations. In contrast, the non-investment grade corporations whose lenders experience losses during the crisis exhibit much lower hedging intensity

[5] SFAS 161 expands on SFAS 133, which required firms to designate hedges as either cash flow or fair value hedges. In particular, SFAS 161 requires firms to disclose information in the context of the firm's primary underlying risk exposure (e.g. interest-rate, foreign exchange and commodity risk), which we exploit in our tests. SFAS 161 applies to all firm-years with fiscal years or periods beginning after November 15th, 2008.
[6] See ISDA 2013 as well as "Hedging and clearing: Where next?", https://cib.bnpparibas.com/adapt/hedging-and-clearing-where-next-_a-2-614.html.

(measured as a fraction of firm sales) thereafter. This finding suggests that lenders with large mortgage portfolio losses rationed hedging to the most vulnerable firms.

We next consider how the rationing of hedging activity during the financial crisis affected firms' reliance on lines of credit, credit line drawdown activity as well as the firm's propensity to save out of realized cash flows. There is very little empirical evidence on how a firm's hedging policy fits into its broader liquidity management strategy. Firms use lines of credit and cash to manage their liquidity risk, which arises in states of the world where hedging is potentially the most beneficial. However, theoretical research make different predictions about how hedging policy relates to the firm's liquidity management strategy, with research outlining reasons for why hedging should complement (Sufi 2009; Disatnik, Duchin and Schmidt 2013) or substitute (Rampini, Sufi and Viswanathan 2014) for a firm's line of credit.

Theories of liquidity such as Tirole (2006) also predict that firms' reliance on cash savings will increase following the termination of the firm's hedging program. Cash savings reduce current investment in financially constrained firms, and hedging can alleviate the need for future savings out of current cash flows. Conversely, the loss of the firm's hedging program can lead firms to increase their savings rate (measured as the cash-flow sensitivity of cash), in order to provision for future liquidity shocks not covered by a hedging program.

In order to examine the effect of hedging program termination on the firm's liquidity policy, we instrument large declines in hedging activity with the firm's lending syndicate loan chargeoffs, and bank capital and liquidity ratios. The rationale for using these instruments is that a lending institution's financial health affects its ability to act as a counterparty in derivative transactions both with its corporate customer base and with other banks. The latter type of counterparty is essential for the lending institution to hedge the risks transferred to its balance sheet through derivative transactions with its corporate customers. Furthermore, mortgage-loss related changes in the lending institution's financial health are plausibly exogenous to a corporate customer's financial circumstance.

We find that hedging program terminations caused by lender mortgage losses do not restrict the availability of credit lines. In fact, firms whose hedging programs are terminated are *less* likely to have their credit lines revoked than comparable firms that maintain their hedging programs. These effects are concentrated in firms that are unrated and below investment grade. One interpretation of this result is that a reduction or termination of the firm's hedging program allowed financially constrained firms to preserve access to lines of credit during the financial crisis. Consistent with the idea that hedging substitutes for other sources of liquidity management, terminated firms are more likely to draw down existing lines of credit following the loss of their hedging program.

We also find that affected firms increase the proportion of cash saved from existing cash flows (i.e. the cash-flow sensitivity of cash) following material reductions or terminations in their hedging programs. For example, firms with 50% or greater reductions in hedging intensity increase the savings rate out of cash flows by 0.74, which means that for every dollar of cash flow, they save an additional 0.74 dollars following the reduction in hedging intensity. This savings rate increases with the magnitude of hedging program reductions.

Finally, we examine the effect of hedging program rationing on firm value during the crisis. Past empirical evidence on the value of hedging paints a mixed picture with regard to its magnitude and contribution to shareholder value (Allayannis and Weston 2001; Guay and Kothari (2003); Carter, Rogers and Simkins 2006; Pérez-Gonzalez and Yun 2013). A potential confounding issue in any empirical study of hedging program initiation is that, given that firms choose to implement derivative programs, it unclear if their use causes the observed increase in firm value. For example, given that the implementation of hedging programs is costly, it is plausible that firms only implement these programs when they have positive outlooks about their future.[7]

[7] Pérez-Gonzalez and Yun (2013) tackle this issue by examining the effect on value of the introduction of weather derivatives, which they argue is exogenous to the firm. In a similar vein, Hoberg and Moon (2017) use the introduction of currency derivatives to explore the interaction of hedging policies with the firm's operations in a set

We use two estimation strategies to explore the value question. The first strategy uses the mortgage-related losses and other measures of lending syndicate health as instruments to infer value effects on the firm. We find that hedging program termination leads to a 25% decline in unrated and below investment-grade firms' market-to-book ratios. Value effects are also largest among firms that have used up existing lines of credit prior to the loss of their hedging program. We infer that firms can insulate themselves from the loss of a hedging program by having a diversified menu of liquidity management tools to draw upon. Since we cannot entirely exclude other channels, such as the lending channel, through which lender mortgage-related losses act on firm value, we also employ a dynamic panel Generalized Method of Moments (GMM) estimator proposed by Wintoki, Linck and Netter (2012) to alleviate endogeneity concerns. Following this methodology, we perform several tests to verify that the assumptions required by the dynamic panel GMM estimator holds in our sample. Our results show that hedging adds value in the most vulnerable firms in our sample: according to this estimator, termination leads to losses of the order 27% of firm value for unrated and rated but below-investment grade firms in our sample.

We make three contributions to the literature. First, our study provide insights into banking contagion and the spillover effect from the financial to the real economy. Prior studies show that reductions in available liquidity due to lender insolvencies or maturing long-term debt during the crisis negatively impact investment and value (Campello, Graham and Harvey 2010, Almeida *et al.* 2011). Hau and Lai (2013) show that stock price declines unrelated to the firm's fundamentals impact real investment activity during the crisis. The contribution of our paper is to show that financial-institution mortgage losses during the financial crisis also have negative spillovers through the corporate hedging channel, negatively affecting the availability of hedging programs in the most vulnerable firms.

Second, our paper provides evidence on the linkage between corporate hedging activity and corporate liquidity policies involving lines of credit and the firm's propensity to save out of existing cash

of multinational firms. Biguri, Brownlees and Ippolito (2018) examine changes in the variance of stock returns around the introduction of commodity derivatives.

flows. This is an understudied area of research, in which theories based on different assumptions make different and sometimes conflicting predictions. Our results suggest that firms may have been willing to sacrifice their hedging programs in order to preserve access to vital lines of credit.

Third, we show that hedging programs are more valuable to financially weaker firms and firms without alternative sources of liquidity in the form of lines of credit. Furthermore, the loss of a hedging program contributes to a decline in value that is larger in absolute magnitude than value changes following initiations of hedging programs documented by other studies. In particular, we explore the impact of hedging programs during an economic downturn, addressing the critique in Bartram, Brown and Conrad (2011) that value effects of having a hedging program may be difficult to detect during good times.

II. Background and hypothesis development

What is the impact of a credit crunch on the availability of over-the-counter derivatives? A negative shock to a firm's lenders' capital base can potentially reduce or terminate corporate hedging programs that are based on over-the-counter derivatives. The firm's primary lender, or a lending syndicate containing the primary lender typically acts as the counterparty to these transactions since they are the most informed about the firm's other financing activities. Since derivatives create a potential liability from the firm's point of view, hedging programs require bank capital to support them. Faced with a capital crunch, firms may thus be rationed with respect to their hedging programs by their lending syndicate.

From the lending institutions' perspective, it can be optimal to ration hedging programs for either its strongest, weakest or both types of customers. Holmstrom and Tirole (1997) show that following a contraction to the lender's capital, poorly capitalized firms are the first to lose their financing. Intuitively, weaker firms can only raise capital from arm's length investors when an informed financial intermediary has taken a large enough interest in the firm that investors can be assured that the firm will behave diligently. Because it is costly for the intermediary to remain informed, constrained customers are the first to lose financing. Since hedging services are provided by the firm's lending syndicate, we expect that contractions

in bank capital can spillover to hedging services, with financially constrained firms losing access to derivatives-based hedges before unconstrained firms.

An alternative hypothesis is that hedging program termination may precipitate financial distress and bankruptcy in the weakest firms, making banks loath to undertake an action that could lead to additional loan impairments. Faced with a credit crunch, banks may instead target their strongest customers when considering a reduction in their derivatives program. Such a reduction would come at the cost of future business with these customers. According to this hypothesis, banks trade-off current capital needs with future reputational concerns.

2.1 Corporate hedging and lines of credit

Hedging potentially complements or substitutes for other sources of corporate liquidity. Hedging serves three main purposes: 1) it insulates manager compensation from risks that are outside of his control (Nance, Smith and Smithson 1993), 2) it allows firms to finance investment in low cash-flow states of the world (Froot, Sharfstein and Stein 1993), and 3) it reduces expected costs of financial distress (Smith and Stulz 1985). However, some or all of these needs can also be satisfied by other corporate policies such as lines of credit (Holmstrom and Tirole 1998), and cash savings (Opler *et al.* 1999). It follows that hedging and other liquidity policies can substitute, complement or interact with each other.

The direction of the potential interaction between hedging and lines of credit are unclear. For example, hedging reduces cash flow volatility, thereby alleviating agency issues that arise when firms are close to their default threshold. Firms with credit lines are more likely to have an active hedging program (Disatnik, Duchin and Schmidt 2013), and firms that hedge also pay lower rates on their loans and have looser loan covenants (Campello *et al.* 2011b), making the case for a complementary relation between hedging and lines of credit. However, hedging and lines of credit may be viewed as substitutes. First, since lines of credit provide liquidity when firms are liquidity constrained (Sufi 2009, Lins, Servaes and Tufano 2010), their role is similar to the role played by hedging in Froot, Sharfstein and Stein (1993), where

hedging permits firms to invest in states of the world in which they would otherwise be financially constrained. Models of corporate liquidity based on Holmstrom and Tirole (1997) also make this prediction (see for example Almeida *et al.* 2014).

Material Adverse Change clauses allow creditors to withdraw liquidity by reducing lines of credit following material adverse changes in the borrower's financial condition. These clauses give banks a wide latitude to limit borrowing under existing credit facilities (Boot, Greenbaum and Thakor 1993, Shockley and Thakor 1997). However, these clauses are rarely invoked, and Roberts and Sufi (2009) show that banks prefer to renegotiate the terms of existing facilities instead of cancelling them outright. Moreover, Campello *et al.* (2011a) find that banks were forgiving of covenant violations during the financial crisis, with most lines of credit being renegotiated to reflect deteriorating economic conditions.

Lines of credit and hedging compete for (possibly scarce) financial intermediary capital. Derivatives create a potential liability for the firm, and therefore require intermediary capital to support their existence on the lender's balance sheet. Since credit lines also become a liability once drawn down, they also require intermediary capital, possibly competing for scarce banking capital during a credit crunch. This argument is related to Rampini, Sufi and Viswanathan (2014) in which the firm's financing and hedging programs both consume scarce firm collateral. Faced with a collateral squeeze, financially constrained firms then ration available collateral in favor of short-term financing over corporate hedging. By analogy, faced with a credit crunch, lenders may have to choose between maintaining a firm's hedging program or preserving the firm's access to their lines of credit. Because hedging programs cover very specific types of risks and lines of credit span a larger set of possible scenarios, this hypothesis predicts that lines of credit are maintained at the expense of the firm's hedging program.

The loss of the firm's hedging program may also affect the frequency with which the firm accesses its line of credit. If the loss of the firm's hedging program exposes it to liquidity shocks in the future, then the firm may compensate for this loss by drawing down existing lines of credit. Under this rationale, hedging and lines of credit act as substitute liquidity management tools, with the loss of one prompting the

firm to exercise the other with a higher frequency. We therefore expect firms with reduced access to over-the-counter hedging to be more likely to draw down their lines of credit following termination of the hedging program. This hypothesis also predicts that the effect of hedging program termination on credit line drawdowns is strongest in firms that are the closest to financial distress, namely firms that are financially constrained.

An alternative hypothesis, which we cannot completely rule out, is that firms draw down their lines of credit following the loss of their hedging program for strategic reasons, i.e. they anticipate the loss of their credit lines in the near future following the loss of their hedging program. Since the reason for the drawdown is strategic and not related to immediate liquidity needs, this explanation predicts that both financially constrained and unconstrained firms drawdown their lines of credit following termination of their hedging program.

2.2 Corporate hedging and cash policies

The loss or reduction of the firm's hedging program may also affect the firm's cash policy. Firms that anticipate financial constraints in the future may choose to hoard cash today by saving a greater proportion of cash out of realized cash flows (Campello, Almeida and Weisbach 2004). However, holding cash today is costly for financially constrained firms since it requires a reduction in current investment. Putting a hedging program in place can alleviate this cost by allowing these firms to both undertake investments today and fund future positive NPV investments. Conversely, the loss of the firm' hedging program may exacerbate financial constraints by exposing the firm to risks that were previously hedged. Thus, we predict that the loss of the firm's hedging program increases the propensity to save cash out of the firm's realized cash flows, i.e. reducing hedging increases the cash-flow sensitivity of cash. Moreover, the effect of the loss of the hedging program on the cash-flow sensitivity of cash should be strongest in financially constrained firms because holding cash is less costly for unconstrained firms.

Another reason to expect the cash flow sensitivity of cash to increase following the termination of a hedging program is that financially constrained firms may be unable to compensate for the loss of their hedging program by increasing their lines of credit. Cash and lines of credit are not perfect substitutes. Acharya, Almeida and Campello (2013) show that firms belonging to industries that are more sensitive to macro-economic conditions prefer cash to lines of credit. Similarly Acharya *et al.* (2014) argue that firms with higher liquidity risk prefer cash over credit lines because of the greater likelihood of credit line revocation by their lenders. The greater liquidity risk of financially constrained firms suggests that they will be more likely to react to the termination of their hedging program by increasing their rate of savings at the expense of current investments than financially unconstrained firms.

III. Data description and preliminary tests

We construct our samples from U.S. COMPUSTAT firms that are member of the Standard and Poor's index of the 1,500 largest firms. Since our empirical strategy depends on loan losses of the firms' lenders, we exclude financial institutions. We also exclude utilities, due to different regulatory environments for these types of firms. We focus on the years surrounding the financial crisis: our sample begins in 2007 and ends in 2011.

3.1 Sample

We base our tests on two sub-samples. The random sample is formed by hand collecting derivative usage data on 499 randomly chosen firms that belong to the S&P 1500 index. We randomly sample without replacement firms from this index with valid COMPUSTAT data in fiscal year 2007.[8] For each of these firms, we manually read their annual 10-K filings and record whether they engage in derivative-based hedging activity, the type of risk they are exposed to, whether they hedge this risk, the type of derivative

[8] We randomly select 500 firms with fiscal 2007 data, but lose one firm because of unavailable 10-K filings in the SEC's EDGAR search service.

used to hedge each risk as well as the notional amount of the hedges.[9] Attrition due to missing data in COMPUSTAT reduces this sample to 469 firms. For each of these firms, we also hand-collect information on credit lines that includes the total line, drawn amount and undrawn amount from firms' 10-K filings. The hand-collection of this information follows Sufi (2009).We then match this sample with information on these firms' lending syndicates in loans initiated in 2006 or 2007 as reported by Dealscan LPC, which yields 279 unique firms with matching FDIC data.

The full sample is comprised of all S&P 1500 index members. Because we do not have hand-collected data for all of these firms, derivative users are identified by searching for keywords in their annual reports or 10-K filing using a word dictionary based on Guay (1999). Because our sample covers the post-SFAS 133 and SFAS 161 rules on derivative disclosures, we modify the word dictionary in order to eliminate the number of false positives that arise due to mandatory disclosures on derivative accounting.[10] In the Appendix (see Table A1), we provide more detail on this process and estimate the accuracy of the original Guay dictionary and our modified dictionary on the random sample.

We match each firm in the full sample to its lending syndicate structure based on deals made in 2006 or 2007 reported in Dealscan. This last step yields a sample to 537 firms with a hedging program in 2007. Table A2 in the appendix provide summary statistics on this sample. Due to the labor-intensive nature of the credit line data collection process, the full sample does not have matching line of credit data.

Table 1 defines the variables of interest and reports some summary statistics for the random sample. As shown, firm revenues and assets are comparable to other studies in the hedging literature. The mean (median) market-to-book ratio equals 1.80 (1.54) with a standard deviation of 0.94. Over 60% of these

[9] Berkman and Bradbury (1996) obtain similar data for a sample of New Zealand firm where detailed reporting of off-balance sheet derivatives is mandatory.

[10] SFAS 133 requires derivative users to report and designate their hedges as either cash-flow, fair-value or non-designated hedging activities. The accounting treatment of profits and gains on derivative positions varies with the accounting designation. For example, cash-flow hedge designations allow the firm to report annual fluctuations in the market value of its derivative positions in other comprehensive income until the expiration date of the derivative contract. SFAS 161 requires firms to report derivative notional amounts and risk sensitivities with fiscal year ends on November 15th, 2008 or later.

firms engage in hedging activity. Of the three types of hedging activity that we can identify, foreign exchange (FX) risk is the most common (40% of observations), with interest-rate (INT) risk a close second (31% of observations). Commodity (COM) risk hedging is less frequent with only 17% of observations. Conditional on hedging, the average notional amount is approximately 7% of the firm's revenue (the median is 0.2%), suggesting significant skewness in the distribution of hedging intensity across our sample.

We next compare the distribution of operating profits between hedging and non-hedging firms for both samples. Figure 2 provides visual evidence of the impact of hedging programs on the distribution of cash flows. As shown, hedging acts as the opposite of a mean-preserving spread. Hedging has little effect on the mean of the distribution but it has a large effect on the kurtosis of the distribution of operating income: hedging programs reduce the thickness of the tails of the distribution and increases the peakedness of the distribution. In unreported tests, we find that the kurtosis of the hedgers in the random sample equals 11 compared to 5 for the non-hedgers in this sample (the kurtosis of a normal distribution is 3). Therefore, if there exists a wedge between internal and external financing costs, firms will benefit from transferring cash flows from high to low-profitability states of the world through hedging. This visual evidence suggests that hedging program termination will negatively affect firm value for these firms.

Panel B of Table 1 reports summary statistics on lines of credit. As shown, over 85% of firm years in the random sample employ a line of credit. On average, the total line equals 16.6% of total assets, the drawn portion in any given year is 4.4% of total assets, and the undrawn portion, 10% of total assets. We also report the ratio of total lines to the sum of total lines plus cash (this ratio equals the firm's liquidity ratio, denoted as LR). The mean value of this ratio is 0.59 (median is 0.62), meaning that almost 60% of the average firm's potential liquidity supply in any given year is met by a line of credit. Overall, lines of credit are an important source of liquidity for these firms.

We also measure correlation coefficients between key firm characteristics. As reported in Table A3 in the Appendix, hedging program and hedging intensity are positively correlated with the presence of a line of credit. Additional evidence on the relation between hedging and lines of credit is provided in Figure

3, which compares hedging activity and line of credit access during the financial crisis. While average hedging, measured as the ratio of notional amounts to sales, increased between 2007 and 2011 for investment-grade firms, it declined over this same period for non-investment grade firms (comprised of unrated and below investment grade rated firms). As shown, hedging intensity in non-investment grade firms declined by almost 50% between 2009 and 2011 from a peak of 16% in 2009 to a low of 8% by the end of 2011. In comparison, we do not find large variations in the availability of lines of credit over this same period. The ratio of total lines of credit to assets declined between 2007 and 2010, and then increased in 2011 for non-investment grade firms, indicating that most of these firms seemed to have preserved access to sources of banking liquidity during this time period.

3.2 Lending syndicate members and financial health

We obtain information on loan syndicate membership from Dealscan. Dealscan LPC reports the syndicate members in each loan package or deal. We identify the firm's lending syndicate and record the syndicate members in deals that were initiated just before the onset of the crisis. Specifically, the firm's lenders are the set of lenders in deals initiated in either 2006 or 2007 that are members of the loan syndicate. Each member of the syndicate is designated as either a lead or participating member of the syndicate based on the stated syndicate role reported in Dealscan. Our study design assumes that syndicate memberships remain constant over the duration of the sample period (2006-2011).

In order to estimate lending syndicate health, we match lending syndicate names to FDIC Bank Call Reports and record the amount of loan chargeoffs (CHARGEOFF), the amount of liquid assets (LIQU), transaction deposits (TRN) and equity capital (EQCAP) at the end of each calendar year for each syndicate member. Loan chargeoffs equal the amount of bad loans written off the bank's balance sheet (see Santos 2011 for an analysis of the relation between chargeoffs and loan spreads). We scale all banking syndicate variables by lender total assets and average the ratios across lending syndicate members in each year. Panel C of Table 1 reports summary statistics for loan chargeoffs scaled by lending institution total assets. Mean chargeoffs in our sample amount to 0.75% of total assets, a significant amount that reflects important losses

experienced by financial institutions on their loan portfolios during our sample period. Lending syndicate chargeoffs increased during the financial crisis. Figure 4 shows that the average lending syndicate had chargeoffs around 0.2% of assets in 2007. However, by the end of 2009, this ratio had increased to 1.1% of total assets, before declining to 0.6% by 2011.

3.3 Lending syndicate health and corporate hedging programs

Anecdotal evidence indicates that many firms were forced to terminate or reduce their hedging program by their lenders during the financial crisis. In this section, we confirm this evidence by comparing lender losses on their mortgage portfolios with over-the-counter derivatives activity of client firms.

Table 2 sorts firm-years into quartiles based on time t-1 levels of lending syndicate loan chargeoffs. The second and third rows of Panel A report the frequency of hedging program terminations in the full and random samples. As shown, the frequency of hedging program terminations increase with loan chargeoffs. Firms with loan chargeoffs in the highest quartile are 2.5 times more likely to terminate their hedging program than firms in the lowest chargeoff quartile. This pattern is also present when we allow for partial reductions in the firm's hedging program. The frequency of reductions that are greater than 50% or 75% of the notional amount of derivatives increases with lender chargeoffs.

The last two rows of Panel A examine proportional changes in the total hedging amount based on observations from the random sample of hand-collected observations. Because of significant outliers in the ratio of the change in total notional amount to lagged notional amount, we focus on the median of this ratio in each chargeoff quartile. Here again, firms with lenders that face high loan chargeoffs are significantly more likely to reduce the magnitude of their hedging program. As shown, the median high chargeoff firm reduces the total notional amount of its derivative hedges by 4% compared to no change for the median firm in the low chargeoff quartile.

3.3.1 Hedging program reversals

We next examine whether hedging program reductions and terminations are reversed at some point in the future. If hedging is valuable and termination occurs because the firm's lenders restrict derivatives trading, then we expect firms to reinstate terminated hedges as soon as their lenders become financially healthy. If termination occurs because of the firm's poor fundamentals, then it is less likely that the firm will be in a position to reinstate its hedging program in the near future. Well-documented measures undertaken by the Federal Reserve and the Treasury during 2008 and 2009 rescued distressed investment banks and led to the conversion of investment banks into bank holding corporations.[11] Thus, the presence of significant reversals in hedging activity by firms with lenders with high loan chargeoffs would be consistent with a spillover effect from the lenders' mortgage portfolio to the firm rather than concerns about the firm's ability to meet future obligations tied to its derivative contracts.

As before, we sort firms into quartiles based on their syndicates' loan chargeoffs. We then measure the scaled change in notional amounts over the next two years. These changes are scaled by lagged assets expressed in market values.[12] Panel B reports these results. As shown, high loan-chargeoff firms are significantly more likely to reverse prior reductions in hedging intensity. High chargeoff (fourth quartile) firms increase their hedging programs between years t and t+2 by 6.9% of firm value, compared with a 0.88% reduction for low chargeoff firms (first quartile). Hedging program reversals are most likely to occur for interest-rate and commodity related risks. For example, interest-rate hedges increase by 4.8% for high chargeoff firms between years t and t+2, compared with a 0.5% reduction for low chargeoff firms over the same period of time. This result is consistent with the fact that interest-rate and commodity hedges are more likely than FX hedges to be set up with a financial institution (i.e. in the over-the-counter market) than on

[11] For studies of the root causes of the financial crisis, see Gorton and Metrick (2012) and Krishnamurthy, Nagel and Orlov (2014) among others.

[12] We use market values instead of notional amounts to scale future changes because prior notional amounts equal zero for firms with terminated hedging programs.

an exchange.[13] Overall, the presence of hedging reversals rules out declines in firm fundamentals as the reason for the association between hedging program terminations and lending syndicate loan chargeoffs.

3.4 Financially constrained vs. unconstrained firms

Financially distressed lending syndicates may first cut back on hedging services with respect to their riskiest customers as these customers consume the most capital on the bank's balance sheet. If banks sort their clients into such a hierarchy, we expect that higher rated client firms (investment grade firms) will fare better than lower rated firms (below investment grade) and unrated firms in this dimension.

In order to tests this hypothesis, we split the sample into investment and below-investment grade firms because a large literature indicates that the presence of an investment-grade rating is correlated with access to financial markets (see Faulkender and Petersen 2006 among others). We group below investment grade firms and firms without a credit rating into one group, which we label non-investment grade firms. There are 106 investment-grade firms and 292 non-investment grade firms.[14] Panel C of Table 2 reports termination frequencies as well as percentage changes in notional amounts of derivatives for both types of firm. As shown, the association between loan chargeoffs and termination frequencies is strongest among non-investment grade firms, with the difference in termination frequencies between the two extreme chargeoff quartiles significant at the 10% level of confidence. The median change in notional amounts are smaller in the high chargeoff quartile than in the low chargeoff quartile, with the median firm in the former quartile experiencing an 11% reduction in hedging activity. In contrast, investment-grade firms show no association between changes in notional amounts and lending syndicate loan chargeoffs.

3.5 Bank lending and loan chargeoffs

[13] Because many firms don't break out the notional amount by type of product (e.g. option vs. swap), but rather by type of risk (e.g. interest rate vs. FX), we report reversals by type of risk rather than by whether the product is traded over-the-counter.

[14] The sum of investment and non-investment grade firms is greater than the total number of firms due to the migration of investment grade firms to non-investment grade status over time.

We next examine if lending syndicate health affects the availability of corporate liquidity through lines of credit. Credit lines may be withdrawn or revoked by the firm's lenders following a covenant violation. In practice however, these covenants are often waived by the firm's lenders (Roberts and Sufi 2009), and existing evidence suggests that such was the case during the financial crisis (Campello *et al.* 2011a). In order to investigate how access to credit lines varied with lending syndicate health, we sort firms by lending syndicate chargeoffs and measure the frequency of credit line revocations and the average percentage change in total lines of credit by chargeoff quartile. Table 3 reports these results. We find no association between lending-syndicate chargeoffs and the supply of lines of credit, measured with total lines of credit. Chargeoffs are not associated with higher credit-line revocation frequencies, nor are they associated with larger proportional changes in total lines of credit. However, firms in the low chargeoff quartile are significantly more likely to draw down existing lines of credit, and investment-grade firms are equally likely to do so as non-investment grade firms (see Panel B).

IV. Hedging program termination and corporate liquidity policies

Hedging may complement or substitute for existing liquidity policies. We examine this question by measuring the effect of hedging program termination on the firm's liquidity policy. Liquidity is measured along three dimensions: 1) total line of credit, 2) credit line drawdowns, and 3) the firm's propensity to save cash out of realized cash flows. Because lines of credit, cash balances and hedging intensity are jointly determined, we base this part of the analysis on instrumental variable estimates of hedging program termination.

We instrument the decision to terminate the firm's hedging program by exploiting time-series and cross-sectional variation in the availability of derivative trading with the firm's lending syndicate members. Both lending and over-the-counter derivatives necessitate bank capital, and banks are likely to ration this capital when they experience funding liquidity shocks themselves. We expect banks who experience large losses on their mortgage portfolios during the financial crisis to be more likely to ration their derivatives or

to force firms to terminate their hedging programs because of capital constraints, or as a condition for preserving access to short-term lending.

The identifying assumption in the instrumental variable analysis is that mortgage-related losses experienced by the firm's lending syndicate are uncorrelated with corporate liquidity policies after controlling for firm profitability, net worth, firm sales, and the firm's credit rating. We measure mortgage-related losses incurred by the firm's lending syndicate with syndicate member loan chargeoffs (CHARGEOFF). We also include various measures of lending syndicate financial health as instruments: LIQU measures the bank's liquid assets as a proportion of total assets; EQCAP measures the bank's capital ratio; TRN measures the proportion of transaction deposits to total assets; and TRNSq is the square of TRN. We consider transaction deposits because of the imperfect correlation between consumer demand for deposits and corporate demand for liquidity (see Kashyap, Rajan and Stein 2002 and Gatev and Strahan 2009). All of the syndicate level measures are computed by taking the average ratio across all syndicate members in each year.

We present first-stage estimates of the effect of lending syndicate health on hedging program termination with the following multivariate model of hedging activity.

$$Hedging\ program_{it} = a + b_1 LIQU_{it} + b_2 TRN_{it} + b_3 TRN_{it}^2 + b_4 EQCAP_{it} + b_5 CHARGEOFF_{it} + cX_{it-1} + Rating_{it-1} + s_t + \varepsilon_{it} \qquad (1)$$

The variable *Hedging program* is defined as follows. In some specifications, this variable equals the ratio of Notional amounts (aggregated across all derivative positions) to total sales (Notional/SALE). In our main specifications, the dependent variable takes on a value of one in the year of the event (a large decline in notional amount), and in each of the consecutive years following the event without a reversal in hedging activity. A reversal occurs whenever there is an increase in hedging activity of 100% or more following a significant reduction (e.g. 50% or 75% reduction) in hedging activity. A 100% increase would

fully revert the hedging program to its pre-reduction amount following a 50% decline. For complete terminations the dependent variable equals one in the first year without hedging and in the following consecutive years in which the firm does not reinitiate its hedging program. The consecutive years between the initial reduction or termination and the subsequent reversal form a spell. Table 1 reports summary statistics on these variables. As shown, approximately 11% of firm-years belong to a spell of reduced hedging activity triggered by a 50% or greater reduction in hedging. Such spells are triggered 5.2% of the time, and the average duration of such spells is 2.5 years. As we increase the severity of the reduction, both the frequency of belonging to a spell year and of triggering a spell decline.

We split the sample into investment and non-investment grade firms, and run equation (1) on each subsample. Results are reported in Table 4. All reported regressions condition on having a hedging program in the 2007 fiscal year. All variations of this equation control for firm size (a known predictor of hedging activity), firm profitability, net worth, firm value (measured with the market-to-book ratio), cash-flow volatility, asset tangibility, and year fixed effects. Panel A regressions include categorical variables measuring whether the firm is investment grade or unrated (Rating FE).[15]

As shown, the effect of chargeoffs on the different measures of hedging activity is significant in the subsample of non-investment grade firms reported in Panel A, but insignificant in the subsample of investment grade firms reported in Panel B. Focusing on non-investment grade firms, mortgage-related losses are negatively associated with hedging activity, with a one standard deviation increase in chargeoffs leading to a 2.9% increase in the probability of any given year belonging to a spell of 50% or greater reduction in hedging activity (column 2, Panel A). The magnitude of the reduction is roughly half of the effect of net worth on hedging program termination. A one standard deviation increase in this variable reduces the probability of a large reduction in hedging activity by 4.7%. We can also gauge the economic significance of chargeoffs on hedging activity by comparing the effect to the average probability of any

[15] We also consider using individual rating dummies. However, in several cases these rating categories completely determine the hedging outcome, which precludes the use of binary choice models for estimation.

given year belonging to a hedging reduction spell. On average the likelihood of any given year belonging to a spell triggered by a 50% or greater reduction is approximately 11%. Thus, a one standard deviation increase in chargeoffs implies a 26% (=0.029/0.11) increase in the relative likelihood of reduced hedging activity. The first-stage Chi-square-statistic for joint instrument significance (last row) reveal that our measures of lending syndicate health are jointly significant in the termination regressions. For example, the test for joint significance for complete termination of the hedging program has a p-value of 0 (column 4).

4.1 Hedging program reversals

In order to provide additional evidence for the derivatives desk channel, we examine the impact of lending syndicate chargeoffs on hedging program reversals following 50% or greater reductions in hedging activity among unrated and below investment grade firms. If lending syndicate losses precipitate a decline in hedging activity, then firms whose lending syndicate continues to experience losses following the reduction in hedging activity should be less likely to reverse these declines by increasing hedging activity in subsequent years. We test this idea by defining a binary variable equal to one whenever the annual increase in total notional amount is greater than a given threshold (e.g. 0%, 50%, or 75%) following a reduction in hedging activity. We label these events reversals. As shown in the Appendix (Table A5), higher lending syndicate chargeoffs reduce the likelihood of a hedging program reversals, providing further support for the derivatives desk channel.

4.2 Instrumental variable estimates

Since investment-grade firms are not subject to rationing by their lenders, we base the instrumental variable analysis on the subsample of non-investment grade firms. We use the fitted value $\widehat{termination}_{ut}$ from a linear probability model estimate of equation (1) to test the effect of hedging program termination on corporate liquidity policies. The identifying assumption is that lending syndicates that experience a given level of chargeoffs are equally likely to target all firms in the subsample of non-investment grade firms for

hedging program reduction after controlling for firm profitability, firm size, net worth, firm value (measured with the market-to-book ratio), and firm rating status (rated or not rated).

In order for the IV strategy be valid, loan chargeoffs must only affect firms through the derivatives channel as opposed to a lending channel after controlling for firm characteristics and whether the firm has a credit rating. We rule out any direct influence of loan chargeoffs on the supply of short-term and long-term credit. If it is the case that chargeoffs affect short- or long-term credit other than through the hedging channel, then the exclusion criterion described above will not hold. We address this issue by examining the association between annual changes in total lines of credit and total debt, CHARGEOFFS, and the bank liquidity ratios: LIQU, TRN, TRNSq, and EQCAP. For brevity, we report these results in the Appendix. As shown in Table A4, F-tests for the joint significance of these variables in the credit line and debt change regressions are not significant. Overall the F-tests indicate that the bank IV's are not significantly related to changes in the availability of credit lines or the total amount of debt.

4.3 Credit line revocations

We first examine the effect of loan chargeoffs on credit line revocations. Credit line revocations are defined as a large decline in total lines of credit. We consider different thresholds for reductions in lines of credit (50%, 75% and complete). If hedging and lines of credit are complementary, then we expect to see firms that lose access to their hedging program to also experience declines in their total line of credit. If hedging and lines of credit are substitutes, then firms that experience the loss of their hedging program will be more likely to preserve access to their credit line facilities.

Before reporting the IV estimates of the impact of hedging program termination on lines of credit, it is worth considering the OLS estimates, and whether we expect them to be lower or greater than the IV-based estimates. Columns (1)-(3) of Table 5 report OLS estimates of credit line revocations. The estimates are based on a linear probability model in which the dependent variable equals one if a credit line is reduced or completely revoked in year *t*, and zero otherwise. The sample is based on firms that have a hedging

program in 2007. All models also include firm controls, year fixed effects, rating fixed effects, and the firm's lagged liquidity ratio (LR, equal to the ratio of total lines to the sum of total lines and cash) as a control variable. As shown, OLS estimates are positive but not significant.

How might the instrumental variable estimates differ from these OLS estimates? If there is endogeneity, the sign of the bias in the OLS coefficients can either be positive or negative (Jiang 2017). Under affirmative endogeneity (SignBiasOLS>0), OLS regression coefficients over-estimate the effect of termination on access to credit lines because the loss of the firm's credit lines causes a decline in the firm's hedging program, i.e. there is reverse causality. For example, distressed firms may lose access to their lines of credit, which then leads to a reduction in the firm's hedging program. Under corrective endogeneity (SignBiasOLS<0), OLS estimates are too small and underestimate the effect of hedging program termination on access to lines of credit. Such would be the case if distressed lenders select only the best firms to cut back on hedging activity in order not to push their financially constrained customers into default on their loan commitments with the lender.

Columns (4)-(6) report IV-based estimates. The first row of estimates shows that for non-investment grade firms with a hedging program in 2007, termination of the firm's hedging program reduces the likelihood that the firm's line of credit is revoked by its lending syndicate. Estimation result indicate the presence of corrective endogeneity, as the estimates are significantly negative and larger in absolute value than the corresponding OLS estimates. For example, based on column (4) estimates, the likelihood of a 50% reduction of the firm's line of credit falls by 22% following the termination of the firm's hedging program. We obtain similar results using a 75% threshold for credit line reductions, and for complete revocations. This result is inconsistent with a credit-supply based explanation. Rather, it is consistent with prior evidence in Campello *et al.* 2011a that lenders did not invoke Material Adverse Change clauses that would have permitted them to cut back on promised lines of credit.

These results also show that corporate liquidity through credit lines does not seem affected by the loss of the firm's hedging program. In fact, firms that terminate their hedging program are more likely to

maintain access to lines of credit. The result is open to several non-mutually exclusive interpretations. First, lenders may have been concerned about causing further distress in firms for whom they rationed hedging services, and kept the credit line in place as a lifeline to the firm (as argued in Gatev and Strahan (2009) lending institutions have a comparative advantage in offering corporate liquidity in the form of credit lines). Second, lender capital may have been rationed by the firm's lending syndicate members. According to this explanation, terminating the hedging program would permit the borrowing customer to maintain its access to short-term liquidity with its bankers. This trade-off could arise if cutting back on the firm's hedging program is a condition for maintaining access to existing lines of credit. In this case, collateral-poor firms pro-actively terminate their hedging relations in order to preserve access to credit lines. Such a situation might occur if the firm were financially constrained and both types of activities require collateral. For example, in Rampini, Sufi and Viswanathan (2014) firms have to "choose" between lines of credit and hedging, and opt to sacrifice their hedging programs in favor of debt.

4.4 Credit line drawdowns

Having established that firms do not lose access to their lines of credit following the loss of their hedging program, we next investigate whether these firms are more likely to draw down existing lines of credit. If hedging and lines of credit both serve to insulate the firm from liquidity shocks, we expect firms that lose their hedging program to be more likely to draw down existing lines of credit following the loss of the hedging program. As such, drawdowns can be interpreted as a measure of liquidity demand by the firm following termination of the program.

Table 6 reports credit line drawdown IV regression estimates. The dependent variable equals the change in drawn amount scaled by total lines of credit measured at the end of the previous year. Because scaled changes in drawn amounts contain significant outliers, we winsorize this variable at the 1% level. The independent variable of interest, *Hedging program reduction*, takes on a value of 1 in the year of the

reduction and zero otherwise.[16] As explained above, we instrument this variable with chargeoffs, the bank liquidity ratio (LIQU), equity capital ratio (EQCAP) as well as transaction deposits (TRN, TRNSq). As shown, the effect of a hedging program reduction of at least 50% on credit line drawdowns is positive and statistically significant (column 1). We obtain similar results using a 75% cutoff for reductions in the firm's hedging activity, as well as complete terminations of the firm's hedging program (column 3). Hedging program reductions appear to force firms to rely on credit lines as an alternative source of liquidity.

An interesting feature of the financial crisis is that some firms drew down their lines of credit for strategic reasons. Ivashina and Sharfstein (2010) provide some anecdotal evidence by reporting management's discussion and analysis for the drawdown of existing facilities. Campello, Graham and Harvey (2010) show, using survey evidence, that strategic considerations played a part in explaining credit line drawdowns. We cannot fully exclude this explanation for our results. However, credit line drawdowns that are motivated by the strategic reasons described in these papers are predicted to occur in both investment-grade and non-investment grade firms. In unreported results, we find that this is not the case, as drawdowns are unrelated to hedging program reductions in investment-grade firms.

4.5 Cash-flow sensitivity of cash

Cash is costly for constrained firms because saving requires these firms to postpone current investment in order to provide for a rainy day. Since firms with an active hedging program are less likely to be constrained in the future, they should therefore save less cash as a proportion of cash flows. Conversely, the loss of the firm's hedging program should lead to an increase in the sensitivity of cash balances to realized cash-flows. In this section, we investigate whether firms respond to the termination of their hedging program by saving a greater proportion of realized cash flows as cash around the reduction or termination of their hedging program.

[16] Termination has no effect on credit line drawdowns in the years following termination.

We test this prediction by estimating the change in the cash-flow sensitivity of cash following a material reduction in the firm's hedging program. We estimate the following regression, which is based on Campello, Almeida and Weisbach (2004).

$$\Delta Cash_{it} = a + b\ Cashflow_{it} + c\ Cashflow \times Hedging\ program\ reduction_{it} + d\ Hedging\ programm\ reduction_{it} + e\ Controls_{it} + d_t + u_{it} \quad (2)$$

The variable *Cashflow* equals operating income before depreciation minus dividends, all scaled by total assets. The loss of a hedging program is predicted to increase the firm's sensitivity of cash flow, measured by the coefficient c on the interaction term between $Cashflow$ and $Hedging\ program\ reduction$. *Hedging program reduction* equals one in the year of a significant reduction in notional amount and in each of the following years without a reversal in hedging activity. The set of control variables includes firm size, the firm's market to book ratio, the change in short-term debt, the change in net working capital, capital expenditures and acquisitions. All variables are scaled by firm assets. We estimate this regression on the subsample of non-investment grade firms. As before, in order to ensure that the change in the sensitivity of cash to cashflows around hedging program termination is not related to changes in the firm's financial condition, we instrument *Hedging program reduction* with measures of lending syndicate health. The interaction term is instrumented with the interaction between cashflows and LIQ, TRN, TRNSq, EQCAP and CHARGEOFF. The scaled acquisition expense (*Acquisition*) and capital expenditure (*Expenditures*) variables in the set of controls are instrumented with their own lagged values. We also include two lags of each of the logatrithm of market to book, short-term debt, net working capital, asset tangibility (defined as net property, plant and equipment over total assets), inflation-adjusted sales and sales growth. We employ GMM in order to exploit the fact that regression error terms are correlated within firm by allowing the weighing matrix to account for clustered errors by firm.

We report results for these tests in Table 7 for both the random and full samples.[17] Control variables have the expected signs. Changes in net working capital (net of cash) have a negative effect on cash balances, as do acquisitions and capital expenditures. The variable of interest, *Cashflow X Hedging program reduction*, is uniformly significant across all three specifications and in both the random and full samples. Both random full-sample based estimates reveal that hedging program reductions that are 50% or greater have a positive and statistically significant effect on the cash-flow sensitivity of cash. For example, column (1) shows that for reductions in total hedging greater than 50% of the total notional amount, the sensitivity of cash to cash flows increases by 0.74. Thus for each dollar of additional cash flow (scaled by assets), firms that reduce their hedging activities save approximately 74 cents. Overall, and in line with our predictions, these estimates indicate that financially constrained firms significantly increase their propensity to save out of cash flows following the termination of their hedging program.

V. Hedging program termination and firm value

The previous sections establish a link between hedging program termination and access to corporate lines of credit, credit line drawdowns and corporate saving rates. The substitution of different forms of liquidity following the reduction or termination of corporate hedging program suggests that firms can mitigate the negative impact of the loss of their hedging program on firm value. However, the loss of an additional liquidity management tool may affect firm values at the margin since firms may be moving from first-best to second-best choices. Accordingly, we next investigate how hedging program status affects firm value.

5.1 Instrumental variable estimates

[17] We also consider the full sample for this test as it does not rely on hand-collected data for estimating the dependent variable.

We explore the impact of hedging program termination on firm value in the context of a lagged dependent variable instrumental variable (IV) estimation framework. Specifically, we wish to obtain unbiased estimates of the coefficient β in the following model.

$$y_{it} = \alpha + \beta_1 y_{it-1} + \beta_2 \times Termination_{it} + \gamma X_{it-1} + d_t + Rating_{it-1} + \varepsilon_{it} \qquad (3)$$

where y_{it} is a measure of firm value. This model is attractive because the lagged dependent variable y_{it-1} allows possible feedback effects between hedging program termination and firm value. In contrast, fixed-effect estimators may underestimate the effect of hedging program termination on firm value when risk management is positively correlated with past market-to-book ratios (Angrist and Pischke 2009).

Because hedging program terminations are correlated with firm value, profitability and financing policies, obtaining an unbiased estimate of β_2 is difficult in an Ordinary Least Squares (OLS) setting. We employ two different strategies to overcome this difficulty. The first uses the instruments described in Section 4 to infer the impact of hedging program termination on firm value in an instrumental variable framework. We also employ a dynamic panel estimates of equation (3) that exploit the fact that the firm's history prior to hedging program termination is predetermined (dynamic panel estimates).

We first consider OLS-based estimates. We concentrate on complete terminations of hedging programs, as these are most likely to significantly affect firm value. As shown in the first column of Table 8, the impact of hedging program termination on firm value (measured with the natural logarithm of the MB ratio) in non-investment grade firms is associated with an 7% loss in firm value. This finding provides some preliminary evidence that hedging programs are of some value to firms. Full sample estimates, reported in column (2), are half the magnitude and less significant, most likely because of the higher error rate in the attribution of hedging status based on an automated textual search.

Next, as in the preceding section, we instrument the decision to terminate a hedging program with the measures of lending syndicate health (CHARGEOFF, LIQU, TRN, TRNSq, and EQCAP). The identifying assumption is that measures of lending syndicate health are unrelated to firm value after

controlling for firm characteristics, firm, a rating dummy, and year effects. Column (3) reports second-stage estimates of the IV specification for non-investment grade firms. As shown, firm value decreases by 25% for below-investment grade firms as a result of hedging program termination; this estimate is significant at the 10% level of confidence. This effect is also several times the magnitude of the OLS estimate, yielding two possible interpretations.

The first interpretation of this result is that the instrument is valid and the difference between estimators is due to corrective endogeneity. The second is that the instrument violates the exclusion criteria and weakly covaries with hedging program termination. As described in Jiang (2017), the latter scenario would yield IV estimates that are orders of magnitude larger than OLS estimates, as would be the case if the result is driven by the credit-supply channel. While the latter explanation is plausible, the fact that we are able to reject the null hypothesis of weak instruments cast some doubt on this explanation (see Wald tests reported in Table 4). As mentioned above, another consideration is that lenders did not invoke Material Adverse Change clauses nor did they revoke corporate lines of credit during the financial crisis (see Campello *et al.* 2011a), thus limiting the extent to which the supply of liquidity to corporations was reduced by restricting access to credit lines. This explanation is consistent with our earlier results that show little relation between lender health and corporate lines of credit. However, we cannot rule out the case that the IV results are due to a combination of weak instruments and a violation of the exclusion criteria. We thus consider an alternative estimator in the next section that does not rely on measures of lending syndicate health to identify the termination event.

5.2 GMM dynamic panel specification

We investigate the impact of hedging status on firm value in the context of a dynamic panel model proposed by Arellano and Bond (1991). The implementation of this methodology is based on Wintoki, Linck and Netter (2012). The advantage of this method is that it does not require finding an exogenous source of variation to identify hedging activity. Instead it relies on a weaker assumption, namely that hedging activity is pre-determined relative to firm value (see Wooldridge 2010 for a discussion of this

condition). This assumption requires that past measures of hedging be uncorrelated with future shocks to firm value that were not anticipated when current and past hedges were maintained or put in place. More specifically, consider the following regression of firm value on hedging activity,

$$y_{it} = \alpha + \sum_{s=1}^{p} \beta_s y_{it-s} + \delta \times Termination_{it} + \gamma X_{it} + d_t + \eta_i + \varepsilon_{it} \qquad (4)$$

where $Termination$ is a measure of hedging activity equal to one in the year of and in the years following the termination of the firm's hedging program, X_{it} is a vector of firm-level variables, η_i is a firm fixed effect, and d_t is a year fixed effect. Under the assumption mentioned above, consistent estimates require that $E[Termination_{it-s}\varepsilon_{it}] = E[X_{it-s}\varepsilon_{it}] = E[y_{it-s}\varepsilon_{it}] = 0$ for $s > p$. These conditions mean that the firm's history beyond p time periods is exogenous with respect to any shocks to firm value in current and future periods. Any effect of history beyond time $t - p$ on current value occurs only through its influence on current firm characteristics and hedging status. This condition seems plausible, as managers are unlikely to be able to predict future unexpected shocks to firm value after taking into account firm characteristics and current and past levels of firm value when determining the firm's hedging program. Given the short time series of our panel, we use two lags of the dependent variable and set $p = 2$. In estimating the system, we also employ the original set of moments proposed by Arellano and Bond (1991), namely, $[\Delta Termination_{it-s}(\varepsilon_{it} + \eta_i)] = E[\Delta X_{it-s}(\varepsilon_{it} + \eta_i)] = E[\Delta y_{it-s}(\varepsilon_{it} + \eta_i)] = 0$ for $s > p$.

The additional advantage of this formulation is that it allows the inclusion of firm fixed effects η_i in order to control for unobserved time-invariant heterogeneity that is correlated with hedging status.[18] In terms of the relation between hedging and value, omitted unobservable variables are likely to be present as we do not observe all of the factors that go into the firm's hedging decision. For example, we do not observe the firm's offshore activities, which may influence its decision to engage in financial hedges (see Hoberg and Moon 2017).

[18] Firm fixed effects lead to biased estimates in the standard within fixed-effect estimator with lagged dependent variables (see Arellano and Bond 1991).

Estimates of the valuation equation (4) are reported in columns (5) and (6) of Table 9. Our specification tests for the random sample confirm that the identifying assumptions are met in this sample. As shown, the Sargan tests of moment exogeneity cannot reject the null that all the moment conditions are met. More importantly, given the short-panel nature of our data, the model seems to satisfy the assumption of sequential exogeneity. As predicted, we cannot reject the null hypothesis of no serial correlation in second-differenced errors, which suggests that setting the number of lags to $p = 2$ is the correct specification.[19]

The variable of interest is $Termination$. The estimate corresponding to this variable is significantly negative in column (5), indicating that the loss of the firm's hedging program reduces firm value by over 27%. The magnitude is almost the same as that obtained using the lending syndicate-based instruments in column (3). We also estimate the dynamic panel model on the full sample. As shown in column (6), full-sample estimates imply that hedging termination causing a 27% reduction in firm value.

The absolute magnitude of estimates obtained using both identification strategies are larger than increases in firm value observed around the initiation of hedging programs, which range between 10-15% of firm value (see Allayannis and Weston 2001 and Carter, Rogers and Simkins 2006). Part of the difference may be due to different estimation methods. However, we suspect that most of the discrepancy can be explained by time-series variation in the benefits of hedging; our sample is particular in that it coincides with a deep contraction in economic activity. The asymmetry in value effects observed in earlier studies around initiations and in our study around terminations, suggests that firms' hedging programs are most beneficial when firms are financially constrained or distressed. The loss of a hedging program matters most when the firm is experiencing a liquidity shock, as was the case for our sample. In comparison, hedging program initiations are typically undertaken by firms that are financially unconstrained, and during periods

[19] See Wintoki, Linck and Netter (2012) for a more detailed discussion of the logic behind the AR-1 and AR-2 specification tests.

of economic expansion. An important caveat is that our estimates may over-estimate the value effects of a hedging program due to the extreme nature of the economic contraction observed during our sample period.

5.3 Pre-existing financial slack and firm value

So far we have shown that firms substitute alternative sources of liquidity such as lines of credit and cash following the loss of their hedging program. Given this substitution, the loss of the firm's hedging program may be more consequential in terms of shareholder value for firms that have already exhausted alternative sources of liquidity such as pre-existing lines of credit and available cash reserves.

We test this idea by splitting the sample of all firms (both investment grade and non-investment grade firms) according to the ratio of the drawn amount of their credit line to the sum of total line of credit and cash reserves (the drawdown to total liquidity ratio) as of the prior year. We keep firms in the top and bottom terciles of this ratio. Intuitively, this ratio represents how much pre-existing liquidity (in the form of lines of credit and cash reserves) has been used up prior to the loss of the firm's hedging program. We then run the value regression (3) separately on each subsample of firms, where the subsamples are defined according to the tercile breakpoints of the drawdown ratio. Results are reported in Table 9. As shown, the loss of the hedging program is inconsequential in firms in the bottom third of the ratio of drawdown to total liquidity. Value effects of the loss of the hedging program are significantly negative and of the same order of magnitude (approx. 29%) as in Table 8 for firms with limited available liquidity from alternative sources (the firms in the top tercile of the ratio of drawdown to total liquidity). These results suggest that forced termination of the firm's hedging program can be mitigated by having alternative sources of liquidity. They also suggest that firms are best served by diversifying their sources of liquidity so as to be able to fall back on alternative sources when needed.

VI. Conclusion

Our study examines corporate hedging activity during the 2007-2008 financial crisis. The financial crisis is a good setting to examine the implications of corporate hedging on other corporate policies because

firms experienced an arguably exogenous shock to the supply of hedging services by their lending syndicates. We identify forced terminations with exogenous shocks to firms' ability to hedge their risks based on their lenders' exposure to mortgage portfolio losses during the financial crisis. Our setting thus allows us to examine the relation between corporate hedging activity and corporate liquidity policies, an important question that is difficult to answer empirically.

Corporate hedging programs are fragile. We show that deteriorations in lending syndicate health due to mortgage related losses cause lenders to target their weakest customers when rationing over-the-counter hedging services. We also find that reductions and terminations of corporate hedging programs affect corporate liquidity policy along several dimensions. Firms that have their hedging program terminated are more likely to hold on to their lines of credit, which suggests that these two aspects of corporate policy act as substitutes. This finding also suggests that these firms' lenders may have been concerned about precipitating their weakest customers into bankruptcy following the loss of a hedging program. We also document a significant increase in credit line drawdowns as well as an increase in the propensity to save out of cashflows in financially constrained firms following the loss of the hedging program. Both effects indicate that firms substitute away from hedging into other forms of liquidity provision following a loss of or reduction in hedging.

The loss of the firm's hedging program also matters to the firm's shareholders: we document declines in value of the order of 25% in financially constrained firms, a magnitude larger than estimates based on initiations of hedging programs documented in other studies. An important contribution of our study is to highlight the asymmetry between hedging program initiations and terminations on firm value. We show that reductions in value from forced termination are larger in absolute magnitude than increases in value due to hedging program initiations that are typically measured in financially healthy firms. These value effects are more severe in firms with limited sources of liquidity prior to the termination event, implying that firms can insulate themselves from the loss of their hedging program by diversifying their sources of liquidity across derivatives, lines of credit and cash savings. Overall, our findings add to our

understanding of how corporate hedging policies interact with corporate liquidity policies and contribute to firm value.

Appendix A: Modified word dictionary to identify derivative users

Step 1: Webcrawl S&P 1500 10-K Filings from 2002 – 2015.

Step 2: Save lines (+/- 2) that mention the words: ‘forward contract’, 'currency exchange contract', 'foreign exchange contract', 'future contract', 'futures contract', 'option contract', 'options contract', 'rate swap', 'swap agreement', 'currency swap', 'exhange swap', 'fx swap', 'hedging instrument', 'hedge instrument'

Note: The departure from Guay is that we do not include 'derivative instrument’ or ‘derivatives instrument’

Step 3: Drop if mentions they also include the words: ‘do not’, ‘does not’, ‘not covered’, ‘did not’, ‘may’, ‘termin’, ‘periodically’, ‘historically’, 'occasionally', ‘prior’

Step 4:
Count lines that mention each of the dictionary words (but not the exclude words) for each firm year.

Step 5:
Set dictionary word mention count to 0 if they only mention that dictionary line count is equal to 1.

Step 6:
Identify as Derivative User if sum of the dictionary word line mentions across all dictionary words in a given year is greater than 1. Non Derivative user if key word mentions = 0 or 1.

Table A1: Predicted accuracy of modified dictionary

Accuracy ratios are estimates by running the Guay dictionary on a sample of 500 randomly selected firms for which we manually look up whether they are derivative users in each year of the sample beginning in 2006. The accuracy ratios are obtained by comparing the dictionary result with the original disclosures in the 10K filing.

	Details	N observations	Prop. Correct	False positives	False negatives
Baseline	Original Guay dictionary	2289	0.74	0.24	0.02
Modification 1	Drop "derivative instruments"	2289	0.78	0.19	0.03
Modification 2	Also exclude lines that have ‘do not’ ‘does not’ etc	2289	0.83	0.14	0.04
Modification 3	Exclude firms that only have 1 dictionary word line mention	2289	0.85	0.09	0.06

Table A2: Summary statistics – Full sample

This table shows summary statistics for 563 firms that are members of the S&P 1500 with matching information in COMPUSTAT and Dealscan on their loan syndicate composition in 2006 or 2007 and that engage in hedging in their 2007 fiscal year.

Variable	Description	Unit	mean	sd	p25	p50	p75	N
der_user	Hedging activity indicator	Binary	0.943	0.232	1.000	1.000	1.000	1712
SALE	Revenues deflated by 2004 CPI	Millions	9,404	22,342	1,080	2,696	6,905	1711
ROA	Return on assets	Decimal	0.135	0.088	0.094	0.132	0.174	1711
BLEV	Book leverage	Decimal	0.303	0.203	0.177	0.276	0.396	1709
MB	Market-to-book ratio of assets	Ratio	1.695	0.818	1.178	1.476	1.957	1670
CFV	Cash flow volatility	Decimal	1.822	6.377	0.186	0.289	0.524	1711
TANG	Asset tangibility	Decimal	0.278	0.225	0.106	0.202	0.399	1711
NTWRTH	Net worth (SEQ/AT)	Decimal	0.375	0.205	0.266	0.395	0.514	1711
Cash holdings	Cash and mark. Securities / assets	Decimal	0.102	0.105	0.030	0.068	0.142	1711
Cashflow	Op. income before dep. minus dividend / assets	Decimal	0.121	0.085	0.086	0.120	0.160	1709
NWC_D1	Change in ratio of net working capita (net of cash) over assets	Decimal	-0.001	0.042	-0.018	0.000	0.017	1624
Shortdebt_D1	Change in ratio of short term debt over assets	Decimal	-0.001	0.051	-0.010	0.000	0.007	1711
Expenditures	Capital expenditures over assets	Decimal	0.046	0.049	0.018	0.032	0.054	1706
Acquisitions	Acquisition over assets	Decimal	0.033	0.085	0.000	0.002	0.022	1574

Table A3: Pearson correlation coefficients

This table reports Pearson correlation coefficients between firm-level variables used in the empirical analysis. Variable definitions are reported in Table 1. The number in parentheses represent p-values for tests of significance of each correlation estimates. Correlation estimates are based on the random sample reported in Table 1.

	der_user	totalhedge	LOC User	LR	Totalline	SALE	ROA	BLEV	MB	CFV	TANG	NTWRTH
der_user	1											
totalhedge	0.489	1										
	(0.000)											
LOC User	0.180	0.080	1									
	(0.000)	(0.001)										
LR	0.039	0.006	0.034	1								
	(0.089)	(0.815)	(0.135)									
Totalline	-0.045	-0.045	0.039	0.627	1							
	(0.047)	(0.079)	(0.086)	(0.000)								
SALE	0.134	0.047	-0.057	-0.135	-0.221	1						
	(0.000)	(0.042)	(0.006)	(0.000)	(0.000)							
ROA	-0.028	0.012	-0.022	-0.039	-0.018	0.021	1					
	(0.177)	(0.611)	(0.287)	(0.087)	(0.444)	(0.319)						
BLEV	0.219	0.273	0.156	0.359	0.161	0.010	0.046	1				
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.621)	(0.026)					
MB	-0.126	-0.043	-0.268	-0.252	-0.089	-0.031	0.544	-0.142	1			
	(0.000)	(0.072)	(0.000)	(0.000)	(0.000)	(0.154)	(0.000)	(0.000)				
CFV	-0.003	-0.022	0.014	-0.008	0.023	0.037	-0.093	0.028	-0.050	1		
	(0.877)	(0.336)	(0.514)	(0.734)	(0.314)	(0.072)	(0.000)	(0.181)	(0.022)			
TANG	0.022	-0.124	0.194	0.309	0.070	0.058	0.078	0.177	-0.152	-0.002	1	
	(0.296)	(0.000)	(0.000)	(0.000)	(0.002)	(0.005)	(0.000)	(0.000)	(0.000)	(0.930)		
NTWRTH	-0.232	-0.162	-0.248	-0.303	-0.137	-0.148	0.057	-0.753	0.210	-0.079	-0.181	1
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.006)	(0.000)	(0.000)	(0.000)	(0.000)	

Table A4: Lender chargeoffs and changes in debt

This table reports F-tests of the joint significance of the bank IVs: CHARGEOFF, LIQU, TRN, TRNSq, EQCAP. Each row reports the p-value for the F-statistics for one regression model. The dependent variables are the change in total lines of credit scaled by lagged assets, or the change in total debt, scaled by lagged assets. The bank IV variables are described in Table 1. All specifications include controls for firm value, size, profitability, networth, cash flow volatility and asset tangibility. Year fixed effects are also included. Standard errors are clustered by firm.

Dep. Variable	Sample	Type of firm	F-test (p-value)	N	AdjRsq
Ch. Total line of credit	Random	All	0.415	551	0.051
		Inv. Grade	0.571	213	0.000
		Non inv. Grade	0.771	338	0.081
Ch. In total debt	Random	All	0.392	639	0.143
		Inv. Grade	0.060	255	0.131
		Non inv. Grade	0.545	384	0.190
Ch. In total debt	Full	All	0.169	1438	0.123
		Inv. Grade	0.302	498	0.063
		Non inv. Grade	0.080	940	0.159

Table A5: Hedging program reversals

This table examines the effect of loan chargeoffs on the propensity to engage in hedging reversals following a 50% or greater reduction in hedging activity. The dependent variable is binary and equals one whenever the annual change notional face value of derivatives is greater than 0% (column 1), 50% (column 2), or 75% (column 3) following a significant reduction in hedging activity (i.e. greater than 50%). The sample consists of below investment grade and unrated firms. All regressions condition the sample on having a hedging program in 2007. All regression have firm controls, and year fixed effects. Rating fixed effects (Rating FE) indicate whether the firm is below investment grade or unrated. Standard errors are in parentheses and they are clustered by firm.

Reversal greater than:	0%	50%	75%
	(1)	(2)	(3)
CHARGEOFF	-3.302**	-3.285*	-4.944***
	(1.486)	(1.799)	(1.424)
LIQU	-7.458	-2.260	-14.761
	(10.297)	(6.764)	(10.379)
TRN X 100	-0.654	-1.784*	-1.276
	(1.120)	(0.991)	(1.010)
TRNSq	0.061	0.134**	0.101**
	(0.069)	(0.060)	(0.048)
EQCAP	-31.916**	-30.815**	-32.629*
	(14.366)	(13.363)	(17.552)
Firm controls	Yes	Yes	Yes
Model	Logistic	Logistic	Logistic
Year FE	Yes	Yes	Yes
Rating FE	Yes	Yes	Yes
N	275	275	275
N Firms	99	99	99

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Figure 1A: Hedging activity and lending syndicate chargeoffs - Investment grade firms

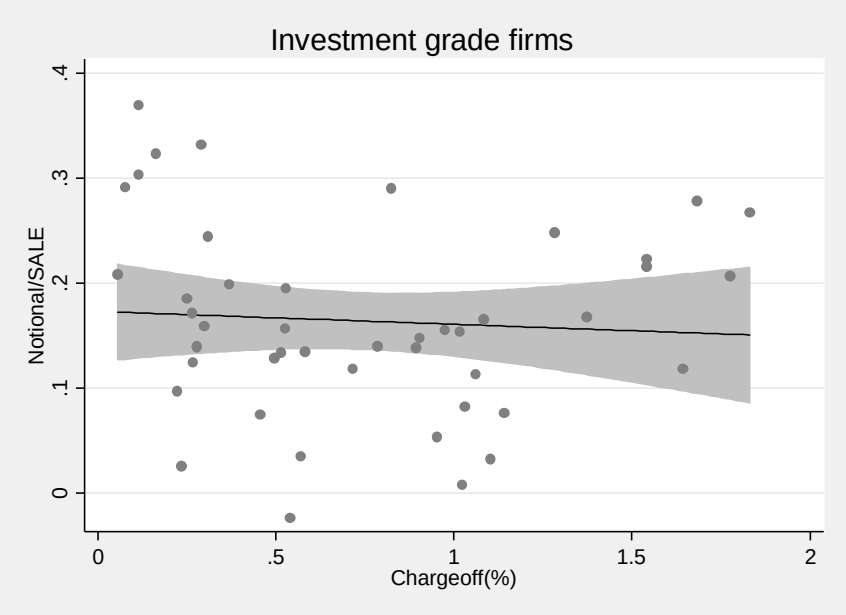

Figure 1B: Hedging activity and lending syndicate chargeoffs - Non-investment grade firms

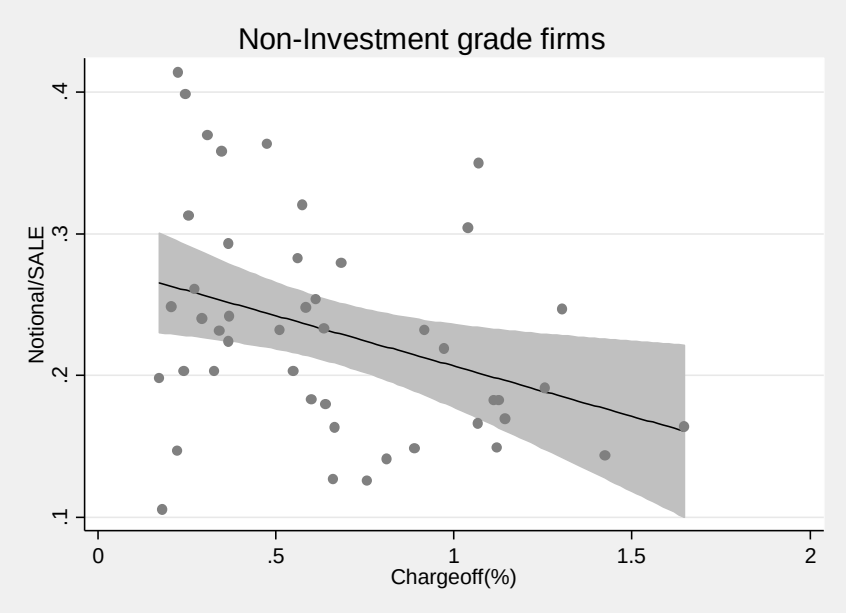

Figure 1 reports the relation between hedging and syndicate loan chargeoffs for investment and non-investment grade firms. The plots report the residuals from a regression of Notional/SALE on the following firm characteristics: return on assets, firm size, cash-flow volatility, market-to-book ratio, asset tangibility, Altman Z-score, R&D over sales, networth ratio, and year dummies. The x-axis measures loan syndicate loan chargeoffs over assets averaged over syndicate members.

Figure 2A: Random sample

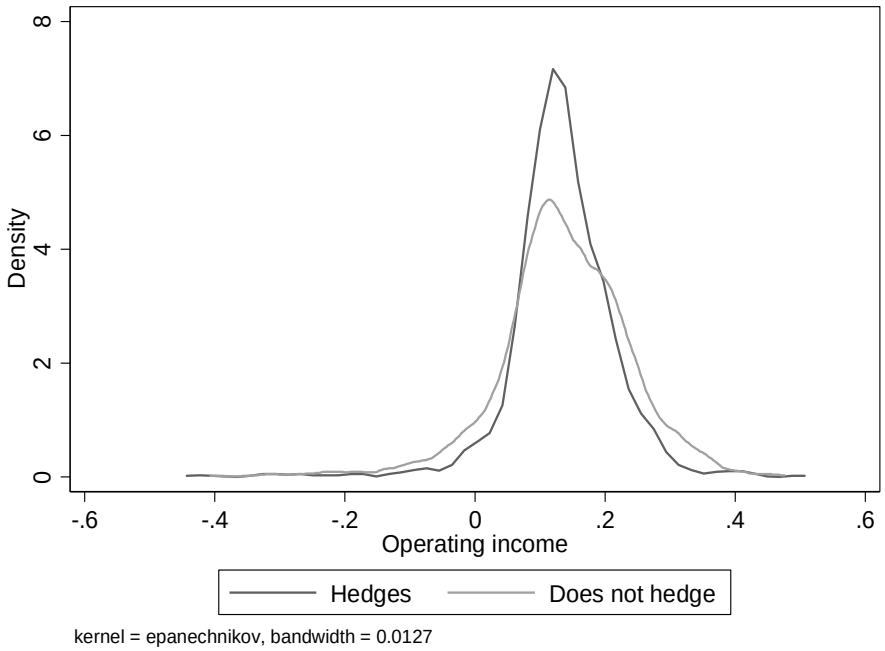

Figure 2B: S&P 1500 sample (full sample)

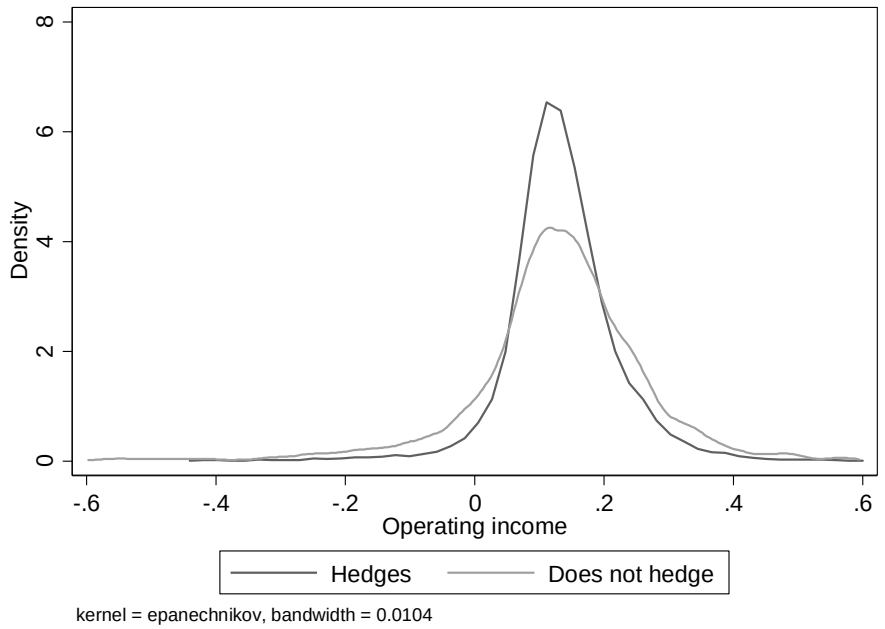

Figure 2 reports kernel density estimates of the distribution of operating income for hedging and non-hedging firms. In Figure 1A hedging firms are identified by reading the 10-K filings of 499 randomly chosen firms. In Figure 1B, hedging firms are identified among the S&P 1500 members with a webcrawl algorithm. The Kolmogorov-Smirnov test statistic for equality of distributions between hedgers and non-hedgers rejects the null of equality in both figures at the 1% level of confidence.

Figure 3A: Hedging activity

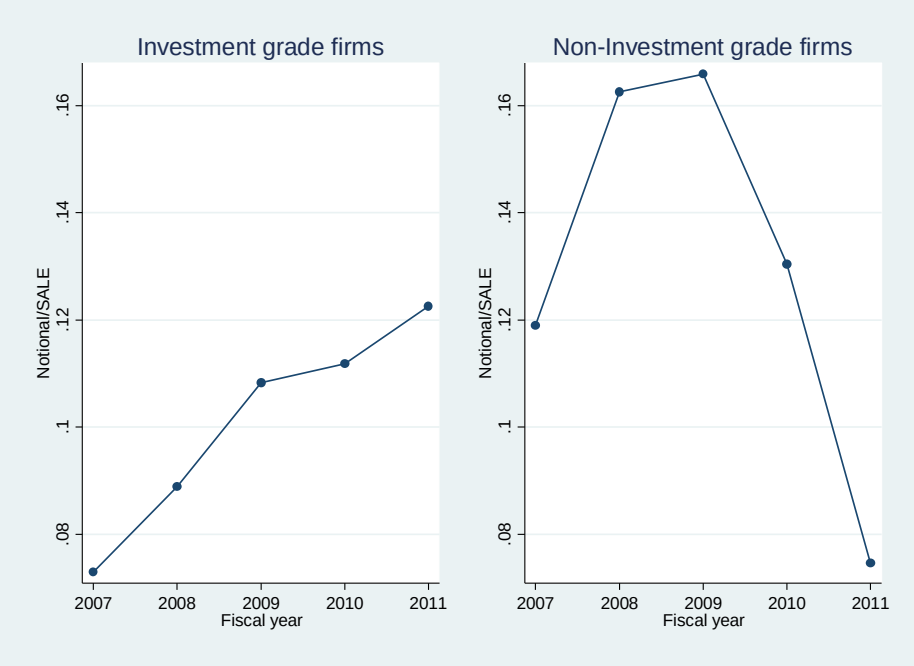

Figure 3B: Lines of credit

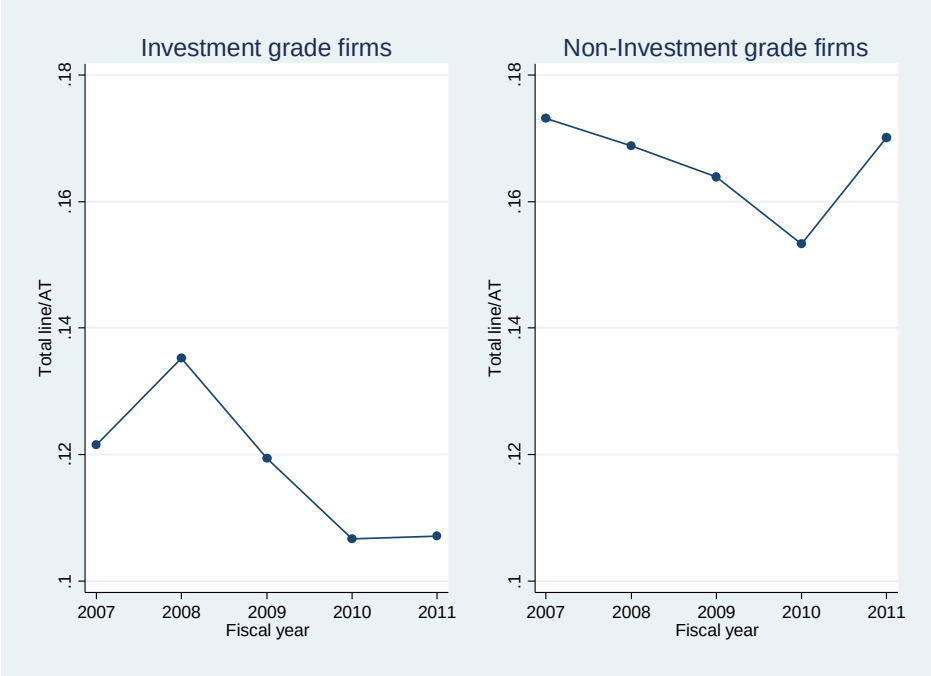

Figure 3 reports the average of the ratio of Notional/SALE and Total line/AT for investment grade and non-investment grade by year. Notional represents the sum of hedging notional amounts across interest, foreign-exchange and commodity derivatives. Total line is the total line of credit amount taken from firms' 10-K filings.

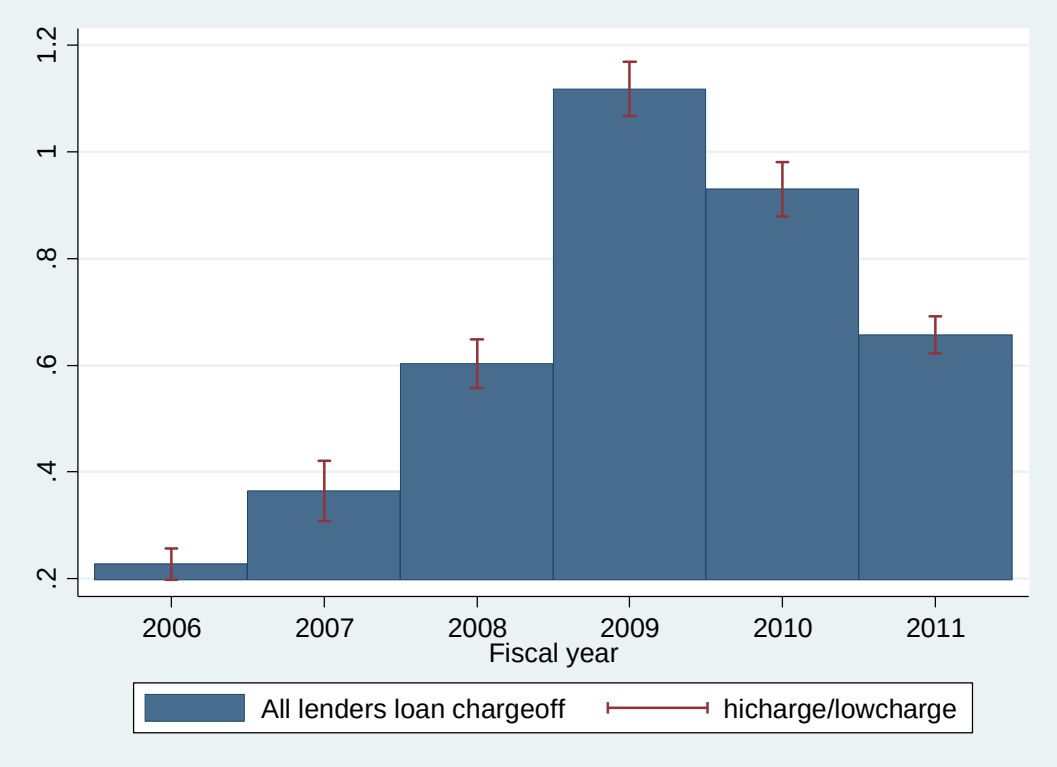

Figure 4 reports average loan chargeoffs for sample firm lending syndicates by year. Chargeoffs are divided by lending institution assets and averaged over syndicate members in each year. The figure reports the average (in %) of this number in each year. Hicharge/lowcharge indicates a 95% confidence interval around the mean.

Table 1: Summary statistics – Random sample

This table shows summary statistics for 469 firms that are members of the S&P 1500 with matching information in COMPUSTAT in fiscal year 2007. The sample is based on an initial random sample of 499 firms, randomly selected from the members of the S&P 1500 index in 2007. Information on derivative usage is hand collected for fiscal years 2007-2011. Panel B reports descriptive statistics for line of credit information. Panel C reports descriptive statistics for lending syndicate financial health for firms for whom we can identify the lending syndicate in Dealscan (279 firms). Lending syndicate information provided by Dealscan is used to identify lender loan chargeoffs (CHARGEOFF) and transaction deposits (TRN), both of which are scaled by bank assets. These variables along with the ratio of marketable securities to assets (LIQU) and the banks' capital ratio (EQCAP) are obtained from Bank Call reports filed with the FDIC.

Panel A: Basic summary statistics – random sample

Variable	Description	Unit	mean	sd	p25	p50	p75	N
der_user	Hedging activity indicator	Binary	0.605	0.489	0.000	1.000	1.000	2061
INT	INT hedging activity indicator	Binary	0.312	0.464	0.000	0.000	1.000	2059
FX	FX hedging activity indicator	Binary	0.402	0.490	0.000	0.000	1.000	2056
COM	COM hedging activity indicator	Binary	0.169	0.375	0.000	0.000	0.000	2048
Notional/SALE	Ratio of total notional amount to sales	Decimal	0.072	0.135	0.000	0.002	0.092	1681
notint	Notional INT over sales	Decimal	0.036	0.088	0.000	0.000	0.021	2007
notfx	Notional FX over sales	Decimal	0.032	0.076	0.000	0.000	0.023	1912
notcom	Notional COM over sales	Decimal	0.001	0.005	0.000	0.000	0.000	1808
SALE	Revenues deflated by 2009 CPI	Millions	6,060	17,284	664	1,615	4,373	2061
ROA	Return on assets	Decimal	0.140	0.100	0.093	0.135	0.188	2061
BLEV	Book leverage	Decimal	0.208	0.195	0.046	0.186	0.312	2061
MB	Market-to-book ratio of assets	Ratio	1.799	0.942	1.206	1.538	2.077	2061
CFV	Cash flow volatility	Decimal	1.275	4.729	0.190	0.295	0.496	2061
TANG	Asset tangibility	Decimal	0.272	0.229	0.100	0.193	0.382	2060
NTWRTH	Net worth (SEQ/AT)	Decimal	0.491	0.209	0.356	0.489	0.641	2061
Cash	Cash and mark. Securities / assets	Decimal	0.152	0.155	0.036	0.099	0.225	2061
Cashflow	Op. income before dep. minus dividend / assets	Decimal	0.124	0.097	0.084	0.124	0.172	2061
NWC_D1	Change in ratio of net working cap.(net of cash)/assets	Decimal	-0.001	0.043	-0.019	0.001	0.020	2026

Shortdebt_D1	Change in ratio of short term debt / assets	Decimal	-0.001	0.047	-0.004	0.000	0.003	2061
Expenditures	Capital expenditures over assets	Decimal	0.050	0.051	0.019	0.032	0.060	2061
Acquisitions	Acquisition over assets	Decimal	0.030	0.072	0.000	0.001	0.022	1959
Rated	Dummy: Has credit S&P long-term issuer rating	Binary	0.514	0.500	0.000	1.000	1.000	2061
Invgrade	Dummy: Investment grade rating	Binary	0.259	0.438	0.000	0.000	1.000	2061
Reduction (>50%) - event year freq.	Dummy: first year of spell	Binary	0.052	0.223	0.000	0.000	0.000	2061
Reduction (>50%) - spell years freq.	Dummy: year part of spell	Binary	0.110	0.313	0.000	0.000	0.000	2061
Reduction(>50%) - spell duration	Length in years of spell	Years	2.500	1.089	2.000	2.500	3.000	108
Reduction (>75%) - event year freq.	Dummy: first year of spell	Binary	0.037	0.189	0.000	0.000	0.000	2061
Reduction (>75%) - spell years freq.	Dummy: year part of spell	Binary	0.069	0.253	0.000	0.000	0.000	2061
Reduction(>75%) - spell duration	Length in years of spell	Years	2.276	1.138	1.000	2.000	3.000	76
Termination - event year freq.	Dummy: first year of spell	Binary	0.029	0.168	0.000	0.000	0.000	2061
Termination - spell years freq.	Dummy: year part of spell	Binary	0.056	0.231	0.000	0.000	0.000	2061
Termination - spell duration	Length in years of spell	Years	2.250	1.068	1.000	2.000	3.000	60

Panel B: Summary statistics on lines of credit data

Variable	Description	Unit	mean	sd	p25	p50	p75	N
LOC User	Dummy: has line of credit	Decimal	0.851	0.356	1.000	1.000	1.000	2037
Totalline	Total line / Assets	Decimal	0.166	0.126	0.075	0.133	0.227	1732
Drawn	Drawn / Assets	Decimal	0.044	0.068	0.000	0.012	0.060	1733
Undrawn	Undrawn / Assets	Decimal	0.102	0.092	0.034	0.085	0.148	2032
LR	Total line / (Cash + Total line)	Decimal	0.592	0.287	0.350	0.624	0.855	1732

Panel C: Summary statistics on lending syndicate financial health

Variable	Description	Unit	mean	sd	p25	p50	p75	N
CHARGEOFF	Chargeoffs over assets	Decimal	0.747	0.540	0.266	0.637	1.139	1002
LIQU	Marketable securities over assets	Decimal	0.163	0.139	0.082	0.145	0.189	1002
TRN	Transaction deposits over assets	Decimal	0.062	0.018	0.049	0.061	0.072	1002
EQCAP	Equity capital over assets	Decimal	0.148	0.066	0.104	0.125	0.178	1002

Table 2: Effect of lending syndicate member loan chargeoffs hedging program reductions, terminations and reversals

This table examines the effect of loan chargeoffs on the propensity to engage in derivative hedging. Both panels sort firm-years by (lagged) lending syndicate chargeoffs. Termination frequencies and the proportional change in notional amounts are reported for each chargeoff quartile. Panel B examines hedging program reversals. Reversals are measured as the average across firm-years of the two-year forward percentage change in total notional hedge amounts scaled by the lagged value of the firms' assets (measured in market value). The first row of Panel B sums up total notional amounts across INT, FX, and COM risks. The next three rows consider each type of risk separately. Panel C compares hedging program outcomes between investment and non-investment grade firms. Non-investment grade firms are comprised of unrated and rated but below investment-grade firms.

Panel A: Hedging activity

	Chargeoff quartile (Q1=Low, Q4=High)					
	Q1	Q2	Q3	Q4	Sample	Q4 vs. Q1: p-value
Chargeoff (pct.)	0.17	0.37	0.75	1.41	Random	0.00
Termination (complete) (freq.)	0.04	0.07	0.10	0.11	Full	0.00
Termination (complete) (freq.)	0.04	0.03	0.03	0.11	Random	0.05
Termination (>50% decline (freq.))	0.06	0.09	0.08	0.15	Random	0.03
Termination (>75% decline (freq.))	0.05	0.04	0.05	0.10	Random	0.14
Mean ch. in total not. (scaled by t-1 total not.)(%)	53.30	58.57	14.94	10.43	Random	0.08
Median ch. in total not. (scaled by t-1 total not.)(%)	0.00	0.23	0.00	-4.07	Random	0.14

Panel B: Hedging program reversals

	Chargeoff quartile (Q1=Low, Q4=High)					
	Q1	Q2	Q3	Q4	Sample	Q4 vs. Q1: p-value
Time (t,t+2) Ch. In total not. (pct.)	-0.88	1.11	-0.84	6.90	Random	0.01
Time (t,t+2) Ch. in total not. INT (pct.)	-0.48	-0.55	-2.06	4.84	Random	0.01
Time (t,t+2) Ch. in total not. FX (pct.)	-0.04	1.74	1.15	-0.12	Random	0.94
Time (t,t+2) Ch. in total not. COM (pct.)	-0.05	-0.06	0.02	1.44	Random	0.00

Panel C: Investment vs. non-investment grade firms

	Chargeoff quartile (Q1=Low, Q4=High)					
	Q1	Q2	Q3	Q4	Sample	Q4 vs. Q1: p-value
Investment grade firms						
Termination (complete) (freq.)	0.040	0.029	0.011	0.076	Random	0.54
Mean ch. in total not. (scaled by t-1 total not.)(%)	0.80	0.51	0.33	0.24	Random	0.23
Median ch. in total not. (scaled by t-1 total not.)(%)	8.93	4.15	5.55	9.22	Random	1.00
Non-investment grade firms						
Termination (complete) (freq.)	0.035	0.029	0.052	0.121	Random	0.06
Mean ch. in total not. (scaled by t-1 total not.)(%)	0.76	0.37	-0.05	0.10	Random	0.08
Median ch. in total not. (scaled by t-1 total not.)(%)	0.00	-0.21	-4.14	-11.02	Random	0.14

Table 3: Credit line revocations and lender chargeoffs

This table reports annual changes in credit lines (total, drawn, and undrawn) for firm years sorted by lending syndicate chargeoffs. Credit line data is manually collected from annual 10-K filings for the random sample. Each year firms are sorted by average lending syndicate chargeoffs into four groups based on the quartiles of annual syndicate chargeoffs. We then measure, for each of the four groups, the average propensity to revoke a credit line and the mean and median change in total lines of credit. The last column reports t-tests or Mann-Whitney tests for differences between the first and fourth quartiles groupings.

Panel A: All firms

	Chargeoff quartile (Q1=Low, Q4=High)					
	Q1	Q2	Q3	Q4	Sample	Q4 vs. Q1: p-value
Revocation (>50% decline)(freq.)	0.008	0.033	0.024	0.024	Random	0.301
MEAN change in TOTAL lines of credit (scaled by t-1 assets)(%)	0.33	0.49	0.24	0.68	Random	0.578
MEDIAN	0.00	0.00	0.00	0.00	Random	0.202
MEAN change in DRAWN lines of credit (scaled by t-1 assets)(%)	1.61	0.07	-0.54	-0.34	Random	0.002
MEDIAN	0.00	0.00	0.00	-0.01	Random	0.069

Panel B: Investment grade vs. non-investment grade

	Chargeoff quartile (Q1=Low, Q4=High)					
	Q1	Q2	Q3	Q4	Sample	Q4 vs. Q1: p-value
Investment grade firms						
Revocation(>50%)(freq.)	0.020	0.033	0.022	0.014	Random	0.80
MEAN change in TOTAL lines of credit (scaled by t-1 assets)(%)	0.071	0.192	0.243	0.513	Random	0.57
MEDIAN	0.000	0.000	0.000	0.000	Random	0.84
MEAN change in DRAWN lines of credit (scaled by t-1 assets)(%)	0.926	-0.417	-0.021	-0.217	Random	0.05
MEDIAN	0.000	0.000	0.000	0.000	Random	0.36
Non-investment grade firms						
Revocation(>50%)(freq.)	0.000	0.032	0.026	0.027	Random	0.17
MEAN change in TOTAL lines of credit (scaled by t-1 assets)(%)	0.522	0.665	0.232	0.735	Random	0.81
MEDIAN	0.000	0.000	0.000	0.000	Random	0.11
MEAN change in DRAWN lines of credit (scaled by t-1 assets)(%)	2.059	0.315	-0.823	-0.253	Random	0.00
MEDIAN	0.000	0.000	-0.087	-0.044	Random	0.10

Table 4: Effect of lending syndicate member loan chargeoffs on hedging propensity – investment vs. non-investment grade firms

This table examines the effect of loan chargeoffs on the propensity to engage in derivative hedging in investment and non-investment grade firms. Columns (1)-(4) are based on the random sample. Column (5) is based on the full sample. All columns condition the sample on having a hedging program in 2007. All regression have firm controls, and year fixed effects. Panel A reports estimates for non-investment grade firms, where below-investment grade and unrated firms are combined together to form the non-investment grade group. Panel B reports estimates for investment-grade firms. Standard errors are in parentheses and they are clustered by firm. The last row of each panel reports the Chi-Square test of joint significance of CHARGEOFF, LIQU, TRN, TRNSq, and EQCAP.

Panel A: Non-investment grade firms

Dep. Variable:	Notional/SALE	Reduction>50%	Reduction > 75%	Termination	Termination (full sample)
	(1)	(2)	(3)	(4)	(5)
CHARGEOFF	-0.033	0.767**	0.763*	1.042**	0.298*
	(0.028)	(0.391)	(0.463)	(0.511)	(0.179)
LIQU	0.183	-0.847	-5.658**	-6.324*	-2.159
	(0.134)	(1.547)	(2.752)	(3.405)	(1.406)
TRN X 100	0.029*	-0.817***	-0.941***	-0.759***	-0.279
	(0.017)	(0.251)	(0.238)	(0.264)	(0.203)
TRNSq	-0.002*	0.046***	0.048***	0.031	0.014
	(0.001)	(0.015)	(0.013)	(0.021)	(0.012)
EQCAP	-0.101	-2.300	-4.724	-5.134	-6.209**
	(0.249)	(4.129)	(5.746)	(7.985)	(3.127)
Firm controls	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Rating FE	Yes	Yes	Yes	Yes	Yes
Model	OLS	Logistic	Logistic	Logistic	Logistic
N	270	401	401	401	1114
Nfirms	89	116	116	116	387
AdjRSq	0.118				
Chi-Sq p-value	0.14	0.00	0.00	0.00	0.03

Panel B: Investment grade firms

Dep. Variable:	Notional/SALE	Reduction>50%	Reduction > 75%	Termination	Termination (full sample)
	(1)	(2)	(3)	(4)	(5)
CHARGEOFF	-0.051	-0.330	-1.401	-0.789	-2.285
	(0.038)	(1.057)	(2.460)	(2.783)	(1.509)
LIQU	-0.237	1.354	-29.754**	-29.867	-0.819
	(0.175)	(1.567)	(15.165)	(20.236)	(3.164)

TRN X 100	-0.097**	1.339	3.419*	2.771	4.950*
	(0.037)	(1.247)	(1.900)	(2.041)	(2.964)
TRNSq	0.006**	-0.089	-0.250*	-0.195	-0.385*
	(0.002)	(0.091)	(0.139)	(0.149)	(0.223)
EQCAP	0.406	-0.720	-5.115	1.245	-3.097
	(0.340)	(4.503)	(10.236)	(11.012)	(5.429)
Firm controls	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Model	OLS	Logistic	Logistic	Logistic	Logistic
N	188	273	273	273	613
Nfirms	61	79	79	79	206
AdjRSq	0.185				
Chi-Sq p-value	0.00	0.84	0.39	0.61	0.30

Table 5: Effect of hedging program termination on credit line revocations – multivariate analysis

This table reports OLS and instrumental-variable (2SLS) estimates of the effect of hedging program termination on credit line revocations. Credit line revocations are measured by whether the firm experiences a 50%, 75%, or 100% or greater annual decline in the total available line of credit. Termination equals one in years in the first year of and the years following a complete termination of the firm's hedging program. The sample is conditioned on having a hedging program in fiscal year 2007 and it consists of firms that are either below investment grade or unrated. Hedging program termination is instrumented with LIQU, TRN, TRNSq, EQCAP and CHARGEOFF in a first-stage using a model similar to the one reported in Table 6. All regressions include firm controls for size, profitability, market-to-book, and net worth. They also include year fixed effects and lagged values of the firm's liquidity ratio (LR), defined as the ratio of total lines to the sum of total lines and cash. Standard errors are clustered by firm and reported in parentheses.

	OLS			2SLS		
Revocation of credit line:	>50%	>75%	Complete	>50%	>75%	Complete
	(1)	(2)	(3)	(4)	(5)	(6)
Termination of hedging program	0.079	0.031	0.043	-0.218**	-0.267**	-0.189*
	(0.052)	(0.042)	(0.041)	(0.109)	(0.113)	(0.100)
LR	-0.075	-0.078**	-0.090***	-0.075	-0.106*	-0.129***
	(0.046)	(0.034)	(0.030)	(0.058)	(0.054)	(0.046)
MB	0.015	0.019	0.021	0.013	0.014	0.025
	(0.019)	(0.017)	(0.017)	(0.031)	(0.031)	(0.029)
Log(SALE)	0.006	-0.001	0.007	-0.017	-0.015	-0.005
	(0.011)	(0.008)	(0.006)	(0.013)	(0.012)	(0.011)
ROA	-0.618***	-0.444**	-0.416**	-0.741***	-0.592***	-0.522**
	(0.205)	(0.176)	(0.185)	(0.250)	(0.210)	(0.236)
NTWRTH	0.020	0.004	0.007	-0.049	-0.108	-0.075
	(0.070)	(0.057)	(0.054)	(0.101)	(0.091)	(0.075)
CFV	-0.004***	-0.003***	-0.002***	-0.004***	-0.004***	-0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
TANG	-0.018	-0.046	-0.014	-0.039	-0.043	-0.002
	(0.037)	(0.028)	(0.021)	(0.047)	(0.041)	(0.032)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Rating FE	Yes	Yes	Yes	Yes	Yes	Yes
N	554	554	554	315	315	315
NFirms	164	164	164	110	110	110
Rsq	0.080	0.084	0.097	0.001	.	0.018
AdjRsq	0.056	0.060	0.073	-0.042	.	-0.024

Table 6: Effect of hedging program termination on credit line drawdowns

This table reports the effect of hedging program termination on credit line drawdowns in the year of hedging program termination. The sample is based on below investment grade and unrated firms (non-investment grade firms) with a hedging program in 2007. The dependent variable is the scaled change in the drawn amount: $\frac{\Delta Drawn_t}{Totalline_{t-1}}$. The sample is based on firms with a hedging program at the beginning of the sample period. *Hedging program reduction* equals 1 if the total notional amount is reduced by more than 50% (column 1), more thatn 75% (column 2) or completely (column 3). *Hedging program reduction* is instrumented with CHARGEOFF, LIQU, TRN, TRNSq, EQCAP using a linear probability model. Reported estimates are based on a 2SLS model. Standard errors clustered by firm are reported in parentheses. All specification include year fixed effects.

Dependent variable:	Drawdown as a percentage of total line		
Hedging program reduced by:	>50%	>75%	Complete
	(1)	(2)	(3)
Hedging program reduction	0.594*	0.591*	0.620*
	(0.337)	(0.323)	(0.338)
MB	0.062	0.038	0.031
	(0.052)	(0.045)	(0.044)
Log(SALE)	0.003	0.007	0.000
	(0.020)	(0.019)	(0.015)
ROA	0.345	0.436*	0.481**
	(0.270)	(0.223)	(0.209)
NTWRTH	0.174	0.209**	0.208**
	(0.119)	(0.106)	(0.103)
CFV	-0.002	-0.002	-0.002
	(0.005)	(0.004)	(0.004)
TANG	0.158*	0.128	0.108
	(0.094)	(0.081)	(0.073)
Year FE	Yes	Yes	Yes
Rating FE	Yes	Yes	Yes
N	301	301	301
NFirms	109	109	109

Table 7: Effect of hedging program termination on the cash-flow sensitivity of cash

This table reports the effect of hedging program termination on the cash-flow sensitivity of cash as defined in Campello, Almeida and Weisbach (2004). The cash-flow sensitivity of cash measures the proportion of each dollar of cash flow that is saved as cash. The dependent variable is the annual change in cash and marketable securities scaled by total assets. *Hedging program reduction* equals one in the year of a significant reduction in notional amount and in each of the following years without a reversal in hedging activity. Termination of the hedging program is instrumented with LIQU, TRN, TRNSq, EQCAP and CHARGEOFF in the random sample. Acquisitions expense (*Acquisitions*), capital expenditures (*Expenditures*) are instrumented with their lagged values. Both variables are scaled by total assets. NWC_D1 equals the change in net working capital (net of cash) scaled by total assets. Shortdebt_D1 equals the change in short-term debt scaled by total assets. Additional instruments include two lags of each of the log of market to book, net working capital, short-term debt, asset tangibility, sales and sales growth. The samples are based on non-investment grade firms and conditioned on having a hedging program in 2007. Standard errors (reported in parentheses) are clustered by firm. The samples are based on firms with available information on the composition of their lending syndicate. The before last row reports p-values for the Sargan test of instrument exogeneity.

Sample:	Random sample			Full sample
Hedging program reduced by:	>50%	>75%	Complete	Complete
	(1)	(2)	(3)	(4)
Cashflow	-0.192***	-0.145***	-0.136**	-0.075
	(0.070)	(0.056)	(0.056)	(0.061)
Hedging program reduction	-0.0667**	-0.0858**	-0.0903**	-0.124**
	(0.027)	(0.037)	(0.040)	(0.048)
CashflowXHedging program reduction	0.743***	0.901**	0.919**	1.008*
	(0.285)	(0.387)	(0.385)	(0.596)
MB	0.018	0.013	0.015	-0.007
	(0.012)	(0.011)	(0.012)	(0.012)
Log(SALE)	0.002	0.000	0.000	0.000
	(0.003)	(0.003)	(0.003)	(0.003)
NWC_D1	-0.510***	-0.473***	-0.509***	-0.620***
	(0.134)	(0.124)	(0.125)	(0.201)
Shortdebt_D1	0.039	-0.047	-0.076	0.048
	(0.111)	(0.109)	(0.111)	(0.110)
Acquisitions	-0.405***	-0.389***	-0.388***	-0.369**
	(0.073)	(0.072)	(0.073)	(0.144)
Expenditures	-0.0672**	-0.0628**	-0.0649**	-0.0695**
	-0.033	-0.029	-0.030	-0.029
Constant	0.024	0.030	0.031	0.032
	(0.022)	(0.020)	(0.021)	(0.023)
N	375	375	375	870
NFirms	105	105	105	323
Sargan J-stat (p-value)	0.81	0.76	0.69	0.65

Table 8: Effect of hedging program termination on firm value

This table reports OLS, IV and dynamic-panel GMM estimates of hedging program status on firm value. Firm value is measured with the logarithm of the market to book value. The estimation equation is

$$y_{it} = \alpha + \sum_{s=1}^{p} \beta_s y_{it-s} + \delta \times Termination_{it} + \gamma X_{it} + d_t + \eta_i + \varepsilon_{it}$$

Where $p = 1$, η_i is a firm fixed effect, y_{it-s} is the lagged dependent variable (the log of the market-to-book ratio), $Termination_{it}$ is a measure of hedging status (binary 1 (for termination) or 0), $X_{it}(NTWRTH, ROA, Log(SALE))$ are firm-level variables, d_t is a year effect. Columns (1-2) reports OLS estimates. Columns (3-4) reports instrumental variable estimates (IV) estimates where *Termination* is instrumented with LIQU, TRN, TRNSq, EQCAP and CHARGEOFF. The Sargan test statistic tests for the endogeneity of the instruments. Columns (5) and (6) report estimates based on Arellano-Bond GMM estimates that use lagged levels (t-3) and lagged differences (t-3) of y_{it}, $Termination_{it}$ and X_{it} as instruments in the levels and differences equations. The Sargan p-value reports the test for exogeneity of moment conditions. The AR-1 and AR-2 tests for serial correlation in first- and second-differenced errors. Dynamic panel standard errors are based on the robust two-step estimator. Standard errors are reported in parentheses and they are clustered by firm.

Sample:	Random	Full	Random	Full	Random	Full
Estimation model:	OLS	OLS	IV	IV	Dynamic panel GMM	Dynamic panel GMM
	(1)	(2)	(3)	(4)	(5)	(6)
Termination	-0.072***	-0.030*	-0.253*	-0.182	-0.266***	-0.265**
	(0.024)	(0.017)	(0.147)	(0.240)	(0.088)	(0.119)
Lag(1) dep. Variable	0.747***	0.779***	0.708***	0.797***	0.058	0.636***
	(0.030)	(0.019)	(0.045)	(0.035)	(0.205)	(0.166)
Lag(2) dep. Variable					-0.157*	-0.048
					(0.090)	(0.086)
ROA	0.256**	-0.003	0.000	-0.004	2.235***	1.980*
	(0.116)	(0.005)	(0.012)	(0.006)	(0.833)	(1.020)
Log(SALE)	0.006	0.072	0.154	0.021	0.043	-0.074
	(0.008)	(0.072)	(0.114)	(0.082)	(0.044)	(0.070)
NTWRTH	-0.012	-0.040*	-0.123*	-0.047	-0.101	0.533*
	(0.046)	(0.022)	(0.070)	(0.035)	(0.374)	(0.321)
Firm FE	No	No	No	No	Yes	Yes

Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Rating FE	Yes	Yes	Yes	Yes	No	No
N	763	2054	430	1033	439	953
NFirms	187	552	115	339	164	460
AdjRsq	0.646	0.664				
Sargan p-value			0.93	0.67	0.45	0.156
AR(1) p-value					0.18	0.017
AR(2) p-value					0.25	

Table 9: Financial slack and value effects of hedging program termination

This table reports IV estimates of hedging program status on firm value where firms are sorted by how much of their available liquidity is used up prior to the loss of their hedging program. Liquidity usage is measured with the ratio of Total amount drawn from a line of credit divided by the sum of total lines of credit and cash holdings. Firms are ranked into tercile groups with this ratio and the top (Drawn amount>67pct.) and bottom terciles (Drawn amount<33rd pct.) are kept for the analysis. Firm value is measured with the logarithm of the market to book value. The estimation equation is

$$y_{it} = \alpha + \sum_{s=1}^{p} \beta_s y_{it-s} + \delta \times Termination_{it} + \gamma X_{it} + d_t + \varepsilon_{it}$$

Where $p = 1$, y_{it-s} is the lagged dependent variable (the log of the market-to-book ratio), $Termination_{it}$ is a measure of hedging status (binary 1 (for termination) or 0), $X_{it}(NTWRTH, ROA, Log(SALE))$ are firm-level variables, d_t is a year effect. Instrumental variable estimates (IV) estimates instrument *Termination* with LIQU, TRN, TRNSq, EQCAP and CHARGEOFF. The Sargan p-value reports the test for exogeneity of moment conditions. Standard errors are reported in parentheses and they are clustered by firm. The last column reports a p-value for the test that the coefficient on Termination is equal across the two groups of firms.

Drawn amount:	< 33rd pct.	> 67th pct.	
Dependent variable:	Ln(MB)	Ln(MB)	
	(1)	(2)	p-value: (2) - (1)
Termination	0.061	-0.289*	0.081
	(0.139)	(0.156)	
Lag(1) dep. Variable	0.842***	0.653***	
	(0.060)	(0.075)	
Log(SALE)	-0.025	-0.008	
	(0.017)	(0.021)	
ROA	0.395	-0.099	
	(0.281)	(0.181)	
NTWRTH	0.024	-0.144	
	(0.108)	(0.124)	
Firm FE	No	No	
Year FE	Yes	Yes	
Rating FE	Yes	Yes	
N	149	180	
NFirms	70	90	
Sargan p-value	0.38	0.65	