Do Adverse Oil-Price Shocks Change Loan Contract Terms for Energy Firms?

By Rajdeep Sengupta, W. Blake Marsh, and David Rodziewicz

Oil prices fell sharply in 2014 and have remained persistently low. While low oil prices may stimulate the U.S. economy overall, they can be disruptive to the domestic oil industry. A decline in prices may reduce oil firm revenues in the short run and increase uncertainty around future oil prices and earnings. These twin effects of oil-price uncertainty and lower potential earnings may, in turn, lower oil firms' creditworthiness, thereby reducing available financing for current operations and future investment.

A firm's creditworthiness determines whether it can get financing and, if so, under what terms. Perhaps the most important term is the interest rate "spread," defined as the difference between the loan's interest rate and a benchmark rate. Banks typically require a higher spread for borrowers who are less creditworthy to compensate for the borrower's increased default risk. As a result, external factors that affect certain borrowers' profitability and creditworthiness—for example, a shock to the oil industry—should be reflected in price changes on new loans.

In this article, we examine whether the relationship between creditworthiness and loan spreads for energy firms in the syndicated loan market changed after the 2014 oil-price shock. We use syndicated

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loans, which are jointly funded by several financial institutions, because the syndicated loan market is a major source of debt financing for oil firms. We find that credit conditions tightened following the oil-price shock in mid-2014. On average, the syndicated market shifted funding toward better quality (investment-grade) borrowers. After controlling for other loan, lender, and borrower attributes, we find that loans were priced higher after the oil-price shock for firms more closely involved in exploration and production relative to other oil firms. These firms were most likely to be adversely affected by the oil-price shock. Moreover, we find that within this subset of firms, spreads were higher for those without access to bond financing and those refinancing existing loans. We also find that larger banks charged higher spreads following the price shock, suggesting these banks are able to exploit their market power in times of distress. Together, our results suggest that credit conditions may not uniformly tighten across the oil industry after a price shock.

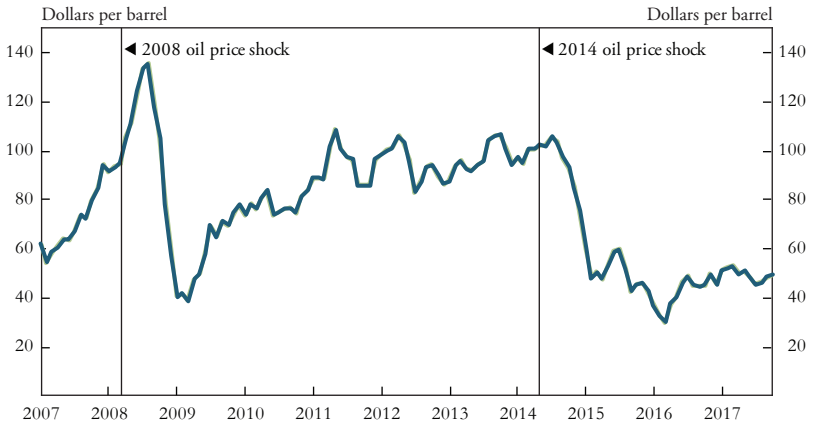
Section I describes the oil-price shock, its effect on firms in the oil industry, and these firms' prospects of obtaining financing. Section II introduces the data and the determinants of loan spreads in the syndicated loan market. Section III reviews our statistical analysis of loan spreads, accounting for nonprice terms and borrower and lender characteristics, to show how lending patterns changed following the oil-price shock.

I. Financing Energy Firms after the Oil-Price Shock

In June 2014, global crude oil prices began to fall dramatically. The price of U.S. West Texas Intermediate (WTI) fell from a monthly average of $106 per barrel in June 2014 to a monthly average of $30 per barrel in February 2016.[1] Chart 1 plots monthly average crude prices from 2007:Q1 to 2017:Q3 using the WTI benchmark. This recent oil-price shock—a peak-to-trough decline of 71.3 percent—was similar in magnitude to the 2008–09 peak-to-trough decline of 70.8 percent (Baumeister and Kilian).[2] However, the 2014 oil-price shock has been much more persistent than the 2008 shock. Monthly average crude prices rose above $100 several times following the 2008 price shock; in contrast, prices have not exceeded $60 since the 2014 price shock.

Chart 1

West Texas Intermediate Crude Oil Spot Price



Sources: U.S. Department of Energy and Energy Information Administration (Haver Analytics).

Effects of the oil-price shock

Oil firms may be able to weather short-term slumps in crude oil prices, but they face significant challenges during extended price declines. In general, the oil industry is competitive and largely composed of firms with high investment costs and little influence over market prices. While a sharp decline in oil prices reduces revenue, its effects on firm production and investment are less certain. Firms with high break-even costs may reduce output and, in some cases, even shut down production. But other firms will continue to maintain or even increase production levels by exploiting unused capacity and other efficiencies (Çakır Melek).[3] Still, profit margins are lower at the reduced price, potentially diminishing firm creditworthiness and access to credit.[4] Indeed, evidence suggests credit quality diminished in the energy sector following the 2014 oil-price shock, as corporate default rates in the sector rose precipitously above long-term averages (S&P 2017). Furthermore, survey results suggest the availability of financing decreased for U.S. energy firms during this period (Federal Reserve Bank of Kansas City).

However, an oil-price shock does not affect all energy firms in the same way. Performance can vary depending on the segment of the oil supply chain in which the firm operates. Even within segments, the effect on firms varies with the price of crude oil. Thus, to understand

the effect of oil-price declines on energy firms, we must examine the different segments of the industry as well as the types of firms operating in each segment.

Firms in the oil supply chain

The oil industry supply chain runs from exploration and production of crude to the refining and marketing of retail gasoline and other products. Firms in the energy industry can be grouped into four broad categories: upstream (producers), midstream (transporters), downstream (refiners and marketers), and support services (providers of specialty contractual services to all segments of the supply chain).

Upstream firms. Upstream firms are at the beginning of the oil supply chain and are involved in the exploration and production of oil. They own or lease the rights to develop crude oil resources. As upstream firms are closest to the production of crude oil, they are most directly affected by changes in crude oil prices. The fixed costs of drilling new wells can be very high, so upstream firms often cut back on drilling activity when oil prices drop below their break-even prices (Anderson, Kellogg, and Salant).

Upstream firms borrow on the basis of their oil reserves through a process called reserve-based lending. Collateral valuations in reserve-based lending depend on current prices and expectations of future crude oil prices. The sharp fall in crude oil prices after mid-2014 substantially reduced reserve valuations (Azar). These reductions, or "write-downs," adversely affected reserve-based lending for upstream firms. Although some upstream firms hedge production in the derivatives markets, which can smooth incomes for a period, hedging programs typically last only one to two years (Mnasri, Dionne, and Gueyie). When prices are low for an extended period, as with the 2014 oil-price shock, even conservatively hedged upstream firms face revenue declines and financing constraints.

Midstream firms. Next in the supply chain are midstream companies that transport oil, usually by pipeline, from the point of production to refineries where it can be processed. Midstream firms also transport refined products from refineries to local or regional distribution centers. These firms typically enter into long-term (multiyear or multidecade) contracts with upstream producers and are paid on

the volume, not the value, of the product transported. Most contracts include a "take-or-pay" clause, which requires upstream firms to pay for transportation even if volumes are lower than originally contracted. As a result, midstream firms are somewhat insulated from near-term price volatility, but can be exposed to changes in volumes in the long run. In a protracted low-price environment, midstream firms may grow concerned about low production as well as the ability of distressed upstream firms to make payments on their take-or-pay contracts. As contracts expire and are renegotiated, a decline in production volumes may result in lower contracted rates, affecting the profitability of these firms. However, given that production volumes did not change significantly following the mid-2014 price shock, midstream firms were arguably less affected by this shock.

Downstream firms. Downstream firms stand at the end of the oil supply chain and are most akin to manufacturing firms. These firms refine crude oil and market and sell finished petroleum products such as gasoline, heating oil, jet fuel, and kerosene. The profitability of downstream firms is largely determined by the spread between input costs—specifically, the price of crude oil—and the price of finished products. Downstream firms are known to hedge on these spreads (Ji and Fan). As a result, revenues of downstream firms are relatively less sensitive to oil price shocks. In fact, due to the robust demand for finished products, U.S. refiners may have benefited from higher margins following the 2014 oil-price shock (EIA 2015, 2016, and 2017). These firms are thus unlikely to have faced credit constraints.

Support services firms. Support services firms provide contractual services to all segments of the supply chain (upstream, midstream, and downstream). For example, servicers provide drilling support, geotechnical services, and site preparation to upstream firms. Although support services firms may derive stable cash flows from projects in the midstream and downstream segments, the profitability of these firms increases significantly when upstream drilling activity is robust. The 2014 shock severely curtailed drilling, decreasing demand for upstream support services and thereby lowering the revenue support services firms received from their upstream customers (EIA 2015). As a result, the profitability and credit availability of support services firms is also sensitive to price shocks, largely due to the drilling decisions of upstream firms.

II. Determinants of Loan Spreads and Empirical Approach

Oil firms face different opportunities in obtaining credit depending on their characteristics. Larger firms with established financial histories, for example, are more likely to have access to securities markets such as those for corporate bonds and equities. Smaller and newer firms, on the other hand, are typically more reliant on bank loans. Banks, however, may be unwilling to lend sufficient funds to meet the financing needs of any single energy-sector borrower. In such cases, the syndicated loan market provides a way for energy firms to obtain financing without overburdening any one bank.

Syndicated loans were an important source of financing for energy firms in the buildup to the 2014 oil-price shock. Domanski and others find that debt in the oil and gas sector increased from about $1 trillion in 2006 to about $2.5 trillion in 2014. In addition, they find that syndicated loans to the sector increased from $600 billion in 2006 to $1.6 trillion in 2014. Clearly, the syndicated loan market fulfills a significant share of the financing needs of oil firms. As a result, changes in financing terms in this market provide a useful gauge of credit availability for oil firms following the 2014 price shock.

Data

The unit of our empirical analysis is a syndicated loan, also referred to as a facility or tranche. Syndicated loans are large dollar loans issued to sophisticated borrowers. While each loan has only one borrower, syndicated loans have multiple lenders. The loan syndicate typically includes a lead bank that arranges for a group of banks or other financial institutions to participate jointly in the loan. We consider only the lead lenders in our analysis, since these banks typically evaluate creditworthiness and set the contract terms (Roman).

We draw loan facility data from the Thomson Reuters' DealScan database. This database contains loan information primarily from public company filings and reporting by banks. The sample consists of syndicated loans to U.S. energy firms originated before and after the oil price collapse in 2014. For each loan in the sample, we collect information on price and nonprice loan terms, borrower characteristics, and lead bank

attributes. Loan terms include the loan spread, loan size, loan maturity, collateral requirements, covenant restrictions, the purpose of the loan, and indicators such as whether the loan has provisions for performance pricing and whether the loan is a refinance.[5]

Information on borrowing-firm characteristics in the DealScan database includes the firm's industry (SIC code) and the firm's senior debt rating (as published by Moody's at the time of origination). We define the oil industry according to the six-digit North American Industry Classification System (NAICS) codes published by the U.S. Census Bureau.[6] Based on the NAICS descriptions, we group firms in the oil industry into four subindustries or segments—upstream, midstream, downstream, and support services.

We use DealScan data to identify the lead lender for each loan facility using the lender titles according to Ivashina. For loans with multiple agents, we select the largest agent following Roman. Data on lead bank characteristics are from the Call Reports and obtained for the quarter immediately prior to the loan origination date. We include information on the lead lender's size as well as measures of its asset quality, capital adequacy, and liquidity.

The final sample includes 3,188 completed loans from 2009:Q3 to 2017:Q1. The average loan size is $528 million with just over a four-year term.[7] The largest share of bank energy loans goes to midstream firms (36 percent) and a slightly smaller share to upstream firms (31 percent). Loans to support services firms (19 percent) and downstream firms (15 percent) firms make up the remainder. A full description of the variables is available in appendix Table A-1. Table A-2 presents the summary statistics for the variables described in Table A-1.

Empirical model

We conduct a statistical analysis of loan spreads accounting for loan terms, firm characteristics, and lender attributes to determine whether spreads were significantly different following the oil-price shock. All else equal, the loan spread is a summary measure that reflects changes in borrower creditworthiness. Thus, we regress *loan spread*, the dependent variable, on a set of explanatory variables and allow all of the coefficients of these explanatory variables to change after the oil-price shock in mid-2014. To do so, we create an indicator variable, *post-shock*, that

takes the value of 1 for all loans originated after 2014:Q2 and 0 otherwise and interact this variable with all explanatory variables.[8] This fully interacted regression allows us to examine the difference between pre- and post-shock period estimates of the explanatory variables.

The loan spread, measured in basis points over the London Interbank Offer Rate (LIBOR), is a summary measure of the lenders' assessment of the loan's risk.[9] As a result, loan spreads vary with other nonprice terms on the loan, borrowing firm characteristics, and lender attributes. We control for each of these factors in our analysis. Lastly, we include binary variables for each of the years in our sample to control for other variations over time.[10]

We control for a variety of nonprice terms on the loan. They include loan maturity in months (*maturity*), loan size (*log* [*loan size*]), and the number of covenants (*covenant count*). In addition, the set of variables on nonprice terms include indicator variables for *secured*, *refinance*, and *performance pricing* that capture whether the loan is secured by collateral, whether the loan is a refinance of a prior loan, and whether the loan includes features that explicitly vary the loan spread with the borrower's credit rating or financial performance, respectively. The set of loan terms also include a categorical variable for loan type depending on whether the loan is a *term*, *revolver*, or *other loan* type.[11] We also control for the firm's stated purpose for the loan and categorize these purposes as *acquisition*, *general*, *leveraged buyout* (LBO), or *recapitalization*.

All price and nonprice terms are determined jointly as part of the loan contract. Tradeoffs between contract terms are common, but they can often be overwhelmed by other attributes of the loan contract. For example, accounting for all lender, borrower, and loan characteristics, larger loans typically require higher spreads. However, other variables such as creditworthiness can also affect the relationship between loan size and loan spreads. Typically, larger loans are made to bigger and more creditworthy firms that are charged lower spreads. As a result, the observed association between spreads and loan size can be negative.

In addition, we control for borrower characteristics that could influence loan spreads. Using industry codes as described previously, we create a categorical variable for firm type depending on whether the borrower is an *upstream*, *midstream*, *downstream* or *support services* firm.

We also control for the firm's observed creditworthiness using a categorical variable based on its Moody's senior debt rating at the time of origination. Firms are categorized as investment grade (*IG*), non-investment grade (*non-IG*), not rated (*NR*), and withdrawn rating (*WR*).

Finally, we control for attributes of the lead lender using proxies for size, asset quality, capital adequacy, and liquidity. These proxies include the logarithm of total assets *(log*[*lender size*]), the ratio of Tier 1 capital divided by bank risk-weighted assets (*Tier 1 capital ratio*), the fraction of nonperforming loans to total loans (*asset quality*), and liquid assets (cash, Treasury and agency debt, and agency mortgage-backed securities) as a share of total assets (*liquidity*). Banks with poor financial health, for example, may be inclined to charge customers higher rates to maintain short-term profitability and fulfill their own financial obligations. Larger banks may use their economies of scale to lower spreads for customers. On the other hand, bigger banks with larger market shares may also exploit their market power to charge higher spreads on loans (Roman; Sufi). Data definitions and measurement details for all variables in the analysis are reported in appendix Table A-1.

III. Changes in Loan Pricing with the Oil Shock

The 2014 oil-price shock may have affected not only loan spreads, but also the types of firms that access the syndicated loan market. To disentangle these effects, we assess syndicated loans to each type of oil firm before and after the oil-price shock.

Summary assessment

Our sample consists of syndicated loans to energy firms originated after the recent financial crisis—that is, from 2009:Q3 to 2017:Q1.[12] We divide the sample into two periods: the pre-oil shock period, which comprises 2,151 loans to energy firms originated from 2009:Q3 to 2014:Q2, and the post-shock period, which comprises another 1,037 loans originated from 2014:Q3 to 2017:Q1 (Table 1).

Surprisingly, loan terms appear to be more lenient in the post-shock sample, when energy firms' creditworthiness had likely declined. Column 4 of Table 1 presents differences in the unconditional means of the pre-shock (column 2) and post-shock (column 3) samples (full results available in appendix Table A-3). Unconditional loan spreads were

Table 1

Differences in the Sample (Pre-Shock versus Post-Shock)

Variable	Full sample (mean) (1)	Pre-oil-price shock (mean) (2)	Post-oil-price shock (mean) (3)	Difference (3)–(2) (mean difference) (4)	Standard errors
Terms					
Loan spread (in basis points)	252.6	260.67	235.86	–24.80***	5.64
Loan size ($ millions)	527.95	485.22	616.58	131.36***	29.97
Maturity (in months)	50.66	49.78	52.48	2.69***	0.76
Refinance	0.56	0.58	0.51	–0.07***	0.02
Firm type					
Upstream	0.31	0.33	0.26	–0.06***	0.02
Midstream	0.36	0.35	0.37	0.02	0.02
Downstream	0.15	0.13	0.17	0.04**	0.01
Support services	0.19	0.19	0.19	0	0.01
Firm rating					
Investment grade	0.19	0.16	0.23	0.07***	0.01
Non-investment grade	0.21	0.22	0.19	–0.04*	0.02
Not rated	0.56	0.57	0.55	–0.01	0.02
Withdrawn	0.04	0.05	0.03	–0.02**	0.01
Lender characteristics					
Lender size ($ billions)	1,159.51	1,113.52	1,254.90	141.38***	28.96
Tier 1 capital ratio	12.36	11.62	13.88	2.26***	0.63
Asset quality	1.94	2.36	1.07	–1.29***	0.05
Liquidity	22.55	20.74	26.32	5.59***	0.46
Observations	3,188	2,151	1,037	3,188	—

* Significant at the 10 percent level
** Significant at the 5 percent level
*** Significant at the 1 percent level

almost 25 basis points lower, on average, in the post-shock sample than in the pre-shock sample. At the same time, loan facilities were almost 27 percent larger on average in the post-shock sample. The post-shock sample of loans also had longer maturities on average and 7 percent fewer refinances.

Differences in the composition of borrowers in the pre-shock and post-shock samples may explain these unexpected results. On average, firms in the post-shock sample were more creditworthy in terms of their senior debt rating. Table 1 shows the number of investment grade (IG) firms increased by 7 percent in the post-shock sample, while the number of non-IG firms and firms with withdrawn ratings (WR) decreased by 4 percent and 2 percent, respectively. In addition, the post-shock sample had 6 percent fewer upstream firms and 4 percent more downstream firms.

Changes in the quality and composition of the borrowers could have driven the overall improvements in terms and conditions on post-shock syndicated loans. But lenders may also have become more selective, introducing stricter post-shock terms and conditions to deter borrowers of poorer quality (those with non-IG, WR and NR ratings).[13] The latter explanation would suggest tightening conditions in the post-shock syndicated market.

Lenders in the post-shock sample, on average, had better asset quality, were better capitalized, and had more liquid assets—largely because the post-shock sample captures the improved condition of lead banks following the financial crisis. Asset quality, measured here by the proportion of nonperforming assets, improved in the years following the crisis. This is perhaps unsurprising, as post-crisis regulation and stress-testing exercises required lead banks to hold more capital and more liquid assets.

While the simple comparison of unconditional means suggests a drop in spreads, it does not account for differences in loan, borrower, and lender characteristics that affect loan spreads. To account for these differences, we turn next to our regression analysis. The regression results suggest that the oil-price shock significantly tightened credit conditions for upstream and support services firms.

Estimation results: all firms

We first examine the effect of nonprice loan terms on loan spreads. Column 1 of Table 2 shows how loan terms, firm characteristics, and bank characteristics affect loan spreads across all firms in our sample (the full regression results are available in appendix Table A-4). The estimated coefficient on loan size, measured by the logarithm of the loan amount in dollars, is statistically significant at the 1 percent level.[14] The estimated coefficient of –13.2 suggests that a 1 percent increase in loan size is associated with about a 0.13 basis point decrease in spreads. This result likely captures the fact that, for firms with a given credit rating, more creditworthy borrowers take out larger loans on average.[15]

The pre-shock association between loan spreads and firm and lender characteristics are consistent with our expectations. Spreads on loans to upstream firms and loans to firms that are not rated IG (NR, WR and non-IG) tend to be higher than loans to downstream firms and loans to IG firms. Moreover, syndicated loans with larger lead lenders tend to charge lower spreads.

The fully interacted coefficients test for statistically significant differences in the model coefficients before and after the shock. The results show no significant change in the association between spreads and nonprice loan terms following the oil-price shock. The estimated coefficients in column 1 of Table 2 on the interaction terms for nonprice loan term variables are not statistically significant.[16] In other words, the model shows no statistically significant difference between the estimates of nonprice loan terms in the pre-shock and post-shock periods.

In contrast, the results show significant changes in the association between post-shock spreads and two categories of firm and lender characteristics. First, upstream and support services firms were charged higher spreads following the oil-price shock. The positive and statistically significant coefficients for the firm type interaction terms in column 1 of Table 2 illustrate that these firms were charged almost 50 basis points more on average than downstream firms.[17] Second, larger lenders were able to charge a premium on spreads following the oil-price shock. The negative sign on the uninteracted lender size coefficient suggests that larger banks originate loans with lower spreads in the pre-shock period: a 1 percent increase in lender asset size is associated with a 0.11 basis point decrease in spreads.[18] In the post-shock period, the same

Table 2
Least Squares Regression with Year Fixed Effects

Variable	All firms (1)	Upstream and support services (2)
Constant	603.1***	634.1***
	(5.78)	(5.08)
Loan terms		
Log(loan size in millions)	−13.24***	−11.88***
	(−4.83)	(−3.82)
Maturity (in months)	−0.140	−0.912***
	(−0.69)	(−2.77)
Refinance=1	2.618	−15.41
	(0.31)	(−1.32)
Firm type		
Midstream	−7.239	—
	(−0.86)	
Support services	17.22	—
	(1.30)	
Upstream	28.29***	25.85**
	(4.43)	(2.30)
Firm senior debt rating		
NR	48.91***	72.37***
	(5.27)	(4.12)
Non-IG	51.74***	57.52**
	(4.50)	(2.55)
WR	61.77***	101.6***
	(3.89)	(2.75)
Lender characteristics		
Log(lender size in billions) (t−1)	−10.48***	−13.66**
	(−2.71)	(−2.24)
Asset quality (t−1)	4.960*	11.79**
	(1.78)	(2.47)
Liquidity (t−1)	0.714*	1.388**
	(1.96)	(2.03)
Tier 1 capital ratio (t−1)	1.467	1.574
	(1.01)	(0.59)
Interactions		
Post-shock=1	−195.6	−487.3*
	(−1.05)	(−1.89)
Post-shock=1 # log(loan size in millions)	−2.761	−5.277
	(−0.59)	(−0.82)
Post-shock=1 # maturity (in months)	0.110	0.565
	(0.34)	(1.11)
Post-shock=1 # refinance=1	13.70	59.56***
	(1.37)	(3.78)

Table 2 (continued)

Variable	All firms (1)	Upstream and support services (2)
Post-shock=1 # midstream	15.41 (0.85)	—
Post-shock=1 # supportservices	46.50** (2.28)	—
Post-shock=1 # upstream	47.63*** (2.89)	1.211 (0.07)
Post-shock=1 # nr	16.81 (1.02)	61.96** (2.22)
Post-shock=1 # nonig	4.224 (0.22)	8.087 (0.27)
Post-shock=1 # wr	4.523 (0.09)	–30.09 (–0.30)
Post-shock=1 # log(lender size in billions) (t–1)	12.95** (2.13)	23.19** (2.26)
Post-shock=1 # asset quality (t–1)	–15.27 (–1.11)	–22.33 (–1.20)
Post-shock=1 # liquidity (t–1)	0.911 (1.07)	1.682 (1.11)
Post-shock=1 # tier1 capital ratio (t–1)	–1.620 (–1.12)	4.814 (0.67)
Year fixed effects	Yes	Yes
Adjusted R^2	0.389	0.393
Observations	3,142	1,559

* Significant at the 10 percent level
** Significant at the 5 percent level
*** Significant at the 1 percent level

Notes: Heteroskedasticity-robust t-statistics are reported in parentheses. Dependent variable is loan spread (in basis points).

increase in lender asset size is associated with an increase in spreads of 0.02 (0.13 minus 0.11) basis points. While this effect is economically insignificant for small changes in bank size, it is significant for borrowers using very large lead agents that tend to dominate the syndicated loan market. For example, a borrower with a lead agent holding $1 trillion in assets would pay almost 20 basis points more than a similar borrower using a lead agent with $100 billion in assets (a 900 percent increase in lender asset size). All else equal, larger banks may have raised spreads more than smaller banks following the oil-price shock. The results suggest larger lead lenders can exploit their market power by raising spreads during a period of financial stress for borrowers.

The main result from the regression analysis appears to be a significant increase in spreads for upstream and support services firms relative

to downstream firms following the oil-price shock.[19] Our estimation suggests that the price shock caused lenders to view these firms as less creditworthy. This result is expected given the greater exposure of these firms to the effects of an oil-price shock. The association between spreads and nonprice loan terms, lender characteristics, and some firm characteristics such as ratings was unchanged. This result does not indicate, however, whether loan terms and conditions changed from the pre- to post-shock period within the subsample of upstream and support services firms.

Estimation results: upstream and support services firms

By extending our estimation procedure to the subsample of upstream and support services firms, we examine the factors that influenced the higher post-shock spreads on these firms relative to their downstream counterparts.

The results show that the pre-shock associations between loan spreads and other explanatory variables for the subsample of upstream and support services firms are similar to those for the full sample. Just as in column 1 of Table 2, column 2 shows that size and maturity have negative associations with spreads. Likewise, loans to upstream firms and non-IG firms tend to have higher spreads than loans to support services firms and IG firms.

We find significant changes in the association between spreads and firm and lender characteristics following the oil-price shock. First, the positive and significant coefficient on the interaction term for refinanced loans and nonrated (NR) firms shows that upstream and support services firms with these characteristics paid higher spreads following the oil-price drop. Spreads on refinanced loans and loans to NR firms increased about 60 basis points relative to new originations and IG firms, respectively. Moreover, just as in the sample of all firms, large lenders were able to charge a premium for post-shock originations. The estimated premium for the subsample of upstream and support services firms is higher than the full sample, suggesting upstream and support services firms drive the high premiums for large firms overall.

In sum, these results are consistent with the view that lenders perceived the oil-price shock to have affected the creditworthiness of only certain segments of the energy industry. As in our results for the

full sample, the relationship between loan spreads and nonprice terms did not change. Instead, lenders simply raised spreads on average for upstream and support services firms. Within these segments, spreads were higher for refinance loans and unrated firms. In some cases, higher spreads for refinance loans and loans originated with larger lead banks suggest that lenders can exploit informational and market power advantages in times of distress. Refinance borrowers may become captive to their original lenders, because seeking out new lenders in times of distress could be a signal to potential lenders of heightened credit risk. Our results also suggest that large lenders are more likely to exploit their market power in times of borrower distress.

IV. Conclusion

Negative oil-price shocks, such as the one that occurred in mid-2014, can significantly affect lending to oil firms. Oil-price shocks not only harm the revenues and profitably of energy firms, but also affect bank lending decisions, terms, and loan pricing. Evidence from the syndicated loan market suggests that upstream and support services firms saw higher loan spreads, on average, following the mid-2014 oil-price shock compared with midstream and downstream firms. Upstream and services firms are closest to the exploration and production of crude oil and thus most likely to be directly affected by the shock; firms further down the supply chain (midstream and downstream) are somewhat insulated in the short run. Our results indicate that the 2014 oil-price shock was not uniformly distributed across the energy sector, but was instead focused on specific segments within the industry. Our results also suggest that lending syndicates are selective about which types of firms they will lend to during an oil-price slump.

Further research is needed to explore the mechanisms behind our results. The post-shock improvement in borrower quality, for example, could be due to credit rationing on the part of lenders. But reduced demand for credit, increased equity financing, or debt financing from alternative sources on the part of non-IG firms may also explain some of our findings. Future research using firm-level information may shed light on oil firms' responses to oil-price shocks, their borrowing decisions, and how energy firm capital structures change with changes in the price of oil.

Appendix
Additional Tables

Table A-1
Variable Definitions

Variable	Definition
Loan spread	Loan spread is measured as all-in spread drawn in the DealScan database. All-in spread drawn is defined as the amount the borrower pays in basis points over LIBOR or LIBOR equivalent for each dollar drawn down. (For loans not based on LIBOR, LPC converts the spread into LIBOR terms by adding or subtracting a differential which is adjusted periodically.) This measure adds the borrowing spread of the loan over LIBOR with any annual fee paid to the bank group.
Loan size	Natural logarithm of the loan facility amount. Loan amount is measured in millions of dollars.
Maturity	Maturity is the loan term measured in months.
Secured	Indicator variable that equals one if the loan facility is secured by collateral and zero otherwise.
Performance pricing	Indicator variable if the spread varies with borrower performance over time.
Refinancing indicator	Indicator variable if the loan is a refinance of an existing facility.
Lender size (t–1)	The natural logarithm of the bank total assets measured in billions of dollars.
Tier 1 capital ratio (t–1)	A proxy of bank capital adequacy, Tier 1 risk-based capital ratio, calculated as the ratio of Tier 1 capital to risk-weighted assets in percentage points.
Asset quality (t–1)	Asset quality evaluates the overall condition of a bank's portfolio and is evaluated by a fraction of nonperforming assets and assets in default. Noncurrent loans and leases are loans that are past due for at least ninety days or are no longer accruing interest. Higher proportion of nonperforming assets indicates lower asset quality.
Liquidity (t–1)	Sum of cash, balances due from DIs, and Treasuries and agency MBS held divided by total assets in percentage points.
Upstream	Indicator for oil and gas exploration and production firms.
Midstream	Indicator for oil and gas transportation and pipeline firms.
Downstream	Indicator for oil and gas refineries.
Support services	Indicator for oil and gas exploration and production support.

Table A-1 (continued)

Variable	Definition
Revolver	Loan type indicator for revolving credit lines: Revolver/Line of Credit, 364-day Facility, or Limited Line.
Term	Loan type indicator for term loans: term loan (regular; A through H) and delay draw term loan.
Other loans	Loan type indicator for all other types of lending facilities.
Acquisition	Loan purpose indicator for acquisition or takeover.
General	Loan purpose indicator for general corporate purposes, capital expenditure, or working capital.
LBO	Loan purpose indicator for leveraged buy out.
Miscellaneous	Loan purpose indicator for the following reasons: project finance, trade finance, equipment purchase, stock buyback, IPO related financing, exit financing, spinoff, real estate, telecom buildout.
Recapitalization	loan purpose indicator for recapitalization or debt repayment.
IG	Indicator for variable for the borrowers' with Moody's senior debt rating of Baa3 or better (investment grade).
Non-IG	Indicator for variable for the borrowers' with Moody's senior debt rating of Ba1 to C.
NR	Indicator for variable for unrated borrowers.
WR	Indicator for variable for the borrowers' with withdrawn ratings.

Table A-2
Summary Statistics

	Full sample				Pre-oil-price shock				Post-oil-price shock			
Variable	Mean	Standard deviation	Min	Max	Mean	Standard deviation	Min	Max	Mean	Standard deviation	Min	Max
Loan spread (basis points)	252.60	149.71	0.00	1,175.00	260.67	142.08	0.00	1,175.00	235.86	163.22	0.00	1,037.50
Loan size (in millions)	527.95	794.95	0.2	8600	485.22	739.65	0.2	7,500	616.58	892.77	0.8	8,600
Maturity (in months)	50.66	20.03	1	282	49.78	17.55	1	168	52.48	24.28	1	282
Secured	0.38	0.48	0	1	0.40	0.49	0	1	0.34	0.47	0	1
Covenant count	0.56	0.94	0	5	0.59	0.99	0	5	0.48	0.81	0	3
Performance pricing	0.19	0.40	0	1	0.22	0.41	0	1	0.15	0.36	0	1
Refinance	0.56	0.50	0	1	0.58	0.49	0	1	0.51	0.50	0	1
Revolver	0.73	0.44	0	1	0.75	0.43	0	1	0.69	0.46	0	1
Term	0.24	0.43	0	1	0.23	0.42	0	1	0.28	0.45	0	1
Other loans	0.03	0.16	0	1	0.03	0.16	0	1	0.03	0.17	0	1
Upstream	0.31	0.46	0	1	0.33	0.47	0	1	0.26	0.44	0	1
Midstream	0.36	0.48	0	1	0.35	0.48	0	1	0.37	0.48	0	1
Downstream	0.15	0.35	0	1	0.13	0.34	0	1	0.17	0.38	0	1
Support services	0.19	0.39	0	1	0.19	0.39	0	1	0.19	0.39	0	1
IG	0.19	0.39	0	1	0.16	0.37	0	1	0.23	0.42	0	1
Non-IG	0.21	0.41	0	1	0.22	0.42	0	1	0.19	0.39	0	1
NR	0.56	0.50	0	1	0.57	0.50	0	1	0.55	0.50	0	1

Table A-2 (continued)

	Full sample				Pre-oil-price shock				Post-oil-price shock			
Variable	Mean	Standard deviation	Min	Max	Mean	Standard deviation	Min	Max	Mean	Standard deviation	Min	Max
Acquisition	0.08	0.27	0	1	0.08	0.27	0	1	0.08	0.27	0	1
General	0.83	0.37	0	1	0.84	0.37	0	1	0.82	0.39	0	1
LBO	0.01	0.12	0	1	0.01	0.12	0	1	0.02	0.13	0	1
Miscellaneous	0.06	0.23	0	1	0.05	0.22	0	1	0.07	0.26	0	1
Recapitalization	0.02	0.13	0	1	0.02	0.13	0	1	0.02	0.13	0	1
Lender size (in billions) (t–1)	1,159.51	768.80	0.17	2,270.87	1,113.52	740.87	0.35	2,138.27	1,254.9	815.86	0.17	2,270.87
Tier 1 capital ratio (t–1)	12.36	16.65	7.14	600.05	11.62	2.68	7.14	41.48	13.88	28.75	9.83	600.05
Asset quality (t–1)	1.94	1.41	0	7.36	2.36	1.48	0	7.36	1.07	0.65	0	2.86
Liquidity (t–1)	22.55	12.48	0.26	92.38	20.74	13.37	0.34	92.36	26.32	9.34	0.26	92.38
Observations	3,188	—	—	—	2,151	—	—	—	1,037	—	—	—

Table A-3
Differences in the Sample (Pre-Shock versus Post-Shock)

Variable	Full sample (mean) (1)	Pre-oil-price shock (mean) (2)	Post-oil-price shock (mean) (3)	(3)–(2) (mean–diff.) (4)	Standard errors
Terms					
Loan spread (in basis points)	252.60	260.67	235.86	–24.80***	5.64
Loan size (in millions)	527.95	485.22	616.58	131.36***	29.97
Maturity (in months)	50.66	49.78	52.48	2.69***	0.76
Secured	0.38	0.40	0.34	–0.06**	0.02
Covenant count	0.56	0.59	0.48	–0.11**	0.04
Performance pricing	0.19	0.22	0.15	–0.07***	0.01
Refinance	0.56	0.58	0.51	–0.07***	0.02
Loan type					
Revolver	0.73	0.75	0.69	–0.05**	0.02
Term	0.24	0.23	0.28	0.05**	0.02
Other loans	0.03	0.03	0.03	0	0.01
Firm type					
Upstream	0.31	0.33	0.26	–0.06***	0.02
Midstream	0.36	0.35	0.37	0.02	0.02
Downstream	0.15	0.13	0.17	0.04**	0.01
Support services	0.19	0.19	0.19	0	0.01
Firm rating					
IG	0.19	0.16	0.23	0.07***	0.01
Non-IG	0.21	0.22	0.19	–0.04*	0.02
NR	0.56	0.57	0.55	–0.01	0.02
WR	0.04	0.05	0.03	–0.02**	0.01
Firm loan purpose					
Acquisition	0.08	0.08	0.08	0	0.01
General	0.83	0.84	0.82	–0.02	0.01
LBO	0.01	0.01	0.02	0	0.00
Miscellaneous	0.06	0.05	0.07	0.02*	0.01
Recapitalization	0.02	0.02	0.02	0	0.01
Lender characteristics					
Lender size (in billions) (t–1)	1,159.51	1,113.52	1,254.90	141.38***	28.96
Tier 1 capital ratio (t–1)	12.36	11.62	13.88	2.26***	0.63
Asset quality (t–1)	1.94	2.36	1.07	–1.29***	0.05
Liquidity (t–1)	22.55	20.74	26.32	5.59***	0.46
Observations	3,188	2,151	1,037	3,188	—

* Significant at the 10 percent level
** Significant at the 5 percent level
*** Significant at the 1 percent level

Table A-4

Least Squares Regression with Year Fixed Effects

Variable	All firms (1)	Upstream and support services (2)
Constant	603.1***	634.1***
	(5.78)	(5.08)
Loan terms		
Log(loan size in millions)	−13.24***	−11.88***
	(−4.83)	(−3.82)
Maturity (in months)	−0.140	−0.912***
	(−0.69)	(−2.77)
Performance pricing=1	−26.74***	−32.58
	(−3.34)	(−1.65)
Refinance=1	2.618	−15.41
	(0.31)	(−1.32)
Secured=1	59.82***	52.38***
	(6.05)	(4.95)
Covenant count	−7.802**	−6.450
	(−2.05)	(−1.13)
Loan type		
Other loans	54.82	177.0***
	(1.07)	(2.91)
Term	105.5***	152.2***
	(8.47)	(7.05)
Firm type		
Midstream	−7.239	—
	(−0.86)	
Support services	17.22	—
	(1.30)	
Upstream	28.29***	25.85**
	(4.43)	(2.30)
Firm senior debt rating		
NR	48.91***	72.37***
	(5.27)	
Non-IG	51.74***	57.52**
	(4.50)	(2.55)
WR	61.77***	101.6***
	(3.89)	(2.75)
Firm loan purpose		
General	−36.31***	−19.99
	(−2.97)	(-1.06)
LBO	80.18***	118.4***
	(3.93)	(5.56)
Miscellaneous	1.043	5.716
	(0.05)	(0.16)
Recapitalization	−14.96	-3.100
	(−0.69)	(-0.09)

Table A-4 (continued)

Variable	All firms (1)	Upstream and support services (2)
Lender characteristics		
Log(lender size in billions) (t–1)	–10.48***	–13.66**
	(–2.71)	(–2.24)
Asset quality (t–1)	4.960*	11.79**
	(1.78)	(2.47)
Liquidity (t–1)	0.714*	1.388**
	(1.96)	(2.03)
Tier 1 capital ratio (t–1)	1.467	1.574
	(1.01)	(0.59)
Interactions		
Post-shock=1	–195.6	–487.3*
	(–1.05)	(–1.89)
Post-shock=1 # log(loan size in millions)	–2.761	–5.277
	(–0.59)	(–0.82)
Post-shock=1 # maturity (in months)	0.110	0.565
	(0.34)	(1.11)
Post-shock=1 # performance pricing=1	–7.332	–24.70
	(–0.73)	(–1.10)
Post-shock=1 # refinance=1	13.70	59.56***
	(1.37)	(3.78)
Post-shock=1 # secured=1	14.63	17.81
	(1.23)	(0.70)
Post-shock=1 # covenantcount	–10.66	–13.67
	(–1.09)	(–0.85)
Post-shock=1 # otherloans	–110.7*	–190.9**
	(–1.82)	(–2.20)
Post-shock=1 # term	–10.31	–0.0725
	(–0.69)	(–0.00)
Post-shock=1 # midstream	15.41	—
	(0.85)	
Post-shock=1 # supportservices	46.50**	—
	(2.28)	
Post-shock=1 # upstream	47.63***	1.211
	(2.89)	(0.07)
Post-shock=1 # nr	16.81	61.96**
	(1.02)	(2.22)
Post-shock=1 # nonig	4.224	8.087
	(0.22)	(0.27)
Post-shock=1 # wr	4.523	–30.09
	(0.09)	(–0.30)
Post-shock=1 # general	–27.52	–15.16
	(–0.98)	(–0.55)
Post-shock=1 # lbo	37.33	51.29
	(0.84)	(1.00)
Post-shock=1 # miscellaneous	–26.47	1.331
	(–0.67)	(0.03)

Table A-4 (continued)

Variable	All firms (1)	Upstream and support services (2)
Post-shock=1 # recapitalization	−12.45 (−0.38)	21.45 (0.37)
Post-shock=1 # log(lender size in billions) (t−1)	12.95** (2.13)	23.19** (2.26)
Post-shock=1 # asset quality (t−1)	−15.27 (−1.11)	−22.33 (−1.20)
Post-shock=1 # liquidity (t−1)	0.911 (1.07)	1.682 (1.11)
Post-shock=1 # tier1 capital ratio (t−1)	−1.620	4.814
Year fixed effects	Yes	Yes
Adjusted R^2	0.389	0.393
Observations	3142	1559

* Significant at the 10 percent levelx
** Significant at the 5 percent level
*** Significant at the 1 percent level

Notes: Heteroskedasticity-robust t-statistics are reported in parentheses. Dependent variable is loan spread (in basis points).

Endnotes

[1]The oil price shock in 2014 was a global phenomenon. The international oil benchmark North Sea Brent fell from a monthly average of $112 per barrel to $31 per barrel during this time period. However, we focus on U.S. firms for this study and use "crude oil prices" to refer to the U.S. WTI benchmark.

[2]In this study, we focus on oil firms and the supply chain of oil. Although some firms in this study produce both oil and natural gas, their production has become increasingly concentrated on crude oil over this period. For example, oil rigs made up 80 percent of active U.S. rigs in 2017:Q1, up from 20 percent of active rigs in 2009:Q1 (Baker Hughes).

[3]Firms with underused capacity and efficiencies in production may seek to increase output to make up for the revenue shortfall.

[4]Our aim is to infer whether credit conditions tightened, loosened, or remained unchanged in the syndicated loan market. A tightening is often characterized by higher spreads and more stringent nonprice terms, which may reduce credit availability for less creditworthy borrowers.

[5]Covenants are terms and conditions in the loan contract designed to mitigate agency problems between the lender and the borrower in the future. They act as "tripwires" that increase the efficiency of a financial contract and the flexibility of renegotiations. In addition, covenants can discipline the borrower, as borrowers who violate covenants must transfer control rights to the lender.

[6]We match NAICS codes to SIC codes using the U.S. Census Bureau's NAICS-SIC matching files because DealScan does not report NAICS industry codes. Due to occasionally missing industry codes in the DealScan database, we augment the sample by matching major industry names pulled from Bloomberg using the methodology described in Cohen, Friedrichs, and others.

[7]In comparison, the average size of syndicated loans to nonoil firms is $365 million.

[8]We estimate the fully interacted regression: $spread_{i,t} = \alpha + \beta X_{i,t} + \delta postshock_t * X_{i,t} + \upsilon_t + \varepsilon_{i,t,}$ where X is a set of nonprice loan terms, firm characteristics, lead bank attributes; *postshock* is the oil crash indicator; υ_t is a set of time fixed effects; and $\varepsilon_{i,t}$ is an idiosyncratic error term. The equation is indexed by loan i and time t. For a given variable, β shows its effect on spreads prior to the shock, and $\beta + \delta$ shows its effect post-shock.

[9]The LIBOR is the benchmark rate for over 99 percent of loans in our sample.

[10]Specifications with binary variables for each quarter yield similar results. Quarterly binary variables account for quarterly variations in economic variables such as oil prices.

[11]See Tables A-1 and A-2 in the appendix for a full description of loan types. The category of *other loans* includes bridge loans and standby letters of credit.

[12]Our results are robust to a smaller sample (loans from 2011:Q1 to 2017:Q1) that does not include loans originated in the immediate aftermath of the financial crisis.

[13]There are several other possible explanations. On average, non-IG firms may have increased equity financing, increased alternative sources of debt financing, or lowered demand for external finance—or they may have been priced out of the syndicated loan market. However, our data do not help sort among these alternative explanations.

[14]Specifications with nonlinear (square) terms of loan size and loan maturity yield similar results.

[15]The senior debt ratings used as controls are somewhat coarse. Therefore, the results can be interpreted as more creditworthy borrowers within a given credit rating, say IG, originate larger loans. Our conjecture is that the variation in creditworthiness within a particular credit rating is likely observable to the bank but remains unobservable in terms of the available data.

[16]The F-test confirms that the estimated coefficients on nonprice loan terms are not jointly significantly different from zero.

[17]For categorical variables such as firm type, the estimated associations are relative to the omitted category, such as downstream firms.

[18]The effect of an increase in a log-transformed variable can be interpreted as a percentage increase. The effect of a percent increase in the independent variable on the untransformed dependent variable is the coefficient divided by 100. See Stock and Watson, section 8.2 for more on interpreting coefficients in linear log models.

[19]In unreported results, we also run regressions separately for subsamples of term loans, revolver loans, loans using LIBOR as the benchmark rate, loans with U.S. banks as lead lenders, and loans for individual firm types. The results for these regressions are qualitatively similar to those of the full sample of loans.

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