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Do Nonfinancial Firms Use Financial Assets to Take Risk?

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Using hand-collected data on financial asset portfolios and exploiting the 2014 oil price crisis as an exogenous cash flow shock, we investigate financial risk-taking at distressed firms. We find that distressed firms, with high debt rollover risk proxied for by short-term liabilities, substantially increase their investments in risky financial assets, including corporate debt, equity, and mortgage-backed securities. The effects are stronger for unhedged firms with low collateral assets. Overall, we provide new evidence that distressed firms take risk using financial assets camouflaged as cash reserves, which, compared to real assets, are less visible and carry lower transaction costs and accelerated payoffs. (*JEL* G32, G34)

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A vast body of theoretical work predicts that firms will invest in riskier projects as they become distressed (Modigliani and Miller 1958; Fama and Miller 1972; Jensen and Meckling 1976; Stiglitz and Weiss 1981; Acharya and Viswanathan 2011; Elkamhi, Ericsson, and Parsons 2012; Della Seta, Morellec, and Zucchi 2020). Despite the prominence of these theories, the evidence is mixed. An earlier study by Andrade and Kaplan (1998) found that firms do not undertake riskier investments as they become distressed. Eisdorfer (2008), Becker and Stromberg (2012), Favara et al. (2017), Denes

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(2018), and Aretz, Banerjee, and Pryshchepa (2019), among others, identify settings in which distressed firms may increase their risk-taking.

We attempt to shed new light on this topic in several ways. First, contrary to prior empirical studies that have exclusively focused on risky real investments, this paper investigates firms' financial investments as a novel conduit for risk-taking. We argue that financial assets can be better conduits for risk-taking than real assets. Compared with traditional real assets, trading in risky financial assets does not require an upfront investment in physical or human capital, can generate immediate/accelerated payoffs, and is less visible.[1] In fact, financial assets are typically reported on the balance sheet as corporate cash holdings, and consequently, allow firms to camouflage their risk-taking as holdings of seemingly safe assets.

Second, we highlight the importance of debt maturity and rollover risk in risk-taking. While prior studies argue that short-term debt can mitigate agency problems by disciplining management (e.g., Calomiris and Kahn 1991; Leland and Toft 1996) and reducing debt overhang (Myers 1977), the rollover risk of short-term debt also introduces incentives to take risk and avoid inefficient liquidation (Della Seta, Morellec, and Zucchi 2020).

Third, we investigate the roles of collateralized debt and corporate hedging in risk-taking. We argue that collateralized debt is less likely to trigger risk-taking because collateral prevents wealth transfers from debtholders to shareholders by mitigating information asymmetry (Boot, Thakor and Udell 1991) and reducing costly monitoring by lenders (e.g., Rajan and Winton 1995; Piskorski and Westerfield 2016). Thus, risk-taking should occur in levered firms with low levels of collateral. We also provide novel evidence on the role of hedging in weakening the incentives to take risk and gamble for resurrection, complementing prior studies on hedging and firm policies or value (e.g., Guay and Kothari 2003; Jin and Jorion 2006; Bartram et al. 2011; Almeida, Hankins, and Williams 2017).

Lastly, we address the identification challenges that can plague studies of risk-taking and distress by exploiting the 2014 oil price crisis as a quasi-natural experiment. The 2014 oil price drop was an exogenous shock that affected firms in the oil and gas industry. As Figure 1 shows, oil prices dropped sharply, by more than 50%, in mid-2014 and remained low through 2016.[2] The rationale for using the crisis is that the substantial drop in oil prices

[1] The merit of accelerated payoffs is well demonstrated by the actions of Fred Smith, the founder of FedEx, who saved his company in 1971 by gambling its last $5,000 in Las Vegas. The immediate payoffs from his speculative positions, which came at the expense of the company's creditors, allowed FedEx to operate for another week and consequently to this very day.

[2] Following the economic recovery from the 2008 global financial crisis, oil prices hovered between $100 and $125 until 2014, when they dropped to $37 per barrel. Several factors contributed to the 2014 drop in oil prices. Technological innovation caused an increase in the supply of oil. In the United States, companies began extracting oil from shale formations in North Dakota using fracking. Canada began extracting oil from Alberta's oil sands, the world's third-largest crude oil reserve. At the same time, Saudi Arabia kept its oil production stable, hoping that low oil prices would force the United States and Canada to abandon their costlier production methods because of a lack of profitability. The demand for oil has also declined since 2010 because

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Figure 1
Brent crude oil price
This figure plots the Brent crude oil price (USD per barrel) from January 2012 to January 2017.
Source: https://www.focus-economics.com/commodities/energy/brent-crude-oil.

reduced the operating income of oil and gas firms, generating an adverse cash flow shock that increased debt rollover risk and consequently financial distress. Short-term debt likely plays a particularly important role in a transitory oil price crisis since it can become due before the crisis ends.

To study the role of financial assets in risk-taking, we collect data on financial investments following the method of Duchin et al. (2017; DGHH). DGHH find that U.S. industrial firms invest in noncash, risky financial assets, such as corporate debt, equity, and mortgage-backed securities. We hand-collect footnote data on financial investments at oil and gas companies from 2011 to 2016 by exploiting the 2009 Statement of Financial Accounting Standards (SFAS) No. 157 that requires firms to report the fair value of major asset classes on their balance sheets. While DGHH focus on large, relatively unconstrained S&P 500 firms over the period 2009–2012, when the economy started to rebound from the 2008 financial crisis, we focus on considerably smaller oil and gas firms around the 2014 oil price crisis. As such, our paper complements the DGHH paper by studying risky financial investments in the aftermath of an adverse cash flow shock at small firms, whose corporate governance and financial constraints are different from those of S&P 500 firms, and whose risky financial asset holdings are predicted to be suboptimal (DGHH 2017).

To study the effect of rollover risk and distress, we follow the literature (e.g., Barclays and Smith 1995; Custódio, Ferreira, and Laureano 2013; Chen, Xu, and Yang 2021) and use the ratio of short-term liabilities to total liabilities

economies with rapid expansion, such as China, which greatly increased their demand for oil in the 2000s, began to slow down after 2010. Other large emerging economies, such as Russia, India, and Brazil, experienced a similar decline after 2010.

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as a proxy for debt rollover risk, in conjunction with the adverse cash flow shock resulting from the 2014 oil price crisis. We also purge our specifications of the variation in short-term liabilities by using only the firm's debt positions measured roughly 2 years prior to the start of the crisis, because changes in a firm's debt positions as the crisis unfolds may be related to other unobserved firm-level changes.[3] We validate our approach by showing that while short-term liabilities are uncorrelated with bankruptcy filings before the crisis, they are a strong predictor of bankruptcy filings following this oil price crisis. An increase of one standard deviation in the pre-crisis ratio of short-term liabilities to total liabilities increases the likelihood of bankruptcy filings by 13.45 percentage points. This finding is consistent with the effect of rollover risk on financial distress and default following adverse cash flow shocks (He and Xiong 2012). Thus, our empirical proxy for financial distress, which combines an unexpected oil price shock and preexisting short-term liabilities, provides a plausibly exogenous instrument to study the impact of rollover risk on risk-taking.

In the main analyses, we find that following the onset of the 2014 oil price crisis, firms with high short-term liabilities (in the top tercile) increase their investments in risky financial assets, on average, from $1.06 billion to $1.43 billion, an increase of $370 million, or 34.8%. Consequently, their ratio of risky financial assets to total financial assets increases from 20.5% in 2013 to 37.2% in 2016. The significant economic increase in risky financial assets is also highly statistically significant and continues to hold in difference-in-differences panel regressions that include year and firm fixed effects as well as time-varying firm-level attributes, such as capital expenditures and sales. We also estimate dynamic regression specifications over a 6-year window around the oil price crisis and show that the changes in risky financial assets do not precede the oil price crisis. These findings are consistent with the parallel trends assumption and mitigate concerns about reverse causality or confounding effects that may be driving the changes in firms' risky financial asset holdings.

A possible explanation for our findings that firms invest in riskier financial assets following the onset of the 2014 oil crisis is that they face lower speculative demand for cash-like securities due to lower expected investment opportunities resulting from the crisis. Under this view, firms invest more in risky financial assets to earn a higher return on their financial asset portfolio in the absence of investment opportunities that require maintaining large and liquid cash reserves. This explanation is consistent with the evidence in Duchin et al. (2017), who find that risky financial assets also tend to be less liquid, and the evidence in Chen, Lesmond, and Wei (2007) and Bao,

[3] This approach is similar to the empirical approach of Duchin et al. (2010) and Almeida et al. (2012), who study the 2007 financial crisis. This approach differs from that of Eisdorfer (2008), who uses z-scores, and that of Becker and Stromberg (2012), who use Merton's distance to default, because both measures use total debt or liabilities and are not able to assess rollover-induced default risk.

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Pan, and Wang (2011) that illiquidity plays an important role in yield spreads. We note, however, that this view does not predict that investing in risky financial assets will be concentrated in distressed firms with high debt rollover risk. Nevertheless, we also investigate this possibility directly by augmenting the regression specifications with measures of investment opportunities, including Tobin's q and a hand-collected measure of firms' real investments following Gilje (2016). Our findings suggest that the tilt in the composition of firms' financial asset portfolios toward riskier assets following the onset of the oil crisis is uncorrelated with measures of investment opportunities. Hence, our findings are less consistent with a shift in asset illiquidity and more consistent with firms' risk-shifting behavior.

We conduct extensive robustness tests. First, we demonstrate that our results hold across alternative measures of short-term liabilities: debt maturities of 1, 2, or 3 years; short-term liabilities scaled by total assets; and both dichotomous and continuous measures of short-term liabilities. Second, we show that the results hold in a subsample of oil producers that excludes firms with diversified operations, such as oil refinement, which entails a directionally opposite exposure to oil price declines. Third, we further validate our measure of debt rollover risk by providing direct evidence on firms that *actually* went bankrupt following the 2014 oil price crisis. Using hand-collected data on bankruptcy filings, we find that soon-to-be-bankrupt firms increase their financial risk-taking. The estimates suggest a significant increase of 25.1% in the ratio of risky financial assets to total financial assets in the year before filing for bankruptcy.

Overall, these estimates imply that distressed firms, with high levels of short-term liabilities and rollover risk before the oil price crisis, gravitated considerably toward riskier financial investments following the onset of the crisis. By the end of 2016, their risky financial investments accounted for a nontrivial fraction of both their financial and total operations. Since risky financial assets comprise longer-maturity fixed rate securities (Cardella, Fairhurst, and Klasa 2021), the combination of high short-term debt positions and long-maturity fixed-rate financial assets exacerbates firms' exposure to interest rate risk, since an increase in interest rates will increase the firm's debt rollover risk and lower the value of its long-term financial assets. Such behavior is yet another dimension of the risk-shifting behavior of distressed firms.

In the second set of analyses, we investigate the roles of debt collateral and corporate hedging in firms' risk-taking. The estimates suggest that the increase in financial risk-taking at high rollover risk firms following the onset of the oil crisis is concentrated in firms with low levels of debt collateral and corporate hedging. In particular, firms with below-median levels of collateral increase their investments in risky financial assets by 72.7% more compared to firms with above-median levels of collateral asset, and this difference is statistically significant at the 1% level. Further, unhedged firms increase their investments in risky financial assets by 52.5% more compared to firms that use derivative hedging, and the difference is statistically different at the 5% level. These

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findings suggest that higher levels of collateral and hedging reduce the risk-taking incentives of firms that experience adverse economic shocks. Overall, they provide new evidence on the effects of collateral and hedging on corporate policies through their role in risk-taking.

In the third set of analyses, we consider several extensions. First, we consider the role of agency conflicts and corporate governance. To capture the severity of the conflicts of interest between equity holders and creditors, we follow the recent literature on funds' simultaneous holdings of a firm's debt and equity (e.g., Jiang et al. 2010; Yang 2021), which we refer to henceforth as "dual holdings," and collect detailed data on the heterogeneity in duals holdings across the firms in our sample. We conjecture that firms with low levels of dual holdings are more likely to suffer from conflicts of interest between their creditors and equity holders, which, in turn, will lead to risk-shifting. In contrast, at firms with relatively high levels of dual holdings, where the firm's creditors are also the firm's equity holders, we would expect to see lower levels of risk-shifting. Consistent with this conjecture and the risk-shifting hypothesis, we find that the increase in risky financial investments is concentrated in firms with low levels of dual holdings.

Second, we investigate the sources of the funds that firms invest in risky financial assets. Following McLean (2011), we estimate regressions in which the dependent variable is the annual change in the ratio of risky financial assets to total assets, and the explanatory variables include the possible sources of funds: safe financial assets, operating cash flows, and debt and equity issuances. We find that firms substitute risky financial assets for safe financial assets following the onset of the oil price shock. Before the crisis, however, there is no significant relation between changes in investments in safe and risky financial assets. This finding suggests that firms actively change the composition of their financial asset portfolios toward riskier assets when they experience an adverse economic shock.

Third, we estimate value of cash regression models á la Faulkender and Wang (2006) separately for firms with low versus high short-term debt positions, before and after the onset of the oil crisis. We find that increasing investment in risky financial assets does not affect share values at nondistressed firms with low short-term debt balances or before the onset of the oil crisis. However, following the onset of the oil crisis, at distressed firms with high short-term debt positions, increasing investment in risky financial assets leads to a considerable increase in stock returns. These estimates are consistent with the risk-shifting hypothesis. In particular, they suggest that equity holders view risk-taking at distressed firms positively, consistent with shifting value from creditors to equity holders.

Altogether, studying risk-taking through financial rather than real investments has several advantages. First, it mitigates concerns about reverse causality. While losses from risky financial investments have no direct effect on operating performance, losses from risky real investments do affect operating

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performance. Hence, studies of real investment struggle to identify the direction of causality, that is, whether deteriorating operating performance results in risky investments or whether risky investments result in deteriorating performance. Since financial investments are performance-neutral, this setting is less subject to a reverse causality critique.

Second, the relative risk of financial assets can be assessed more precisely ex ante than the risk of real assets. For instance, corporate debt, equity, and mortgage-backed securities are riskier than treasury bonds and notes. In contrast, it is difficult to determine which real assets are riskier ex ante. Consequently, most previous studies of corporate risk-taking relied on measures of realized ex post cash flow volatility (e.g., Eisdorfer 2008; Aretz, Banerjee, and Pryshchepa 2019; Chen et al. 2021; Chen and Strebulaev 2019). These measures, however, suffer from a look-ahead bias, are not necessarily attributable to risk-taking, and can be driven by correlated omitted variables.

Nevertheless, we also provide evidence on the consequences of risky financial investments for realized ex post cash flow volatility in the aftermath of the oil crisis. We emphasize that the ex post consequences of risky financial investments are unclear ex ante. For example, if firms substitute risky financial investments for risky real investments, the overall effect on the firm's risk can go either way because the reduction in the riskiness of the real asset portfolio can offset the increase in the riskiness of the financial asset portfolio. Moreover, risky financial investments can eliminate idiosyncratic risk by diversifying the firm's investment portfolio. Using the volatility of the firm's cash flows and earnings following as our ex post risk measures, we find that higher risky financial investments following the onset of the crisis lead to considerably higher levels of volatility. For example, an increase of one standard deviation in the ratio of risky financial assets to total financial assets leads to an increase of 3.1% in the annualized volatility of earnings.

Overall, we augment the extant research on corporate cash holdings, risk and distress. Contrary to the predominant view of corporate cash holdings as precautionary savings that mitigate the costs of distress (e.g., Opler et al. 1999; Acharya et al. 2012; Bates et al. 2009; Duchin et al. 2010), we show that distressed firms increase risk-taking by investing their cash in risky financial assets. In addition, since undrawn lines of credit cannot be invested in risky assets, risk-taking of distressed firms is another dimension on which lines of credit and cash holdings differ (e.g., Lins, Servaes, and Tufano 2010; Acharya et al. 2014; Disatnik, Duchin, and Schmid 2014).

1. Empirical Strategy, Data, and Variables

1.1 Sample

The sample period spans a 6 years window around the onset of the oil price crisis in 2014. The sample period starts in 2011, 3 years before the onset of the

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crisis, and ends in 2016, 3 years after the onset of the crisis. The start of the sample period in 2011 occurs 2 years after SFAS No. 157 went into effect, requiring all firms to report the fair value of their financial asset classes in their annual 10-K reports. Appendix B provides examples of financial asset disclosures at oil and gas firms.

The empirical analyses focus on the oil and gas industry because it experienced a substantial negative shock after SFAS No. 157 went into effect. To construct the sample, we merge the hand-collected data on financial asset portfolios with annual Compustat data. We use the Compustat data to construct the lagged, time-invariant measures of short-term liabilities as of the end of 2012 and 2013. We also use these data to construct the time-varying control variables, whose annual frequency matches that of firms' financial asset reporting.

More specifically, we begin constructing the sample with all firms in the oil and gas industry with nonmissing observations on financial assets and positive total book assets from 2011–2016.[4] This procedure yields a sample of 115 distinct oil and gas firms and 690 firm-year observations. For the subsequent multivariate regression analyses, we also require that the other control variables, such as *Market-to-book*, *Profitability*, *Cash dividends*, and *Capital investment*, have nonmissing values. Consequently, we lose 4 firm-year observations, and end up with the final sample that includes 115 distinct oil firms and a total of 686 firm-year observations. Appendix A defines the variables in detail.

1.2 Empirical strategy

The identification strategy exploits the 2014 oil price crisis, which represents an exogenous shock that affected the entire oil and gas industry. The Brent crude oil price dropped sharply in mid-2014 from over $110 per barrel to less than $50 per barrel and remained low through 2016, with prices reaching their lowest point, under $30 per barrel, by the beginning of 2016. The drop in oil prices had a significant effect on the profitability of our sample firms. The average profitability of our sample firms, measured by return on assets (ROA), declined from 9.2% in 2013 to −8.9% in 2015.

We employ a difference-in-differences approach in which we compare the composition of the financial asset portfolio of firms before and after the onset of the crisis as a function of their pre-crisis rollover risk, measured by the relative size of their short-term debt positions, controlling for firm and year fixed effects, as well as observable time-varying firm attributes, such as expenditures and sales.

[4] Oil and gas industries include the following SIC codes: Crude Petroleum and Natural Gas (1311), Natural Gas Liquids (1321), Drilling Oil and Gas Wells (1381), Oil and Gas Field Exploration Services (1382), Oil and Gas Field Services (1389), Petroleum Refining (2911), and Miscellaneous Products of Petroleum (2999).

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We are interested in studying the role of firms' rollover risk surrounding the oil price crisis. Inferences may be confounded, however, if variation in short-term debt positions (and rollover risk) as the crisis unfolds is endogenous. To address this concern, we purge our specifications of this variation by using only the average ratio of a firm's short-term liabilities to total liabilities measured at the end of 2012 and 2013, long before the onset of the crisis in July 2014. Thus, our main framework is akin to an instrumental variables approach. The identifying assumption is that firms did not predict the oil price shock, and therefore, their short-term debt positions before the onset of the crisis are independent of the ensuing crisis. This empirical design is similar to that in papers such as Almeida et al. (2012).

1.3 Measures of the composition of firms' financial assets

To study the composition of firms' financial assets, we follow DGHH (2017) and collect data on firms' financial portfolios that comprise (1) the balance sheet accounts "cash and cash equivalents" and "short-term investments," which constitute Compustat's data item CHE, the standard measure of cash holdings in the literature, and (2) any additional financial assets reported as "long-term investments" or "other assets."

We hand-collect detailed information on the asset classes that constitute firms' financial portfolios from the footnotes of annual reports.[5] To classify the riskiness of firms' financial assets, we follow DGHH (2017) and define safe financial assets as those that fall into the following asset classes: cash, cash equivalents, demand deposits, money market securities, treasury bills, treasury notes and treasury bonds. We consider all other financial assets as risky. We exclude from the analyses restricted assets, deferred executive compensation, and derivative hedging.

Using these data, we construct the following measures of the composition of firms' financial assets. The first two measures focus on the absolute size of the asset portfolio and are defined as the amount (in $ millions) of safe and risky financial assets. These two measures are unscaled by a firm's investments or assets, and therefore are unaffected by changes in other firm-level attributes unrelated to its financial investments. The third measure is the ratio of risky financial assets to total financial assets, defined as follows:

$$\begin{aligned} &\textit{Risky financial assets/finanical assets} \\ &= \frac{\textit{Risky financial assets}}{\textit{Safe financial assets} + \textit{Risky financial assets}}. \end{aligned}$$

This measure captures the percentage of financial investments allocated to risky financial assets. It measures the composition of a firm's total financial asset portfolio, reflecting the relative allocation to both safe and risky assets.

[5] We focus on annual reports because firms do not disclose information on financial asset classes in their quarterly reports.

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As such, an increase in financial risk-taking according to this measure can reflect an increase in risky assets or a decrease in safe assets, holding constant the size of the financial asset portfolio.

1.4 Summary statistics

Table 1 presents summary statistics for the sample. Based on panel A, the dollar amount of risky financial assets is highly right-skewed and ranges from \$0 to roughly \$31 billion, with a mean value of \$724 million and a median value of \$19.8 million. The ratio of risky financial assets to total financial assets is also right-skewed, with a maximum value of 1, a mean value of 0.33, and a median value of 0.24. These values are smaller compared to the risky financial assets of S&P 500 firms reported by DGHH (mean = 0.40 for the ratio of risky financial assets to total financial assets). This is consistent with the findings of DGHH that larger firms invest more in risky financial assets. The median firm size (book value of assets) in our sample is roughly \$1.9 billion, compared to a median firm size of \$9.8 billion the DGHH sample.

Panel B describes the other variables employed in this study. The ratio of short-term liabilities to total liabilities has mean and median values of 0.46 and 0.35, respectively. Further, the oil and gas firms in our sample are on average profitable (mean profitability = 0.1) and have a mean market-to-book ratio of 1.3. About half of the firms in our sample do not pay dividends, consistent with the findings in prior studies (Brav et al. 2005). Lastly, total liabilities are, on average, 45% of book assets.

Panel C of Table 1 investigates the covariate balance between low- and high-short-term-liabilities firms in the year before the crisis, that is, at the end of 2013. Since we sort firms on their short-term liabilities before the crisis, we first verify that there is substantial variation in short-term liabilities between low- and high-short-term-liabilities firms. As panel C shows, the difference in short-term liabilities is economically large (High minus Low = 0.54) and statistically significant at the 1% level (t-statistic = 19.67). In contrast, the differences across other observable firm attributes, such as size, profitability, and payout, are small and statistically indistinguishable from zero. These findings suggest that the two sets of firms are observationally identical before the crisis on observable dimensions, except for the treatment variable, that is, short-term liabilities.

2. Main Empirical Results

This section studies how the variation in short-term debt and rollover risk affects oil firms' investments in risky financial assets. To validate our approach, we begin by showing that high short-term debt positions before the crisis were associated with higher bankruptcy rates in the aftermath of the crisis. We then use a difference-in-differences regression to examine the

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Table 1
Summary statistics

A. Financial assets

Variable	N	Mean	SD	Min	25th percentile	Median	75th percentile	Max
Safe financial assets ($millions)	686	680	1,943	0	9.777	56.716	443.8	21,913
Risky financial assets ($millions)	686	724	3,309	0	0.252	19.792	168.849	30,985
Risky financial assets/ financial assets	686	0.333	0.330	0.000	0.010	0.243	0.585	1.000

B. Firm-level variables

Variable	N	Mean	SD	Min	25th percentile	Median	75th percentile	Max
Short-term liabilities/total liabilities	686	0.455	0.310	0.000	0.211	0.354	0.665	1.000
Total liabilities/book assets	686	0.450	1.050	0.000	0.246	0.341	0.426	10.000
Size	686	6.627	2.530	0.001	5.187	6.675	8.288	12.980
Profitability	686	0.097	0.220	−1.500	0.065	0.135	0.204	0.560
Market-to-book	686	1.313	1.240	0.123	0.768	1.004	1.363	10.000
Capital investment	686	0.188	0.160	0.000	0.068	0.138	0.257	0.750
Cash dividends	686	0.018	0.040	0.000	0.000	0.000	0.022	0.270
Collateral	686	0.686	0.230	0.000	0.583	0.748	0.868	0.950
Volatility of earnings	632	5.829	6.176	0.221	1.131	3.908	8.417	31.97
Volatility of profitability	632	0.140	0.160	0.006	0.037	0.076	0.188	0.860
Real investments, $ millions	686	1131	4903	0	0	4	537	112591
Real investments/book assets	686	0.141	0.212	0.000	0.000	0.030	0.211	1.000
Short-term investments	686	102.094	626.51	0.000	0.000	0.000	1.567	10241
Short-term investments/ book assets	686	0.074	0.17	0.000	0.000	0.000	0.029	0.91
Excess stock returns	445	0.020	1.038	−0.983	−0.333	−0.050	0.232	2.000

C. Covariate balance in 2013

	High short-term liabilities firms		Low short-term liabilities firms			
Variable	Mean	SD	Mean	SD	Difference	*t*-statistic
Short-term liabilities/total liabilities	0.793	0.173	0.251	0.119	0.542	19.667
Total liabilities/book assets	0.242	0.152	0.371	0.119	−0.129	−0.468
Size	6.207	3.680	7.035	1.697	−0.828	−0.156
Profitability	0.057	0.339	0.156	0.093	−0.099	−0.225
Market-to-book	1.284	0.870	1.375	1.137	−0.091	−0.041
Capital investment	0.128	0.136	0.213	0.148	−0.085	−0.280
Cash dividends	0.011	0.016	0.026	0.050	−0.015	−0.169

This table reports summary statistics. The sample consists of 115 oil and gas firms with nonmissing observations from 2011 to 2016. All variable definitions appear in Appendix A.

effects of short-term liabilities on financial risk-taking, followed by a battery of robustness tests.

2.1 Short-term debt and bankruptcy rates

Not all the firms become financially distressed, when facing the substantial oil price drop or the negative profitability shock. While it is reasonable to

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Table 2
Short-term liabilities and bankruptcy rates

	Pre-crisis (1)	Crisis (2)
Short-term liabilities/total liabilities	0.119	0.434**
	[0.475]	[2.296]
Total liabilities/book assets	0.880	0.153
	[1.538]	[1.421]
Size	0.589	0.303
	[0.981]	[0.663]
Profitability	0.381	−0.044
	[1.634]	[−0.385]
Market-to-book	−0.326	0.195
	[−1.253]	[1.558]
Cash dividends	0.002	0.025
	[0.053]	[0.507]
Capital investment	0.081	−0.078
	[1.070]	[−0.954]
No. obs	443	430
Adj. R^2	.171	.173
Firm FE	Y	Y
Year FE	Y	Y

This table presents evidence on the relation between a firm's outstanding short-term liabilities and the likelihood of bankruptcy filings. Column 1 examines the relationship before the crisis over the period 2011–2013, whereas column 2 examines the relationship in the aftermath of the crisis over the period 2014–2016. The dependent variable is an annual indicator variable that equals one if the firm files for bankruptcy and zero otherwise. The key explanatory variable is the ratio of short-term liabilities to total liabilities. Bankruptcy data come from the UCLA-LoPucki Bankruptcy Research Database. All variable definitions appear in Appendix A. The *t*-statistics [in brackets] are adjusted for heteroscedasticity and clustered by firm.
*$p < .1$; **$p < .05$; ***$p < .01$.

conjecture that firms with more short-term liabilities prior to the oil price crisis are likely to become distressed, we begin the analysis by validating our empirical approach, which focuses on firms' short-term liabilities to measure their exposure to rollover risk and financial distress surrounding the 2014 oil price crisis. In Table 2, we investigate the relation between short-term liabilities and firms' likelihood of bankruptcy filings in the 3 years before the oil price crisis (2011–2013) and the 3 years after the crisis (2014–2016). The dependent variable in Table 2 is an annual indicator variable that equals one if the firm files for bankruptcy and zero otherwise. The key explanatory variable is the ratio of short-term liabilities to total liabilities. The bankruptcy data come from the UCLA-LoPucki Bankruptcy Research Database.

The estimates in Table 2 show that before the oil prices crisis, over the period 2011–2013, high short-term liabilities did not expose firms to significant debt rollover or financial risks. The coefficient on the ratio of short-term liabilities to total liabilities is economically small and statistically insignificant during that time period. However, following the onset of the oil crisis in 2014, firms with high short-term liabilities have had a significantly higher likelihood of filing for bankruptcy. An increase of one standard deviation in the ratio of short-term liabilities to total liabilities is associated with an increase of 13.45% in the likelihood of filing for bankruptcy, and this effect is statistically

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significant at the 5% level (p-value = 0.02). This finding supports our conjecture that rollover risk, measured by firms' short-term debt positions, played an important role in the aftermath of the oil price crisis at oil and gas companies. Hence, in subsequent analyses we investigate the effect of short-term debt positions on the ex ante and ex post composition of firms' cash holdings across safe and risky financial assets.

2.2 Multivariate regression evidence on risky financial assets

We begin the analysis of the financial asset composition of corporate cash holdings by presenting regression evidence on the relation between firms' pre-crisis short-term liabilities and the riskiness of their financial asset portfolios before versus after the crisis. Table 3 shows multivariate evidence on the effect of pre-crisis short-term liabilities on firms' investments in risky financial assets with a full system of controls and fixed effects. Panel A of Table 3 provides estimates from difference-in-differences regressions explaining the allocation of cash holdings to safe and risky financial assets. In column 1, the dependent variable is the logarithm of the dollar value of firms' risky financial assets. In column 2, the dependent variable is the ratio of risky financial assets to total financial assets. For each dependent variable, we report estimates from specifications that include both firm and year fixed effects.

(continued) The main variable of interest is the interaction term *High short-term liabilities x Crisis*, which captures the effect of high pre-crisis short-term liabilities on the composition of firms' financial asset portfolios following the onset of the crisis. The variable *High short-term liabilities* is an indicator variable that equals one for firms in the top tercile of the ratio of short-term liabilities to total liabilities in 2012 and 2013 and zero for firms in the bottom two terciles. This time-invariant variable is absorbed by the firm fixed effects.

Column 1 shows that firms with high outstanding short-term liabilities have increased substantially more the dollar amount invested in risky financial assets compared to firms with low levels of short-term liabilities. The coefficient on the interaction term *High short-term liabilities x Crisis* is positive and highly statistically significant at the 1% level. The economic magnitude implies that following the onset of the crisis highly, high short-term liabilities firms increased their investments in risky financial assets by 59.9% more compared to low liabilities firms. These findings hold after controlling for time-invariant differences across firms (firm fixed effects) and macroeconomic trends (year fixed effects).

In column 2, we consider risky financial assets relative to total financial investments. The findings suggest that firms with high short-term liabilities have increased the fraction of their financial assets invested in risky financial assets by 11.5 percentage points more compared to low liabilities firms following the onset of the oil price crisis. These findings are statically significant

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Table 3
Regression evidence on the composition of corporate cash holdings

A. Difference-in-differences regressions

Dependent variable	*log(Risky financial assets)* (1)	*Risky financial assets/financial assets* (2)
High short-term liabilities × Crisis	0.599***	0.115**
	[3.206]	[2.326]
Size	0.270***	0.001
	[3.173]	[0.053]
Profitability	−0.142	−0.043
	[−0.544]	[−0.692]
Market-to-book	0.077	−0.005
	[1.366]	[−0.361]
Cash dividends	0.573	0.112
	[0.295]	[0.274]
Capital investment	0.458	0.087
	[1.265]	[0.764]
Total liabilities	−0.067	−0.017
	[−1.526]	[−1.328]
No. obs	686	686
Adj. R^2	.9063	.6582
Firm FE	Y	Y
Year FE	Y	Y

B. Dynamic regressions

Dependent variable	*log(Risky financial assets)* (1)	*Risky financial assets/financial assets* (2)
High short-term liabilities × d2011	−0.169	0.025
	[−0.733]	[0.547]
High short-term liabilities × d2012	−0.286	0.027
	[−1.254]	[0.606]
High short-term liabilities × d2014	0.130	0.079
	[1.038]	[1.579]
High short-term liabilities × d2015	0.280	0.109*
	[1.221]	[1.699]
High short-term liabilities × d2016	1.089**	0.231***
	[2.503]	[3.050]
Size	0.285***	0.002
	[3.060]	[0.110]
Profitability	−0.368	−0.076
	[−1.316]	[−1.216]
Market-to-book	0.079	−0.006
	[1.404]	[−0.393]
Cash dividends	0.182	0.068
	[0.091]	[0.156]
Capital investment	0.374	0.075
	[0.980]	[0.639]
Total liabilities	−0.067	−0.017
	[−1.632]	[−1.257]
No. obs	686	686
Adj. R^2	.909	.663
Firm FE	Y	Y
Year FE	Y	Y

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Table 3
Continued

C. Investment opportunities

Dependent variable	*log(Risky financial assets)* (1)	*Risky financial assets/financial assets* (2)
High short-term liabilities × Crisis	0.570***	0.104*
	[2.856]	[1.875]
Size	0.278***	0.003
	[2.939]	[0.114]
Profitability	−0.184	−0.047
	[−0.695]	[−0.806]
Cash dividends	0.559	0.003
	[0.288]	[0.006]
Capital investment	0.346	0.071
	[0.846]	[0.616]
Total liabilities	−0.067	−0.019
	[−1.485]	[−1.326]
Market-to-book	0.077	−0.007
	[1.360]	[−0.458]
Market-to-book × Crisis	−0.003	0.014
	[−0.061]	[1.064]
Real investments	0.035	0.057
	[0.589]	[0.689]
Real investments × Crisis	−0.031	−0.096
	[−1.116]	[−0.950]
No. obs	686	686
Adj. R^2	.9066	.6596
Firm FE	Y	Y
Year FE	Y	Y

This table reports estimates on the relation between a firm's outstanding short-term liabilities before the 2014 oil price crisis and its risky financial assets. Panel A reports estimates from difference-in-differences regressions, whereas panel B reports estimates from dynamic panel regressions. Panel C considers firms' investment opportunities following the onset of the crisis. *High short-term liabilities* is an indicator that equals one for firms in the top tercile of short-term liabilities/total liabilities (measured over the period 2012–2013) and zero otherwise. *Crisis* in panels A and C is an indicator that equals zero in 2011–2013 and equals one in 2014–2016. *d2011* to *d2016* in panel B are indicators variables for the corresponding years. *Real investment opportunities* are measured using hand-collected data on exploratory and development wells following the approach in Gilje (2016). The sample consists of 115 oil and gas firms with nonmissing observations from 2011 to 2016. All variable definitions appear in Appendix A. The *t*-statistics [in brackets] are adjusted for heteroscedasticity and clustered by firm.
*$p < .1$; **$p < .05$; ***$p < .01$.

at the 5% level and continue to hold after controlling for firm and year fixed effects.

We also investigate the dynamic treatment effects in panel B of Table 3. We estimate dynamic regression specifications in a 6-year window around the oil price crisis by including interaction terms for each year in this window. The year prior to the oil price crisis (2013) is defined as the base year. Panel B reveals two important results. First, economically/statistically meaningful changes in the amount of risky financial assets or the ratio of risky financial assets to total financial asset do not precede the oil price crisis. Second, both the amount and fraction of risky financial assets increase following the onset of the crisis at firms with high short-term liabilities, particularly in 2016 when

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oil prices reached their lowest levels and oil and gas firms experienced the strongest cash flow squeeze. These findings are consistent with the parallel trends assumption for the identification strategy and mitigate concerns about reverse causality or confounding effects that may be driving the changes in firms' risky financial asset holdings.

In panel C of Table 3, we consider the possibility that the increase in risky financial assets is driven by a drop in speculative demand for cash-like securities due to declining investment opportunities in the aftermath of the 2014 oil crisis. Under this view, firms invest more in risky financial assets to earn a higher return on their financial asset portfolio in the absence of investment opportunities that require maintaining large and liquid cash reserves. This explanation is consistent with the evidence in Duchin et al. (2017), who find that risky financial assets also tend to be less liquid, and the evidence in Chen, Lesmond, and Wei (2007) and Bao, Pan, and Wang (2011) that illiquidity plays an important role in yield spreads.

While this view does not predict that investing in risky financial assets will be concentrated in distressed firms with high debt rollover risk, we nevertheless investigate this possibility directly by augmenting the regression specifications with two measures of investment opportunities: (1) the market-to-book ratio as a proxy for Tobin's q; and (2) a hand-collected measure of firms' real investments following Gilje (2016). In particular, we hand-collect data on real investments from the 10-K reports of the Crude Oil & Natural Gas firms (SIC 1311) in the sample. These data are collected from firms' disclosures on "Costs Incurred in Natural Gas and Oil Exploration and Development, Acquisitions and Divestitures," which provide information related to expenditures on exploratory wells and development wells. Our measure of real investments comprises all activities associated with exploratory drilling, including both the capital to drill and the capital to acquire unproven acreage in which to drill, and all activities associated with development drilling, which include the drilling of development wells and the acquisition of proven/producing acreage for development drilling. Columns 1 and 2 include *log(Real investments)* and the ratio of *Real investments to total book assets*, respectively, and their interactions with *Crisis*.

The findings in panel C of Table 3 show that the shift in the composition of distressed firms' financial asset portfolios to riskier investments following the onset of the oil crisis is not significantly correlated with their investment opportunities. This is evident by the insignificant coefficients on the interaction terms *Market-to-book* × *Crisis* and *Real investments* × *Crisis*, and the robust significant coefficient on the interaction term *High short-term liabilities* × *Crisis* across all the specifications. This finding, in turn, is more consistent with the risk-shifting hypothesis than the notion that firms invest in more illiquid assets to earn a higher yield in the absence of future investment opportunities that require liquid reserves.

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Taken together, these results are consistent with theories of risk-shifting at high short-term liabilities firms that are more exposed to rollover risk and financial distress (Della Seta, Morellec, and Zucchi 2020). They uncover a novel channel through which firms take risk – investing their cash holdings in risky financial assets, which, compared to real assets, are less visible and carry lower transaction costs and accelerated payoffs.

2.3 Robustness

In this subsection, we provide estimates from several robustness tests. First, we reestimate the analyses in a subsample of oil producers that excludes firms with diversified operations, such as oil refinement, which entails a directionally opposite exposure to oil price declines. Second, we consider alternative measures of short-term liabilities, including different maturities and continuous measures. Third, we reestimate the analyses in a first-differences framework. Lastly, we consider investments in risky real assets.

In panel A of Table 4, we reestimate the regressions in a subsample of 102 oil producers that exclude large oil firms with diversified operations, such as oil refinement. The purpose of these analyses is to investigate whether the results continue to hold after excluding large firms that may vary in their exposure to the oil price crisis and consequently have different degrees of risk-taking incentives. For instance, operating in oil refinement entails a directionally opposite exposure to oil price declines. Despite the lower test power in the smaller sample of focused oil producers, the results are consistent with the full-sample estimates. Oil producers with high levels of short-term liabilities have increased the fraction of their financial portfolio invested in risky financial assets by 19.3 percentage points compared to firms with low levels of short-term liabilities following the onset of the oil price crisis.

(continued) In panel B of Table 4, we consider debt maturities of 1 and 3 years rather than the 2-year maturity structure used in the main analyses. As shown in panel B, we obtain estimates similar to those in the main analyses for both dependent variables (*log(Risky financial assets)* and *Risky financial assets/financial assets*). These findings suggest that the results are not sensitive to alternative definitions of short-term liabilities, consistent with the effect of rollover risk on risk-taking. In particular, since we measure firms' short-term liabilities in the 2 years preceding the onset of the oil price crisis, liabilities with maturities of 1–3 years were all likely to become due following the onset of the crisis, potentially triggering financial distress.

While we follow the literature on debt rollover risk (e.g., Barclays and Smith 1995; Custódio, Ferreira, and Laureano 2013; Chen, Xu, and Yang 2021) and scale short-term liabilities by total liabilities, in panel C of Table 4 we provide estimates from an alternative scaling method that scales short-term liabilities by total book assets. As shown in panel C, we obtain similar results using this alternative scaling method. The reason is that the

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Table 4
Robustness

A. Oil and gas producers

Dependent variable	*log(Risky financial assets)* (1)	*Risky financial assets/financial assets* (2)
High short-term liabilities × Crisis	0.901**	0.193**
	[2.477]	[2.465]
Size	0.280**	0.003
	[2.566]	[0.189]
Profitability	−0.135	−0.039
	[−0.486]	[−0.891]
Market-to-book	0.081	−0.003
	[1.458]	[−0.248]
Cash dividends	−1.275	0.015
	[−0.936]	[0.034]
Capital investment	0.253	0.015
	[0.733]	[0.180]
Total liabilities	−0.075	−0.015
	[−1.633]	[−1.567]
No. obs	572	572
Adj. R^2	.9044	.688
Firm FE	Y	Y
Year FE	Y	Y

B. Alternative debt maturities

Debt maturity	One-year short-term liabilities		Three-year short-term liabilities	
Dependent variable	*log(Risky financial assets)* (1)	*Risky financial assets/financial assets* (2)	*log(Risky financial assets)* (3)	*Risky financial assets/financial assets* (4)
High short-term liabilities × Crisis	0.630***	0.120**	0.530***	0.134***
	[3.457]	[2.444]	[2.781]	[2.774]
Size	0.266***	0	0.263***	−0.001
	[3.117]	[0.019]	[2.758]	[−0.071]
Profitability	−0.132	−0.041	−0.11	−0.04
	[−0.505]	[−0.660]	[−0.420]	[−0.658]
Market-to-book	0.078	−0.005	0.076	−0.004
	[1.393]	[−0.359]	[1.296]	[−0.242]
Cash dividends	0.397	0.08	0.589	0.085
	[0.201]	[0.196]	[0.306]	[0.204]
Capital investment	0.408	0.078	0.413	0.068
	[1.171]	[0.703]	[1.146]	[0.597]
Total liabilities	−0.067	−0.017	−0.074*	−0.019
	[−1.530]	[−1.325]	[−1.706]	[−1.587]
No. obs	686	686	686	686
Adj. R^2	.9066	.6588	.9056	.6609
Firm FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y

(continued)

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Table 4
Continued

C. Short-term liabilities scaled by total assets

Dependent variable	*log(Risky financial assets)* (1)	*Risky financial assets/financial assets* (2)
High short-term liabilities × Crisis	0.447**	0.078*
	[2.426]	[1.756]
Size	0.272***	0.002
	[2.844]	[0.087]
Profitability	−0.126	−0.037
	[−0.485]	[−0.583]
Market-to-book	0.053	−0.01
	[0.883]	[−0.710]
Cash dividends	0.636	0.131
	[0.345]	[0.325]
Capital investment	0.523	0.104
	[1.488]	[0.873]
Total liabilities	−0.07	−0.017
	[−1.432]	[−1.320]
No. obs	686	686
Adj. R^2	.905	.6542
Firm FE	Y	Y
Year FE	Y	Y

D. Continuous ranking variables

Dependent variable	*log(Risky financial assets)* (1)	*Risky financial assets/financial assets* (2)
Short-term liabilities × Crisis	0.846***	0.140**
	[2.915]	[2.171]
Size	0.272***	0.004
	[2.775]	[0.271]
Profitability	−0.047	−0.016
	[−0.171]	[−0.359]
Market-to-book	0.062	−0.007
	[1.179]	[−0.562]
Cash dividends	0.267	−0.002
	[0.153]	[−0.006]
Capital investment	0.464	0.051
	[1.352]	[0.642]
Total liabilities	−0.074*	−0.014
	[−1.666]	[−1.374]
No. obs	686	686
Adj. R^2	.905	.678
Firm FE	Y	Y
Year FE	Y	Y

alternative scaling method does not have a material effect on the classification of firms into the high versus low short-term liabilities buckets.

In panel D, we replace the indicator variable *High short-term liabilities* with the continuous variable *Short-term liabilities*, defined as the average ratio of short-term liabilities to total liabilities in 2012 and 2013, the 2 years before the onset of the oil price crisis. The results in columns 1 and 2 indicate that

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Table 4
Continued

E. Changes in risky financial assets

Dependent variable	Δ *log(Risky financial assets)*		Δ *Risky financial assets/financial assets*	
	Pre-crisis (1)	Crisis (2)	Pre-crisis (3)	Crisis (4)
Short-term liabilities/total liabilities	−0.308	1.324*	−0.019	0.440***
	[−0.867]	[1.828]	[−0.258]	[2.910]
Size	−0.008	0.013	−0.006	0.007
	[−0.166]	[0.153]	[−0.858]	[0.611]
Profitability	−0.275	0.687	−0.008	0.132
	[−0.319]	[0.846]	[−0.051]	[1.144]
Market-to-book	−0.050	0.077	−0.001	−0.013
	[−0.784]	[0.662]	[−0.083]	[−0.617]
Cash dividends	1.841	-1.37	0.096	0.691
	[0.722]	[−0.407]	[0.141]	[0.774]
Capital investment	−0.350	0.715	0.042	0.124
	[−0.530]	[0.501]	[0.334]	[0.478]
Total liabilities	0.022	0.148	−0.003	0.218
	[0.425]	[0.112]	[−0.301]	[0.660]
No. obs	111	115	111	115
Adj. R^2	.023	.04794	.006	.09957

F. Risky real assets

Dependent variable	*log(Risky financial assets)* (1)	*Risky financial assets/financial assets* (2)
High short-term liabilities × Crisis	0.593***	0.115**
	[3.149]	[2.303]
Size	0.271***	0.000
	[3.173]	[−0.013]
Profitability	−0.16	−0.039
	[−0.631]	[−0.613]
Market-to-book	0.074	−0.004
	[1.258]	[−0.263]
Cash dividends	0.611	0.07
	[0.318]	[0.160]
Capital investment	0.433	0.085
	[1.231]	[0.743]
Total liabilities	−0.065	−0.018
	[−1.430]	[−1.451]
Risky real investments	0.023	−0.06
	[0.395]	[−0.572]
No. obs	686	686
Adj. R^2	.9064	.6582
Firm FE	Y	Y
Year FE	Y	Y

This table provides regression estimates from robustness tests. In panel A, the sample is restricted to a subset of 102 oil and gas producers (SIC codes from 1300 to 1399) with nonmissing observations from 2011 to 2016. In panel B, we replace 2-year short-term liabilities with 1- and 3-year liabilities. In panel C, we scale short-term liabilities by total assets. In panel D, we use the continuous ratio of short-term liabilities to total liabilities. In panel E, we examine the relation between a firm's outstanding short-term liabilities and changes in its risky financial assets. In columns 1 and 3, which correspond to the pre-crisis period, we measure *Short-term liabilities* in 2010, just before the pre-crisis period. In columns 2 and 4, which correspond to the post-crisis period, we measure *Short-term liabilities* in 2013, just before the crisis period. In panel F, the regression models control for firms' investments in risky real assets, defined as all activities associated with exploratory drilling, including both the capital to drill and the capital to acquire unproven acreage in which to drill. All regressions include year and firm fixed effects. All variable definitions appear in Appendix A. The *t*-statistics [in brackets] are adjusted for heteroscedasticity and clustered by firm.
*$p < .1$; **$p < .05$; ***$p < .01$.

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firms with higher levels of short-term liabilities invested more in risky financial assets following the onset of the crisis. The estimates are economically meaningful and statistically significant. They imply that an increase of one standard deviation in short-term liabilities (standard deviation = 0.310) corresponds to an increase of 26.23% in the dollar amount of risky financial assets and an increase of 4.3 percentage points in the ratio of risky financial assets to total financial assets.

In panel E, we provide estimates from an alternative regression specification that considers *changes* in firms' financial assets. A key feature of panel E is that changes in financial investments are measured separately before the crisis from 2011 to 2013 and after the onset of the crisis from 2014 to 2016. The results in panel E are twofold. First, in the 3 years before the oil price crisis (2011–2013), firms' short-term liabilities did not affect changes in the composition of their financial assets. Second, in the 3 years following the oil price crisis (2014–2016), firms with higher short-term liabilities decreased the allocation to safe financial assets and simultaneously increased the allocation to risky financial assets. These estimates are statistically significant at conventional levels and economically large. An increase of one standard deviation in the ratio of short-term liabilities to total liabilities corresponds to an increase of 41.1% (13.6 percentage points) in the dollar amount (fraction) of cash invested in risky financial assets. Collectively, these findings suggest that following the onset of the crisis (but not before the crisis), firms with high short-term liabilities reduced their investments in safe assets in lieu of risky financial assets.

In panel F, we control for investments in risky real assets. Following Gilje (2016), we construct a measure of firms' risky real investments that includes all activities associated with exploratory drilling. This includes both the capital to drill and the capital to acquire unproven acreage in which to drill. In contrast, safe real assets include development wells, which are those drilled within the proven area of an oil or gas reservoir to the depth of a stratigraphic horizon known to be productive.

We construct two measures of risky real assets investments, which are similar to the measures of risky financial investments. The first measure is the logarithm of the amount (in $ millions) of risky real investments:

$$log(Risky\ real\ investments) = log(1 + \ exploratory\ oil\ wells).$$

The second measure is the ratio of investment in exploratory wells to total investment in wells:

$$Risky\ realinvestments/real\ investments = \frac{Exploratory\ oil\ wells}{Exploratory + development\ wells}.$$

Panel F shows evidence on the effect of pre-crisis short-term liabilities on firms' investments in risky financial assets after controlling for risky real

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assets. *Risky real investments* is *log(Risky investments)* and *Risky real investments/real investments* in columns 1 and 2, respectively. Both coefficient estimates are statistically insignificant, while the coefficients on the interaction term *High short-term liabilities* × *Crisis* remain similar in size and statistical significance, implying that the results are robust to including firms' real assets investments.

2.4 Bankruptcy

In this subsection, we provide direct evidence on the role of debt rollover risk, distress, and subsequent bankruptcy in risk-taking by collecting information on bankruptcy filings and delistings of oil and gas companies following the onset of the oil price crisis. We obtain these data from the UCLA-LoPucki Bankruptcy Research Database and CRSP for a total of 5 bankruptcy filings and 4 delistings in 2015 and 16 bankruptcy filings and 5 delistings in 2016. To investigate the role of bankruptcy in the firms' financial investments, we construct an indicator variable *Bankruptcy* that equals one for firms that file for bankruptcy in the subsequent 1 or 2 years, respectively, and zero otherwise. As before, we estimate panel regressions explaining the composition of corporate cash holdings that include time-varying controls and firm and year fixed effects.

Table 5 shows that distressed firms, which end up filing for bankruptcy following the oil price crisis, invest more in risky financial assets 1 or 2 years

Table 5
Bankruptcy filings

	log(Risky financial assets) (1)	*Risky financial assets/financial assets* (2)
Bankruptcy	0.875**	0.195*
	[2.128]	[1.746]
Size	0.154	−0.043
	[0.546]	[−0.951]
Profitability	0.046	−0.014
	[0.078]	[−0.147]
Market-to-book	−0.081	−0.03
	[−0.586]	[−0.912]
Cash dividends	−2.007	−0.038
	[−0.518]	[−0.059]
Capital investment	0.367	−0.063
	[0.691]	[−0.439]
Total liabilities	−0.009	0.001
	[−0.163]	[0.083]
No. obs	452	452
Adj. R^2	.894	.7589
Firm FE	Y	Y
Year FE	Y	Y

This table reports estimates from panel regressions on the relation between future bankruptcy and investment in risky financial assets. *Bankruptcy* is an indicator that equals one if the firm will file for bankruptcy in the next 2 years. We obtain data on bankruptcy filings from the UCLA-LoPucki Bankruptcy Research Database. The sample consists of 115 oil and gas firms with nonmissing observations from 2011 to 2016. All regressions include year and firm fixed effects. All variable definitions appear in Appendix A. The *t*-statistics [in brackets] are adjusted for heteroscedasticity and clustered by firm.
*$p < .1$; **$p < .05$; ***$p < .01$.

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before the bankruptcies. The coefficients on *Bankruptcy* are positive across both measures of risky financial assets and are statistically significant at the 5% or 10% level. The economic magnitudes are large. Future bankruptcy filings imply an increase of 87.5% in the dollar amount of risky financial assets and 19.5 percentage points in the ratio of risky financial assets to total financial assets. These findings provide evidence that the most distressed firms, which ended up filing for bankruptcy following the crisis, used their financial asset portfolios to take considerable amounts of risk, consistent with theories of risk-shifting.

3. Extensions

3.1 Collateral

In this subsection, we present subsample analyses of the role of collateral assets in risk-taking at financially distressed firms. We hypothesize that higher levels of collateral assets will be associated with lower levels of investments in risky financial assets following the onset of the oil price crisis because collateral attenuates firms' risk-taking incentives. In particular, collateral prevents wealth transfers from debtholders to shareholders by mitigating information asymmetry (Boot, Thakor and Udell 1991) and reducing costly monitoring by lenders (Rajan and Winton 1995). Thus, risk-taking should occur primarily at distressed firms with low levels of collateral.

To test this hypothesis, we estimate regressions explaining firms' risky financial investments separately in subsamples of firms with high versus low levels of collateral assets. To construct these subsamples, we divide all sample firms into two groups around their median collateral values at the end of 2012–2013. Following the literature (e.g., Rampini and Viswanathan 2013; Li, Whited, and Wu 2016), we measure the value of collateral assets using the value of tangible assets scaled by book assets.

Table 6 provides the results. Specifically, it provides estimates from difference-in-differences regressions explaining risky financial investments that include the set of time-varying controls from the previous tables as well as firm and year fixed effects. Columns 1 and 3 estimate the effect of the oil crisis on *log(Risky financial assets)* of high-liabilities firms with low versus high values of collateral assets, respectively. The estimates suggest that highly levered firms with low levels of collateral increased their risky financial investment by 69.7% more than counterparts with low levels of short-term liabilities (coefficient = 0.697; *t*-statistic = 3.013), whereas highly levered firms with high levels of collateral assets did not increase them significantly (coefficient = −0.03; *t*-statistic = 0.147). Moreover, the difference between these coefficients is 72.7%, and is highly statistically significant at the 1% level (*t*-statistic = 3.256).

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Table 6
Debt collateral

Subsamples	Low collateral (below median)		High collateral (above median)		Difference	
Dependent variable	*log(Risky financial assets)* (1)	*Risky financial assets/financial assets* (2)	*log(Risky financial assets)* (3)	*Risky financial assets/financial assets* (4)	*log(Risky financial assets)* (5)	*Risky financial assets/financial assets* (6)
High short-term liabilities × Crisis	0.697***	0.111*	−0.03	−0.068	0.727***	0.179**
	[3.013]	[1.910]	[−0.147]	[−0.966]	[3.256]	[2.322]
Size	0.295**	−0.007	0.252*	0.009		
	[2.243]	[−0.243]	[1.700]	[0.301]		
Profitability	−0.075	−0.061	−0.481	−0.096		
	[−0.265]	[−0.771]	[−0.918]	[−0.866]		
Market-to-book	0.046	0.007	0.137	−0.001		
	[0.765]	[0.561]	[1.138]	[−0.029]		
Cash dividends	2.238	0.431	−4.842**	−1.433		
	[1.057]	[1.360]	[−2.040]	[−1.398]		
Capital investment	0.815	0.404**	0.331	−0.072		
	[1.099]	[2.318]	[0.859]	[−0.614]		
Total liabilities	0.001	−0.041**	−0.115*	−0.002		
	[0.008]	[−2.166]	[−1.918]	[−0.134]		
No. obs	342	342	344	344		
Adj. R^2	.9055	.7636	.8989	.6038		
Firm FE	Y	Y	Y	Y		
Year FE	Y	Y	Y	Y		

This table reports subsample estimates from difference-in-differences regressions on the relation between a firm's outstanding short-term liabilities before the 2014 oil price crisis and its risky financial assets. We divide the sample around median collateral values over the period 2012–2013. *High short-term liabilities* is an indicator variable that equals one for firms in the top half of *Short-term liabilities/total liabilities* (measured over the period 2012–2013) and zero otherwise. *Crisis* is an indicator variable that equals zero in 2011–2013 and equals one in 2014–2016. The sample consists of 115 oil and gas firms with nonmissing observations from 2011 to 2016. All regressions include year and firm fixed effects. All variable definitions appear in Appendix A. The *t*-statistics [in brackets] are adjusted for heteroscedasticity and clustered by firm.
*$p < .1$; **$p < .05$; ***$p < .01$.

Similarly, columns 2 and 4 focus on *Risky financial assets/financial assets* across firms with low versus high collateral assets, respectively. The estimates show that highly levered firms with low collateral values increased the ratio of risky financial assets to total financial assets by 17.9 percentage points more than firms with low collateral values, and this difference is also highly statistically significant (*t*-statistic = 2.322). Together, the subsample estimates in Table 6 suggest that collateral assets mitigate the effect of rollover risk and distress on firms' financial risk taking.

3.2 Derivative hedging

In this subsection, we investigate the influence of derivative hedging on corporate risk-taking. While theory on corporate risk management suggests that hedging can effectively mitigate risk and enhance firm value (e.g., Froot et al. 1993; Leland 1998; Chidambaran et al. 2001), prior empirical studies do not offer conclusive evidence that hedging matters for firm policies and value (e.g., Guay and Kothari 2003; Jin and Jorion 2006; Bartram et al. 2011). We

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seek to provide novel evidence on an unexplored channel through which hedging can influence incentives, policies, and outcomes in firms, namely, the risk-taking channel. We conjecture that derivative hedging can weaken the incentives to take risk by reducing the exposure of highly levered firms to adverse shocks.

To investigate the role of derivative hedging in risk-taking, we hand-collect detailed data on oil and gas firms' use of oil derivative contracts in 2013, before the onset of the oil price crisis. Using these data, we classify the sample firms into hedging and nonhedging firms, and estimate regressions explaining risky financial investments separately in each subsample.

Table 7 presents these results. Specifically, it provides estimates from difference-in-differences regressions in which the key explanatory variable is the interaction term, *High short-term liabilities x crisis.* The results suggest that the increase in risky financial assets following the onset of the oil price crisis is larger in unhedged firms with high outstanding short-term debt positions. When the dependent variable is *log(Risky financial assets)* (columns 1 and 3), the difference in the coefficient estimates on *High short-term liabilities*

Table 7
Derivative hedging

Subsamples	Firms without hedging		Firms with hedging		Difference	
Dependent variable	*log(Risky financial assets)* (1)	*Risky financial assets/financial assets* (2)	*log(Risky financial assets)* (3)	*Risky financial assets/financial assets* (4)	*log(Risky financial assets)* (5)	*Risky financial assets/financial assets* (6)
High short-term liabilities × Crisis	0.627**	0.148**	0.102	0.026	0.525**	0.122*
	[2.485]	[2.115]	[0.793]	[0.524]	[2.135]	[1.916]]
Size	0.198	−0.027	0.368***	0.016		
	[1.196]	[−0.809]	[3.283]	[0.597]		
Profitability	−0.023	−0.038	−0.205	−0.006		
	[−0.075]	[−0.408]	[−0.412]	[−0.068]		
Market-to-book	0.084	0.003	0.116	0.011		
	[1.496]	[0.171]	[0.892]	[0.293]		
Cash dividends	−1.73	0.469	2.237	−0.29		
	[−0.922]	[0.847]	[0.846]	[−0.416]		
Capital investment	−0.037	0.292	0.625	−0.02		
	[−0.050]	[1.243]	[1.444]	[−0.146]		
Total liabilities	−0.048	−0.043**	−0.103	−0.004		
	[−0.899]	[−2.461]	[−1.634]	[−0.250]		
No. obs	263	263	423	423		
Adj. R^2	.8969	.6947	.9079	.643		
Firm FE	Y	Y	Y	Y		
Year FE	Y	Y	Y	Y		

This table reports tests from difference-in-differences regressions on the relation between a firm's outstanding short-term liabilities before the 2014 oil price crisis and its risky financial assets. We divide the sample firms into two subsamples based on whether or not they report derivative hedging prior to the crisis. *High short-term liabilities* is an indicator that equals one for firms in the top half of *Short-term liabilities/total liabilities* (measured in 2012 and 2013) and zero otherwise. *Crisis* is an indicator that equals zero in 2011–2013 and equals one in 2014–2016. The sample consists of 115 oil and gas firms with nonmissing observations from 2011 to 2016. All regressions include year and firm fixed effects. All variable definitions appear in Appendix A. The *t*-statistics [in brackets] are adjusted for heteroscedasticity and clustered by firm.
*$p < .1$; **$p < .05$; ***$p < .01$.

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x Crisis between unhedged and hedging firms is 0.525 (*t*-statistic = 2.135), suggesting that unhedged firms with high short-term liabilities increase risky financial investments by 52.5% more than their counterparts with derivative hedging. When the dependent variable is *Risky financial assets/financial assets*, the difference between these coefficient estimates is 0.122 (*t*-statistic = 1.916), suggesting that unhedged firms increase the ratio of risky financial assets to total financial assets by 12.2 percentage points more than their counterparts with derivative hedging position. These findings support the hypothesis hedging weakens firms' incentives to increase their financial risk-taking amid adverse economic shocks.

3.3 Agency conflicts and funds' dual holdings of debt and equity

In this subsection, we seek to provide more direct evidence on the role of agency conflicts and corporate governance in distressed firms' risky financial investments. To do so, we construct a measure of corporate governance that captures the severity of the conflict of interest between equity holders and creditors. In particular, we follow the recent literature on funds' simultaneous holdings of a firm's debt and equity (e.g., Jiang et al. 2010; Yang 2021), which we refer to henceforth as "dual holdings," and collect detailed data on the heterogeneity in duals holdings across the firms in our sample. We hypothesize that firms with low levels of dual holdings are more likely to suffer from conflicts of interest between their creditors and equity holders, which, in turn, will lead to risk-shifting. In contrast, at firms with relatively high levels of dual holdings, where the firm's creditors are also the firm's equity holders, we would expect to see lower levels of risk-shifting.

In Table 8, we provide subsample regression estimates explaining firms' risky financial investments We divide the sample around the median level of firms' dual holdings, measured before the onset of the oil crisis in 2012–2013. Consistent with our hypothesis and the risk-shifting hypothesis, the estimates in Table 8 suggest that the increase in risky financial investments at following the onset of the oil crisis is concentrated in firms with low levels of dual holdings. In particular, the coefficient estimates on the interaction term *High short-term liabilities* × *Crisis* are positive, economically large, and statistically significant at the 1% or 5% level in the subsample of low dual holdings firms, and are small and statistically insignificant in the subsample of high dual holdings firms. Furthermore, the differences between the coefficient estimates for low versus high dual holdings firms are statistically significant at the 5% level.

Taken together, these findings provide direct evidence that conflicts of interest between creditors and equity holders play a role in distressed firms' risk-shifting through risky financial investments. In low dual holdings firms, the creditors and equity holders are separate, and equity holders therefore have

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Table 8
Agency conflicts: Funds' dual holdings of debt and equity

Subsamples	Low dual holdings		High dual holdings		Difference	
Dependent variable	*log(Risky financial assets)* (1)	*Risky financial assets/financial assets* (2)	*log(Risky financial assets)* (3)	*Risky financial assets/financial assets* (4)	*log(Risky financial assets)* (5)	*Risky financial assets/financial assets* (6)
High short-term liabilities × Crisis	0.504***	0.121**	0.039	−0.027	0.465**	0.148**
	[2.672]	[2.189]	[0.196]	[−0.450]	[2.186]	[2.212]
Size	0.163	−0.004	0.518***	0.015		
	[1.379]	[−0.162]	[3.414]	[0.416]		
Profitability	−0.142	−0.114*	−0.102	0.028		
	[−0.656]	[−1.724]	[−0.149]	[0.221]		
Market-to-book	0.078	0.005	0.372*	0.012		
	[1.447]	[0.289]	[1.712]	[0.193]		
Cash dividends	1.181	−0.091	−1.446	3.189*		
	[0.602]	[−0.253]	[−0.317]	[1.761]		
Capital investment	−0.154	−0.02	1.204**	0.108		
	[−0.459]	[−0.179]	[2.098]	[0.482]		
Total liabilities	−0.092	−0.034**	−0.154*	−0.002		
	[−1.635]	[−2.066]	[−2.002]	[−0.080]		
No. obs	339	339	347	347		
Adj. R^2	.9128	.7301	.889	.6134		
Firm FE	Y	Y	Y	Y		
Year FE	Y	Y	Y	Y		

This table reports subsample estimates from difference-in-differences regressions on the relation between a firm's outstanding short-term liabilities before the 2014 oil price crisis and its risky financial assets. *Dual holdings* measure the heterogeneity in funds' simultaneous holdings of a firm's debt and equity across firms (e.g., Jiang et al. 2010; Yang 2021). We divide the sample around the median level of dual holdings in our sample over the period 2012–2013. *High short-term liabilities* is an indicator variable that equals one for firms in the top half of *Short-term liabilities/total liabilities* (measured over the period 2012–2013) and zero otherwise. *Crisis* is an indicator variable that equals zero in 2011–2013 and equals one in 2014–2016. The sample consists of 115 oil and gas firms with nonmissing observations from 2011 to 2016. All regressions include year and firm fixed effects. All variable definitions appear in Appendix A. The *t*-statistics [in brackets] are adjusted for heteroscedasticity and clustered by firm.
*$p < .1$; **$p < .05$; ***$p < .01$.

an incentive to increase the equity value at the expense of creditors, that is, to risk-shift.

3.4 Sources of risky financial assets

In this subsection, we investigate the sources of the funds that firms invest in risky financial assets before and after the onset of the oil price crisis. We follow McLean (2011) and estimate the propensity to invest in risky financial assets out of the firm's safe financial assets, operating cash flows and security issuances. In these analyses, the dependent variable is the annual change in the risky financial assets scaled by last year's total assets, and the explanatory variables include the possible sources of funds: safe financial assets, operating cash flows, and debt or equity issuances, scaled by total assets of the previous year.

The estimates in Table 9 show that in the 3 years before the onset of the oil price crisis, high short-term liabilities firms did not allocate funds to risky

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Table 9
The sources of investments in risky financial assets

Period	Pre-Crisis		Crisis	
	(1)	(2)	(3)	(4)
Δ *Safe financial assets(t)/assets(t−1)*	−0.013	0.036	−0.069	0.016
	[−0.375]	[0.929]	[−1.148]	[0.368]
Δ *Safe financial assets(t)/assets(t−1)* × *High short-term liabilities*		−0.087		−0.249**
		[−1.412]		[−2.436]
Cash flows	0.012	0.009	−0.007	−0.004
	[0.813]	[0.547]	[−0.357]	[−0.179]
Debt issue	0.022**	0.022**	0.035**	0.031*
	[2.117]	[2.117]	[2.134]	[1.934]
Equity issue	0.02	0.023*	0.012	0.006
	[1.615]	[1.836]	[0.140]	[0.074]
Other funds	0.02	0.023	0.082	0.089
	[0.506]	[0.561]	[0.975]	[1.278]
Size	−0.002	−0.002	−0.006	−0.013
	[−0.244]	[−0.354]	[−0.492]	[−1.137]
Profitability	0.006	0.003	−0.048*	−0.035
	[0.447]	[0.180]	[−1.952]	[−1.495]
Market-to-book	0	−0.001	−0.01	−0.01
	[−0.032]	[−0.322]	[−1.188]	[−1.144]
Cash dividends	−0.131	−0.115	0.117	0.122
	[−0.634]	[−0.602]	[0.804]	[0.824]
Capital investment	0.021	0.019	0.001	−0.002
	[1.375]	[1.160]	[0.036]	[−0.096]
Total liabilities	−0.002	0.003	0.004	0.003
	[−0.052]	[0.086]	[1.178]	[0.862]
No. obs	336	336	343	343
Adj. R^2	.468	.4843	.3306	.3743
Firm FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y

This table reports regression estimates of the funding sources of investments in risky financial assets. The dependent variable in the annual change in a firm's risky financial assets scaled by last year's total assets. The main explanatory variables include the scaled annual change in a firms' safe financial assets (and its interaction with *High short-term liabilities*), operating cash flows, net debt and equity issuances, and all other sources of funds, which include the sale of assets and investments. *High short-term liabilities* is an indicator variable that equals one for firms in the top tercile of Short-term liabilities/total liabilities (measured over the period 2012–2013) and zero otherwise. The pre-crisis period is from 2011 to 2013. The crisis period is from 2014 to 2016. The sample consists of 115 oil and gas firms with nonmissing observations from 2011 to 2016. All variable definitions appear in Appendix A. The *t*-statistics [in brackets] are adjusted for heteroscedasticity and clustered by firm.
*$p < .1$; **$p < .05$; ***$p < .01$.

financial assets out of their safe financial assets. The main sources of firms' investments in risky financial assets were debt and equity issuances. In contrast, in the 3 years following the onset of the crisis, high liabilities firms invested funds out of their safe financial asset in risky financial assets. These findings provide direct evidence that distressed firms with high levels of debt rollover risk increased their risk by reallocating safe financial assets into risky financial assets. By actively changing the composition of their cash holdings, these firms increased their exposure to riskier, higher yield financial assets despite being financially constrained.

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Therefore, this evidence is consistent with risk-shifting theories (Della Seta, Morellec, and Zucchi 2020), which predict that highly levered firms will increase their risk-taking when they face debt rollover risk.

3.5 The marginal value of risky financial assets

In this subsection, we investigate the marginal market value of risky financial assets by estimating value of cash regression models a-la Faulkender and Wang (2006) separately for firms with low versus high short-term debt positions, before and after the onset of the oil crisis. Table 10 presents these analyses. In these regression models, the key independent variable is Δ *Risky financial assets*. This variable captures how shareholders perceive the marginal value of increasing the firm's investment in risky financial assets by one dollar.

Table 10
The marginal value of risky financial assets

	Low short-term liabilities		High short-term liabilities	
	Pre-crisis (1)	Crisis (2)	Pre-crisis (3)	Crisis (4)
Δ *Risky financial assets*	−0.368	1.054	−0.864	2.384**
	[−0.465]	[0.940]	[−0.147]	[2.270]
Δ *Safe financial assets*	0.986	0.070	1.231*	−0.359
	[1.653]	[0.061]	[1.880]	[−0.335]
Δ *Earnings*	−0.210	0.149	−0.318	0.248
	[−1.174]	[0.571]	[−0.380]	[0.683]
Δ *Net assets*	−0.114	−0.247	0.036	0.185
	[−0.948]	[−1.082]	[0.085]	[0.441]
Δ *Interest expenses*	−2.855	12.606	−5.753	7.558
	[−0.608]	[0.869]	[−0.318]	[0.436]
Δ *Cash dividends*	−1.04	2.467	5.789	−9.604
	[−0.199]	[0.257]	[0.749]	[−1.156]
Net financing	0.231	0.199	0.17	−0.768
	[0.757]	[0.213]	[0.239]	[−1.002]
Cash holding	0.698	0.815	−0.077	−0.431
	[1.007]	[0.537]	[−0.167]	[−0.580]
Leverage	1.029	−1.172	0.294	1.255
	[1.247]	[−0.558]	[0.156]	[0.687]
Size	−0.055	−0.103	−0.060	−0.378
	[−0.483]	[−0.526]	[−0.192]	[−1.534]
No. obs	176	133	81	78
Adj. R^2	.685	.7732	.5619	.6755

The table estimates the marginal value of financial assets for firms with low versus high short-term liabilities. The dependent variable is excess return, which is the cumulative return in the past 1 year minus the return on corresponding Fama-French 25 size and BE/ME portfolio. The main explanatory variables include the annual change in a firms' risky and safe financial assets, earnings, net assets, interest expenses, and cash dividends, scaled by equity value of the previous year, as well as the net financing, cash holding, leverage, and size of the previous year. We sort firm into terciles based on short-term liabilities/total liabilities (measured over the period 2012–2013), and classify the firms in the top tercile as those with high short-term liabilities and those in the bottom two terciles as those with low short-term liabilities. The pre-crisis period is from 2011 to 2013. The crisis period is from 2014 to 2016. The sample consists of oil and gas firms with nonmissing stock returns and observations from 2011 to 2016. All variable definitions appear in Appendix A. The *t*-statistics [in brackets] are adjusted for heteroscedasticity and clustered by firm.
*$p < .1$; **$p < .05$; ***$p < .01$.

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The estimates in Table 10 show that increasing investment in risky financial assets does not affect equity values at nondistressed firms with low short-term debt balances or before the onset of the oil crisis in 2014. This finding is consistent with the prediction that financially unconstrained firms are indifferent to investing in risky financial assets. However, following the onset of the oil crisis, at distressed firms exposed to the rollover risk of high short-term debt positions, increasing investments in risky financial assets lead to a considerable increase in stock returns. In particular, the coefficient estimate on the variable Δ *Risky financial assets* in column 4, which corresponds to high-short term debt firms following the onset of the crisis, is positive, economically large (coefficient = 2.384), and statistically significant (t-statistic = 2.270), suggesting that the marginal value of a dollar invested in risky financial assets is considerably higher than one.

These estimates are consistent with the risk-shifting hypothesis. In particular, they suggest that equity holders view risk-taking at distressed firms positively, consistent with shifting value from creditors to equity holders. Importantly, these findings hold after controlling for the change in safe financial asset holdings, thus capturing the tilt in the risk composition of firms' financial asset portfolio, holding its size constant.

3.6 Ex post cash flow volatility

In the final set of analyses, we investigate the relation between the composition of corporate cash holdings and firms' overall risk. For example, if firms substitute risky financial investments for risky real investments, the overall relation to a firm's risk can go either way because the reduction in the riskiness of the real asset portfolio can offset the increase in the riskiness of the financial asset portfolio. Moreover, risky financial investments can eliminate idiosyncratic risk by diversifying the firm's investment portfolio. Under this scenario, the link between risky financial investments and risk-taking becomes less clear.

In Table 11, we investigate this possibility by estimating the relation between risky financial investments and the volatility of a firm's earnings (columns 1 and 2) or profitability (columns 3 and 4) over the eight quarters following the onset of the crisis. For each measure of volatility, we report regression results corresponding to both measures of risky financial assets: *log(Risky financial assets)* and *Risky financial assets/financial assets*.

Table 11 shows that across both measures of volatility, higher risky financial investments following the onset of the crisis are followed by higher levels of volatility. This result is evident from the positive coefficient on the interaction term *Risky financial assets x Crisis*. The estimates are statistically significant at conventional levels and the economic magnitudes are meaningful. For example, an increase of one standard deviation in *Risky financial assets/total financial assets* is associated with an increase of 3.1% in the

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Table 11
Overall risk

Dependent variable	Volatility of earnings		Volatility of profitability	
Risky financial assets	*log(Risky financial assets)* (1)	*Risky financial assets/financial assets* (2)	*log(Risky financial assets)* (3)	*Risky financial assets/financial assets* (4)
Risky financial assets × Crisis	0.007***	0.101***	0.005***	0.058**
	[2.819]	[3.117]	[2.824]	[2.409]
Size	0.012	0.007	0.004	0.001
	[0.912]	[0.488]	[0.384]	[0.112]
Profitability	0.025	0.024	0.049	0.047
	[0.586]	[0.548]	[1.158]	[1.119]
Market-to-book	−0.016	−0.013	−0.019	−0.017
	[−1.066]	[−0.895]	[−1.388]	[−1.267]
Cash dividends	−0.081	−0.045	0.059	0.087
	[−0.466]	[−0.270]	[0.380]	[0.563]
Capital investment	0.041	0.034	0.023	0.021
	[0.516]	[0.422]	[0.322]	[0.302]
Total liabilities	0.006	0.004	0.011	0.010
	[0.463]	[0.340]	[1.147]	[1.033]
No. obs	599	599	632	632
Adj. R^2	.5387	.5537	.658	.667
Firm FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y

This table provides evidence on the effect of investments in risky financial assets around the 2014 oil price crisis on the firm's overall risk, as measured by the volatility of earnings (columns 1 and 2), and profitability (columns 3 and 4) over the eight quarters following the onset of the crisis. In columns 1 and 3, we measure risky financial investments using *log(Risky financial assets)*. In columns 2 and 4, we measure risky financial investments using *Risky financial assets/financial assets*. The sample consists of 115 oil and gas firms with nonmissing observations from 2011 to 2016. *Crisis* is an indicator variable that equals zero in 2011–2013 and equals one in 2014–2016. All variable definitions appear in Appendix A. The *t*-statistics [in brackets] are adjusted for heteroscedasticity and clustered by firm.
*$p < .1$; **$p < .05$; ***$p < .01$.

annualized volatility of earnings and an increase of 1.8% in the annualized volatility of profits.

Overall, these results suggest that risky financial investments do not reduce overall risk by substituting for risky real investments or by diversifying a firm's holdings portfolio, consistent with their role in corporate risk-taking.

4. Conclusion

We hand-collect detailed data on firms' financial asset portfolios to study how nonfinancial distressed firms use financial securities to increase their risk. We find that firms with large outstanding positions of short-term debt at the onset of the crisis, primarily uncollateralized and unhedged, substantially increased their investments in risky financial assets, such as corporate bonds, stocks, and mortgage-backed securities. Thus, while most empirical research on agency problems at distressed firms focused on real investments, often with no or mixed results, our evidence shows that distressed firms take on more risk through their financial asset portfolios.

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We put forth several reasons why firms would prefer to take risk by investing in risky financial assets rather than risky real assets. First, compared with traditional real assets, financial assets are easier to access and carry substantially lower transaction costs. Second, trading in risky financial assets is less visible, does not require an upfront investment in physical or human capital, and can generate immediate/accelerated payoffs. Third, financial assets are typically reported on the balance sheet as corporate cash holdings, and consequently, camouflage risk-taking as investments in seemingly safe asset classes.

Our findings have important implications because the financial asset portfolios of nonfinancial firms are large, typically opaque, with poor disclosure requirements and little monitoring, and therefore can be used to take risk, possibly with consequences described by the agency and moral hazard problems of asset substitution. Hence, our findings suggest that increased disclosure standards and monitoring of corporate financial investments may alleviate concerns about firms' risk-taking.

We note, however, that the value implications of investments in risky financial assets are not obvious. In theory, risky financial assets have zero net present values ex ante if the market is efficient, which implies that their effect on firm value is neutral. Recent evidence (e.g., Ang et al. 2006; Frazzini and Petersen 2014), however, shows that investments in financial assets with high systematic or idiosyncratic risk lead to lower (and negative) stock returns or lower alphas, respectively, suggesting that investments in risky financial assets can have negative net present values. Further, even if financial investments have zero net present values ex ante, debt holders bear any potential realized losses, implying that the equity holders shift the risk to the creditors ex post (Jensen and Meckling 1976).

Overall, our paper highlights two key factors in corporate risk-taking. First, it demonstrates that investment in risky financial securities rather than risky real assets can be a preferred conduit for risk-taking. Second, it highlights the importance of debt maturity in risk-taking by showing that outstanding, time-pressing short-term obligations rather than long-term obligations trigger risk-taking behavior.

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Appendix A. Variable Definitions

A.1 Measures of Financial Assets

Safe financial assets = Dollar amount (in millions) of safe financial assets

Risky financial assets = Dollar amount (in millions) of risky financial assets

log(Risky financial assets) = Logarithm of one plus the dollar amount (in millions) of risky financial assets

Risky financial assets/financial assets = Risky financial assets divided by total financial assets (the sum of safe financial assets and risky financial assets)

A.2 Main Explanatory Variables

Crisis = An indicator that equals zero in 2011–2013 and equals one in 2014–2016

Bankruptcy = An indicator that equals one for a firm-year observation if the firm will go bankrupt or become delisted over the next 2 years

Short-term liabilities/total liabilities = Current short-term liabilities (Compustat item LCT + DD2) divided by total liabilities

High short-term liabilities = An indicator variable that equals one for firms in the top tercile of Short-term liabilities/total liabilities in 2012–2013, and zero otherwise

Collateral = Physical assets (Compustat item PPNET) divided by total book assets (Compustat item AT) in 2012–2013

Hedging = An indicator variable that equals one for firms that have oil derivatives contracts in 2013 in SEC 10-K filing (Item 7A in 10-K reports)

Dual holdings = Ratio of the market value of the debt held by institutions to the total value of debt and equity by the same institutions

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A.3 Control Variables

A.3.1 Stock variables

Market-to-book = Sum of equity (Compustat items PRCC_F*CSHO) and total debt (Compustat items DLTT + DLC) divided by total book assets (Compustat item AT)

Total liabilities/book assets = Total liabilities (Compustat items DLTT + LCT) divided by total book assets (Compustat item AT)

Size = Logarithm of sales (Compustat item Sale)

A.3.2 Flow variables

Capital investment = Capital expenditure (Compustat item CAPEX) divided by total book assets of the previous year (Compustat item AT)

Cash flows = Operating income plus depreciation (Compustat items NI + DP) divided by total book assets (Compustat item AT) of the previous year

Profitability = Operating income before depreciation (Compustat item OIBDP) divided by total book assets of the previous year (Compustat item AT)

Cash dividends = Cash dividends (Compustat item DVC) divided by total book assets of the previous year (Compustat item AT)

Debt issues = Changes in total debt (Compustat items DLTT + DLC) divided by total book assets (Compustat item AT) of the previous year

Equity issues = Equity issues minus repurchases (Compustat items SSTK - PRSTKC) divided by total book assets (Compustat item AT) of the previous year

Other funds = Sum of sales of assets, investments, and other funds (Compustat items SPPE + SIV + FSRCO) divided by total book assets (Compustat item AT) of the previous year

Volatility of earnings = Annualized standard deviation of quarterly earnings percentage growth rates (Compustat item IBQ) over the eight quarters following the onset of the crisis

Volatility of profitability = Annualized standard deviation of quarterly profitability (OIBDPQ/AT) over the eight quarters following the onset of the crisis

Short-term investments = Short-term investments (Compustat item IVST)

log(Short-term investments) = Logarithm of one plus the dollar amount (in millions) of short-term investments

Short-term investments/(Cash and Short-term investments) = Short-term investments divided by the sum of cash (Compust item CH) and short-term investments (IVST)

Excess stock returns = Annual stock returns from CRSP in excess of the returns of corresponding Fama-French 25 size and BE/ME portfolios

Δ *Earnings* = Changes in earning (Compustat item IB + XINT + TXDI + ITCI), scaled by equity size (Compustat items CSHO × PRCC_F) of the previous year

Δ *Net assets* = Changes in net assets (Compustat item AT minus CHE), scaled by equity size (Compustat items CSHO × PRCC_F) of the previous year

Δ *Interest expenses* = Changes in cash dividends (Compustat item XINT), scaled by equity size (Compustat items CSHO × PRCC_F) of the previous year

Δ *Cash dividends* = Changes in cash dividends (Compustat item DVC), scaled by equity size (Compustat items CSHO × PRCC_F) of the previous year

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Net financing = Difference of stock issuance and retirement, and long-term debt issuance and retirement, and short-term debt change (Compustat items SSTK - PRSTKC + DLTIS - DLTR DLCCH), scaled by equity size (Compustat items CSHO × PRCC_F) of the previous year

Real investments = Dollar amount (in millions) of capital expenditure in proven and exploratory oil wells

log(Real investments) = Logarithm of one plus the dollar amount (in millions) of real investments

Real investments/book assets = Total real investments divided by total book assets

log(Risky investments) = log(1+ exploratory oil wells)

Risky real investments/real investments = Exploratory oil wells divided by the sum of exploratory and development wells

Appendix B: Examples of Financial Asset Disclosures at Oil and Gas Firms

B.1 Rowan Companies PLC

	Target range	Total	Quoted prices in active markets for identical assets (Level 1)	Significant observable inputs (Level 2)	Significant unobservable inputs (Level 3)
December 31, 2014:					
Equities:	**53% to 69%**				
U.S. large cap	22% to 28%	$ 159,541	$ —	$ 159,541	$ —
U.S. small cap	4% to 10%	38,106	—	38,106	—
International all cap	21% to 29%	135,947	—	135,947	—
International small cap	2% to 8%	29,736	—	29,736	—
Real estate equities	**0% to 13%**	45,758	—	45,758	—
Fixed income:	**25% to 35%**				
Cash and equivalents	0% to 10%	8,416	1	8,415	—
Aggregate	9% to 19%	85,412	—	85,412	—
Core plus	9% to 19%	86,325	86,325	—	—
Group annuity contracts		2,719	—	2,719	—
Total		$ 591,960	$ 86,326	$ 505,634	$ —

B.2 Barnwell Industries, Inc.

		Fair Value Measurements Using:		
	Carrying Amount as of September 30, 2014	Quoted Prices in Active Markets (Level 1)	Significant Other Observable Inputs (Level 2)	Significant Unobservable Inputs (Level 3)
Financial Assets:				
Cash	$ 817,000	$ 817,000	$ -	$ -
Corporate bonds	660,000	660,000	-	-
Fixed income exchange- traded funds	521,000	521,000	-	-
Preferred securities	232,000	232,000	-	-
Equity securities exchange- traded funds	758,000	758,000	-	-
Equities	4,034,000	4,034,000	-	-
Total	$ 7,022,000	$ 7,022,000	$ -	$ -

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