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The externalities of fire sales: evidence from collateralized loan obligations

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Abstract

This paper investigates how covenants, intrinsic to Collateralized Loan Obligation (CLO) indentures, may amplify idiosyncratic shocks, imposing negative externalities on unrelated firms in CLO portfolios. Following a negative shock to the oil & gas industry, CLOs with exposure to oil and gas loans are pushed closer to their covenant thresholds and fire-sell unrelated loans in the secondary loan market to alleviate these constraints. These fire sales exert price pressure on the securities of unrelated firms, creating market dislocations. The erosion in the liquidity positions of exposed firms spills over into real economic activity. The findings highlight the real effects from fire sales arising due to contracting frictions.

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1 Introduction

Financial contracts include provisions designed to align incentives and mitigate capital market imperfections. While these provisions are useful for addressing incentive issues, they may introduce negative externalities on asset prices in some states of the world. This paper uses the setting of Collateralized Loan Obligations (CLOs) to examine the externalities on asset prices and the associated real effects that arise from contracting frictions. Covenants are a common feature of CLO managerial contracts with the objective of mitigating agency frictions and allocating control rights, ex-ante, to facilitate the expansion of credit in the economy.[1] However, when there are adverse shocks, covenants in CLOs may introduce and amplify fire sale risk, in turn, reducing the availability of credit to borrowers.

I postulate the following *contractual arbitrage* mechanism through which covenants in CLO managerial contracts may kindle fire sales after adverse shocks. Managers are incentivized to comply with the covenants in their contracts.[2] These covenants are designed in a piecewise fashion. As a result, when a loan becomes sufficiently risky, it is no longer accounted at book value and the covenants may be tightened. If a loan experiences default, it is marked to the lower of its market value or recovery value. If a loan is a discount obligation, it is marked at the purchase price until the loan trades above a specified threshold (typically 90 ¢/$) for more than 30 days. If the loan puts the CLO in excess of its CCC/Caa1 limit, it is marked to the lowest market value among the CCC/Caa1 loans, respectively. In these circumstances, managers can loosen their covenants by selling loans which exhibit higher market values than accounted values. This suggests that covenant-induced sales are concentrated among riskier loans issued by distressed borrowers. Hence, it is hypothesized that contractual arbitrage creates contracting frictions.

To study the externalities of fire sales, I employ a reduced-form instrumental variable (IV) strategy. The ideal empirical design compares the differences in outcomes between two identical innocent bystanders – firms whose creditworthiness is unrelated to the source of covenant tightness – held in different CLO portfolios with differing degrees of covenant tightness. To this end, I use a Bartik-style difference-in-differences identification strategy. This strategy exploits the timing of the oil and gas (O&G) price plunge in 2014, as well as cross-sectional variation in (non-O&G) firms' exposure to oil and gas through CLOs before the shock. I construct a firm's exposure to O&G through CLOs through aggregation of CLO exposures to O&G. That is, a firm's exposure to O&G is measured by weighting each CLO's exposure to O&G by

[1] Intermediaries, in general, have covenants to address these issues.

[2] Kundu (2022*b*) documents that CLO covenant breaches are associated with significant pecuniary and non-pecuniary costs.

the firm's exposure to the CLO. I argue that the O&G price plunge was exogenous and conduct a battery of tests to assess selection concerns. This empirical design largely mitigates concerns about non-random matching between CLOs and portfolio firms.[3]

I begin by validating that a CLO's exposure to O&G is related to covenant tightness. CLOs with greater ex-ante exposure to O&G experience greater tightening of their covenants, relative to CLOs with lower exposure. Specifically, a 1 percentage point increase in the O&G share is associated with a 0.22% to 0.52% decline in the distance to the most stringent capital covenant, after the O&G shock. This is a nontrivial effect as the median CLO operates within 4% of the most stringent covenant threshold.

I document that contracting frictions can lead to loan sales and produce price distortions. Firms whose loans are held by CLOs with greater O&G exposure experience greater loan sales, after the O&G shock. These CLO-induced loan sales are associated with security-level distortions. A 1 percentage point increase in a firm's exposure to O&G through CLOs is associated with a decrease in its loan price by 61 bps in the secondary loan market. The dislocation in the secondary loan price passes through to primary loan spreads. I find that a 1 percentage point increase in a firm's exposure to O&G through CLOs is associated with an increase in the primary loan spread by 22 bps. This is consistent with a limited investor base for syndicated loans creating segmented markets, thereby, inhibiting arbitrage.[4] I further find that there is limited substitution to other sources of financing.

What are the effects of market dislocations in the security prices of exposed firms on real economy activity? As firms' effective cost of capital increases, firms substitute away from external sources of funding. I find that firms whose loans are held by CLOs with greater O&G exposure draw down lines of credit more aggressively. Exposed firms also make operational adjustments, following a pecking order. The largest reductions are in R&D growth and debt growth, followed by acquisitions, cash flow, investment, and employment growth.

A question that remains unanswered is whether CLOs uniformly sell all innocent bystanders' loans, or are more likely to sell riskier loans. I investigate the underlying mechanism behind CLO sales and provide empirical evidence in support of the contractual arbitrage mechanism, described earlier. CLOs are more likely to sell riskier loans after the O&G price plunge. CLO sales of these riskier loans result in compositional changes across portfolios. After the shock, CLOs hold the lower-yielding loans issued by firms with higher O&G exposure

[3] Generally, one is concerned that the incidence of firm distress in a portfolio may be attributed to correlated omitted characteristics of the fund. Using variation in oil price changes circumvents concerns of matching between CLOs and portfolio firms to a large extent.

[4] See Shleifer and Vishny (1992), Shleifer and Vishny (1997), Gabaix, Krishnamurthy and Vigneron (2007), Mitchell, Pedersen and Pulvino (2007*a*)), Chernenko and Sunderam (2012) for theory and evidence on segmented markets and arbitrage.

and are less likely to hold defaulted loans issued by these firms.[5] These findings are consistent with the motives established by contractual arbitrage – CLO managers derisk and deleverage upon experiencing a tightening of their covenants. Lastly, I show that the aggregate declines in debt prices and real economic activity are driven primarily by distressed firms, which experience effects that are over five times as large as the effects experienced by non-distressed firms.

I conduct a series of additional tests to assess the robustness of the main findings on loan sales and price effects. I demonstrate that the financial market dislocations are persistent and endure long enough for the real effects to materialize. Moreover, I supplement the baseline empirical strategy with a cross-sectional approach and IV approach to show that the main findings are robust to alternative empirical designs and that CLO covenants are the source of cross-firm spillovers. Additional tests are conducted to address concerns regarding measurement, omitted variable bias, and strength of the empirical strategy. I dispel alternative hypotheses that the findings may reflect changes in firm fundamentals or bank constraints, using two falsification tests that exploit institutional differences across loan facilities. Lastly, I assess external validity using the COVID-19 shock. I show that the proposed mechanism has a larger impact during contractionary periods.

1.1 Related Literature

This work contributes to three different strands of the literature.

First, the literature on fund organizational structure has highlighted that covenants are a solution to the agency problems in closed-end funds which arise due to lack of open-ending-ability of investors to withdraw funds. I contribute to this literature by showing that the remediation that is designed to address the agency problem within the closed-end fund structure can create fire sale risk like in open-end funds. I also find that these fire sales lead to dislocation in security prices and real effects. In essence, this work highlights that differences in the fund organizational structure cannot eliminate fire sale risk. The closest paper to this work is Kundu (2022*b*), which shows the primary impact of financial distress on CLOs. It demonstrates how CLO covenants can exacerbate the effects of shocks to a firm's own creditworthiness, i.e., if an O&G firm experiences default, constrained CLOs may sell loans issued by the O&G firm, exerting price pressure for loans issued by the O&G firm. In contrast, this paper highlights the *spillovers* of idiosyncratic shocks to other firms, i.e., if an O&G firm experiences default, constrained CLOs may sell a software company's loans, exerting price pressure for loans issued by

[5] At the fund level, CLOs with a greate ex-ante exposure to O&G hold a lower share of defaulted loans after the shock.

the software company. In addition, this paper also finds that unlike other intermediaries that sell their most liquid loans to minimize selling costs and fire sale discounts, constrained CLOs sell the riskier segment of loans.[6] These results have important implications for the design of securitized assets.[7] These results also have important implications financial stability given that there is an increasing amount of loans held by CLOs in the syndicated loan market.[8]

Second, this paper contributes to the existing literature by providing evidence of how a source of market financing can have negative externalities due to contracting frictions which, in turn, can affect firm financial decisions and have real effects. Firms operating in informationally sensitive environments cannot readily substitute to other sources of financing. The literature on credit supply shocks has focused on the role of bank lending relationships on firm outcomes (e.g., Bernanke and Blinder (1988); Bernanke and Gertler (1989); Holmstrom and Tirole (1997); Peek and Rosengren (2000); Khwaja and Mian (2008)).[9] Iyer et al. (2014) show that the credit supply reduction is strongest for smaller firms which cannot compensate the credit crunch with other sources of debt. This paper emphasizes the role of financing frictions in a market-based setting, featuring larger firms.[10] I show that contracting frictions in the CLO market can propagate to firms that cannot substitute to other sources of financing, even at times when other markets are not dislocated. Hence, this work demonstrates that shocks to CLOs, which are a market-based financing mechanism, can transmit to firms and have real effects.

Third, this paper contributes to the literature that examines the externalities of fire sales. The theoretical literature posits that fire sales may exacerbate the real effects of credit crunches (see Kashyap et al. (2008)). Shleifer and Vishny (2010) show that during fire sales, lower security prices can present investment opportunities to banks that are superior to direct lending, causing banks to forgo funding real activity, creating systemic risk and economic volatility. Diamond and Rajan (2011) show that banks that are active in securities trading may have incentives to hold onto illiquid securities and increase investments of fire-sold securities akin to underinvestment. Empirically, Abbassi et al. (2016) show that fire sales in securities mar-

[6]See Manconi, Massa and Yasuda (2012) and Irani and Meisenzahl (2017) which document that mutual funds and banks experiencing liquidity shortages are more likely to sell liquid, less informationally-sensitive assets.

[7]See Benmelech, Dlugosz and Ivashina (2012) that examines incentives and adverse selection in the CLO market.

[8]See Irani et al. (2021) that documents the growing share of loans held by CLOs, with increasing regulation in the banking sector.

[9]Bank intermediaries are known to be more efficient at resolving informational asymmetries than the market. See Kashyap, Lamont and Stein (1994); Gertler and Gilchrist (1994); Kashyap and Stein (2000); Paravisini (2008); Ivashina and Scharfstein (2010); Chava and Purnanandam (2011); Benmelech, Bergman and Seru (2021); Schnabl (2012); Chodorow-Reich (2014); Huber (2018); Amiti and Weinstein (2018); Kundu and Vats (2021); Kundu, Park and Vats (2021) for evidence on the propagation of credit supply shocks.

[10]CLOs are not directly involved with firms, nor do they possess any firm-specific private information about fundamentals (Kundu (2022*b*)).

kets can have externalities on credit supply through the trading behavior of financial intermediaries. Benmelech and Bergman (2011) demonstrate that bankrupt firms impose negative externalities on their non-bankrupt competitors through a collateral channel mechanism – a type of financial accelerator which increases the cost of external debt finance across the industry. Mitchell, Pedersen and Pulvino (2007*b*) and Mitchell and Pulvino (2012) examine the right-hand side of arbitrageurs' balance sheets and provide evidence of how immediate withdrawals of capital used to finance arbitrage portfolios and the lack of offsetting new capital can lead to a vicious cycle of losses. A key challenge with identifying the externalities of fire sales in this literature is that typically, when a fire sale occurs, the entire economy is dislocated. This paper applies an empirical strategy that is better adept at identifying the externalities of fire sales across industries. Specifically, I exploit variation from an idiosyncratic sectoral shock, which helps identify the pass-through of fire sales of secondary loans to other markets and real economic activity. This aids in understanding whether a fire sale may merit regulatory intervention (Stein (2013)).[11]

The roadmap for the paper is as follows. I explain the institutional setting and contractual arbitrage in Section 2. The data sources used in this study are described in Section 3. The empirical strategy used in this analysis is discussed in Section 4. I present the main results in Section 5. I explore the underlying mechanism in Section 6. I conduct and detail the findings of robustness tests in Section 7. Lastly, I conclude in Section 8.

2 Institutional Background

This section provides a brief summary of how CLOs function.[12]

CLO liabilities consist of debt tranches and an equity tranche which face the canonical agency problem of Jensen and Meckling (1976): riskshifting. Covenants intrinsic to to CLO managerial contracts are intended to address this problem. There are two classes of covenants: quality covenants and coverage covenants. Quality covenants are maintain-or-improve constraints. If a quality covenant is triggered, the manager must maintain the credit quality of the portfolio. In contrast to quality covenants, if a coverage covenant is triggered, proceeds from the underlying loans may be diverted from junior tranches, junior management fees, and equity distributions towards prematurely paying down liabilities in order of seniority, or towards

[11]See Bergman, Iyer and Thakor (2020) for evidence on the economic effect of interventions designed to strengthen firms' balance sheets during financial crises.

[12]For a more detailed discussion, I refer readers to Kundu (2022*a*).

the purchase of "higher-quality" collateral. Coverage covenant violations are potentially costly to the manager in several ways.[13]

Given the course-correcting nature of coverage covenants, I center my focus on these covenants. CLOs are typically subject to: overcollateralization (OC) covenants, interest diversion (ID) covenants, and interest coverage (IC) covenants. Among the coverage covenants, The OC and ID covenants are *capital covenants*, which ensure that there is sufficient coverage and subordination of tranches relative to the tranche-specific triggers. They are akin to measures of leverage. The ID covenant has a lower threshold than the OC covenants, hence, it is triggered before any of the OC covenants. An ID covenant violation results in the diversion of proceeds towards the purchase of high-quality, value-increasing loans to eliminate the opportunity for asset substitution. This effect differs from the OC violations which result in deleveraging. The IC covenants ensure that there is a specific level of coverage for interest due on tranches relative to the triggers. These are *liquidity covenants*. The IC covenants are similar to the OC covenants, insofar as they may also cause CLO managers to pay down liabilities early. Broadly, covenants create first-loss tranches, namely, cushions for principal losses for more senior tranches.

CLOs operate closest to the ID threshold. From 2009-2018, CLOs operated within a 3% margin of the ID threshold. Given the variation in the degree of constraint across covenants, I narrow my attention to the capital covenants, and in particular, the ID covenant.

$$OC/ID = \frac{\text{Par value of collateral+Defaulted collateral value+Purchase price of discounted collateral-“CCC” excess adjustment}}{\text{Principal balance of tranche and all senior tranches}} \tag{1}$$

In the calculation of the capital covenants, loans are marked at par value and are not subject to market fluctuations unless, *(1)* a loan has experienced default, *(2)* a loan is rated CCC/Caa1 or below, putting the CLO in excess of its limit, or *(3)* a loan is a discount obligation. In these cases, the loan is marked to the lower of market value and recovery value, the lowest market values among loans in the CCC/Caa1 bucket, or the purchase price until the loan trades above a threshold (typically 90 ¢/$) for more than 30 days, respectively. I discuss the implications of these accounting rules next.

[13] First, fees and payments may be siphoned off from the manager and other junior stakeholders. These constraints may hinder the manager in making portfolio-enhancing trades. Second, investors may also lose confidence in the manager's ability to administer the CLO portfolio. If CLO failures persist, i.e., the manager serially breaches contractual provisions, the manager may be dismissed. Further, if the underlying loans default, equity holders may elect to not exercise the call until the defaulted loans rebound in price. These ramifications may result in a CLO operating well-beyond its expected call date until legal maturity. Kundu (2022*b*) explores some of the costs of covenant violations.

2.1 Contractual Arbitrage

The piecewise nature of the accounting of covenants can influence the incentives of CLO managers in their selling behavior. Consider the following illustration of how CLO managers can participate in *contractual arbitrage*. As an example, I focus on the accounting of CCC/Caa1 loans. The general framework may be extrapolated to the other cases of defaulted loans and discount obligations.

A CLO faces a limit on loans rated CCC/Caa1 or below, typically set to 7.5%. The loans in excess of this percentage are marked at the lowest market value of the loans in the CCC/Caa1 bucket.

Let τ denote the stipulated portfolio share of CCC/Caa1 loans, A denote total CLO assets, and L denote total CLO liabilities. For simplicity, assume the portfolio has two types of assets – bad, risky assets, and good, risky assets – the sum of which counts toward the CCC/Caa1 limit, τ. The share of bad, risky assets is denoted by b, whereas the share of good, risky assets is denoted by g. This distinction is important; regardless of whether the risky assets are good or bad, they are marked to the lowest market value of the CCC/Caa1 share of loans – the market value associated with the bad assets, β. The market value of the good assets is γ.

Suppose the CLO breaches its limit on CCC/Caa1 loans, i.e., $b + g > \tau$. The capital covenants will tighten and the OC/ID ratio will be the following.

$$OC/ID = \frac{(1-(b+g-\tau))A + (b+g-\tau)\beta A}{L}. \tag{2}$$

Selling the good, risky assets, g from the portfolio at market price γ may loosen the capital covenants. Sales of good, risky assets can improve the capital covenants by $\frac{g(\gamma-\beta)A}{L}$ under a binding CCC/Caa1 constraint.[14] The new OC/ID ratio will be:

$$OC/ID = \frac{(1-(b+g-\tau))A + (b-\tau)\beta A + g\gamma A}{L}. \tag{3}$$

A numerical example illustrating contractual arbitrage is provided in Appendix Section A. The implications of this trading strategy are discussed in Section 6.1.

[14]The improvement to the covenant is lower from selling bad, risky assets under a binding CCC/Caa1 constraint, as shown in Appendix Section C.

3 Data Sources

This paper investigates whether contracts impose externalities on asset prices, and the mechanism through which firm distress may propagate to other firms in CLO portfolios. An empirical challenge in studying fire sale spillovers is the lack of granularity in data coverage. Granularity is important in three ways: (1) for identifying firm exposure to intermediary distress, (2) for observing the connections between firms through financial intermediaries, and, (3) for distinguishing fire sale transactions and the characteristics thereof. The CLO setting is the ideal laboratory to meet the research objectives because of the availability of comprehensive data on CLO portfolios.

There are a number of data sources used in this project, ranging from financial data to firm fundamental data. In this section, I describe the datasets used in this project. The sample period for this study is 2013 to 2015.

The primary data source is the *CreditFlux CLO-i Database*. The CLO-i database reports a coverage of 52-68% of the market in the sample period.[15] On average, each issuer's loans are held in 125 CLOs, and total to $230 million. I restrict my analysis to firms that received a syndicated loan, as reflected in DealScan. The processed data covers a total of 1,631 distinct issuers.

To supplement the data on transaction prices reported in the CreditFlux CLO-i database, I collect additional financial data from WRDS-Thomson-Reuters' LPC DealScan, WRDS Bond Returns, and CRSP. I use data on primary issuance from WRDS-Thomson-Reuters' LPC DealScan. The processed data covers a total of 439 distinct issuers. In addition to primary issuance data, I use the WRDS Bond Database for retrieving information related to bond credit spreads and liquidity. The processed dataset covers a total of 136 distinct issuers. I retrieve monthly equity returns from CRSP. The monthly Fama-French five factors used in my analysis are from Kenneth French's website. The processed data covers a total of 263 distinct issuers.

For firm characteristics, I use two databases from S&P Capital IQ: Compustat North America (Compustat) and Capital Structure. I describe the construction of firm-level variables in Section D. A limitation of my analysis is that Compustat only reports data for publicly held companies, whereas CLOs hold loans issued by both private and public firms. Hence, firm coverage is limited. The processed data covers a total of 300 distinct issuers. I use Capital Structure data to understand the dynamics of firm liquidity, specifically, data on lines of credit.

[15] International Monetary Fund (2020)'s figures on total outstanding US CLOs from 2013 to 2015 are used to compute this.

The processed dataset covers a total of 224 distinct issuers. Both datasets are collapsed to the quarterly frequency.

Lastly, I use time-series data from FRED. I obtain WTI crude oil data from FRED. This data is used to track the start of the oil price plunge as well as price movements.

A significant hurdle to this empirical analysis is matching firms across datasets. There is no identifying code in the Creditflux CLO-i database that allows for easy matching across databases. Case sensitivity, abbreviations, inconsistent syntax, punctuation, and the conflation of subsidiaries and holding companies are some of the issues that hinder automatic matching. For this reason, I manually encode the data and generate several crosswalks between the CLO-i database and other datasets. For completeness and correctness, I have verified and supplemented matches through fuzzy string matching, matching on the first six characters of the firm's name, and the Roberts Dealscan-Compustat Linking Database (Chava and Roberts (2008)).

4 Empirical Strategy

The objective of this paper is to study how CLO covenants affect the transmission of idiosyncratic shocks. A microcosm of the empirical setting is presented in Figure 1, demonstrating how idiosyncratic risk may amplify to systemic risk. The figure shows that shocks to firms can transmit to CLOs and shocks to CLOs can transmit to firms.[16] Empirical approaches that rely on explicit measures of CLO health such as covenant tightness to identify the effects of CLO covenants on the transmission of shocks raise concerns regarding non-random matching between CLOs and firms. Specifically, the performance of CLO portfolios may be related to the characteristics of the firms they hold, confounding identification of spillover effects. To circumvent this issue, I use a reduced-form instrumental variable (IV) strategy. I exploit cross-sectional variation in firms' exposure to the O&G industry as a measure of risk that directly affects the capital covenants.

To fix ideas, consider the following thought experiment of the ideal empirical design, depicted in Figure 2. There are two CLOs: CLO A and CLO B. CLO A does not hold debt

[16] Firms are connected to other firms through the CLO. The spokes connecting firms to CLOs are bidirectional as firm performance affects cash flow to CLOs and CLO distress may also transmit to firms (left figure). If a firm experiences extreme distress – represented by the red outer circle – a CLO's covenants may tighten, represented in pink (center figure). In this event, the CLO manager may loosen the covenants by preemptively selling loans issued by the distressed firm. Hence, the red firm is disconnected from the CLO in the diagram. The CLO manager may also sell other unrelated risky loans – loans issued by innocent bystanders with no direct exposure to the source of distress – in order to generate more slack in the covenants. This is represented by the pink firms with dashed connections to the CLO (right figure). These sales may alleviate CLO covenants, but may potentially lead to future distress (bottom figure).

issued by any O&G firms. CLO B holds debt issued by O&G firms. Both CLOs hold similar portfolios of other loans. When the O&G price plunge occurs, CLO A is unaffected because it is not exposed to O&G. However, CLO B's covenants tighten, as many O&G firms experience distress and fall back on making interest and principal payments. The question of interest is the following. If CLO A holds a loan issued by WidgetCo X and CLO B holds a loan issued by WidgetCo Y – both of which are vulnerable to fire sales – how does the distance to the covenant threshold impact these innocent bystanders' cost of financing and real economic activity? Broadly, how do idiosyncratic shocks propagate to other portfolio firms through CLO intermediaries?

This paper focuses on the impact of CLO actions on innocent bystanders and examines the mechanism through which covenants may impose externalities. The research objective is motivated by findings that fire sales of distressed loans may occur when loans are concentrated among constrained CLOs, which experience lower returns compared to unconstrained CLOs around default events – see Appendix Figure C.1 for evidence of price pressure (Kundu (2022*b*)). Kundu (2022*b*) finds that the realization of default is not necessary to drive sales, as CLOs sell distressed loans before default occurs. This finding motivates the study of how covenants affect CLO management of the other unrelated loans which are issued by innocent bystanders who are not directly affected by the initial shocks.

4.1 Specification

The baseline specification is a Bartik-style difference-in-differences design. Non-O&G firms' (innocent bystanders') exposure to O&G is measured by weighting each CLO's exposure to O&G by the firm's exposure to the CLO, before the shock in June 2014. The sample period of study is 2013-2015 – a window around the O&G price plunge.

$$\text{Firm O\&G Exposure}_f = \sum_{c \in C} \underbrace{\left(\frac{\sum_{k \in K} \mathcal{L}_{f,k,c}}{\sum_{c \in C} \sum_{k \in K} \mathcal{L}_{f,k,c}} \right)}_{\text{Firm exposure to CLO}} \times \underbrace{\left(\frac{\sum_{f \in F} \sum_{k \in K} L_{O\&G,f,k,c}}{\sum_{i \in I} \sum_{f \in F} \sum_{k \in K} L_{i,f,k,c}} \right)}_{\text{CLO exposure to O\&G}} \tag{4}$$

The baseline empirical strategy is the following.

$$\begin{aligned} Y_{f,t} = {} & \beta_0 + \beta_1 (\text{Firm O\&G Exposure})_f + \beta_2 (\text{Oil Shock})_t \\ & + \beta_3 (\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \alpha_f + \alpha_{m,y} + \epsilon_{f,t} \end{aligned} \tag{5}$$

$L_{i,k,f,c}$ denotes the loan amount for loan k ($k \in K$), issued by firm f ($f \in F$), in industry i ($i \in I$), held by CLO c ($c \in C$), and $\mathcal{L}_{k,f,c}$ is a function of $L_{i,k,f,c}$, keeping the industry fixed.

Firm O&G Exposure$_f$ is measured before the shock occurs. Oil Shock$_t$ is an indicator variable that takes a value of 1 if the O&G price plunge has occurred, and 0 otherwise. t indexes the time, and m, y denote the month and year, respectively. For simplicity, I refer to the *Oil Shock* variable as *Post*, hereafter. In addition, I use the phrase "a firm's exposure to O&G" as shorthand notation to refer to to a non-O&G firm's exposure to O&G through CLOs.

Several assumptions underlie this empirical specification. In the remaining section, I discuss these assumptions and address related concerns.

4.1.1 Addressing Exogeneity

A common concern with difference-in-differences specifications for causal inference is the exogeneity of shocks. If the shocks are not exogenous, the policy may be correlated with the errors, causing the estimator to be inconsistent. This section argues that the O&G price plunge is exogenous.

Figure 3 exhibits the average crude oil price ($ per barrel) from 1960 through 2020.[17] The oil price precipitously dropped in June 2014. The plunge lasted until 2016, making the O&G price plunge of 2014-2016 one of the three largest declines since World War II and the longest-lasting since the supply-driven price plunge of 1986 (Stocker, Baffes and Vorisek (2018)).[18]

Several major factors contributed to the price plunge. First, booming shale production in the US and improvements in fracking technology reduced the break-even prices of shale production. Specifically, post-crisis financing conditions facilitated developments in hydraulic fracking and horizontal drilling, improving oil extraction.[19] Given the shorter life cycle of these projects and lower capital cost relative to conventional extracting methods, shale production presented itself as a viable substitute to conventional crude production in the wake of the price plunge as it is more elastic to oil price changes than crude oil (Baffes et al. (2015); Krane and Agerton (2015); McCracken (2015)). Second, OPEC announced a shift in policy, renouncing price targeting, partly, in response to the increasing shale share of the global oil supply. Third, receding geopolitical tensions allowed oil production to function without disruption or conflict, hence, supply remained steady. Fourth, the appreciation of the dollar from June 2014 and June 2015 increased the local cost of oil in countries where the currency was not pegged to the dollar. This increase contributed to "weaker oil demand in those countries and greater supply from non-US dollar producers" (Baffes et al. (2015)). Although some demand shocks also occurred contemporaneously, for example, the stock market turbulence in China reduced

[17] See Appendix Figure C.2 for the monthly crude oil price trend.

[18] A plot of monthly crude oil prices from 2012-2018 is available in Appendix Figure C.2.

[19] Other developments that increased oil extraction include increased biofuel production and extraction from Canadian oil sands.

demand for oil, consensus has formed around supply-driven factors as dominant contributors to the oil price plunge (e.g., Arezki and Blanchard (2014); Hamilton (2014)). Regardless of the exact source, the main point is that it is outside of the leveraged loan and CLO markets.

4.1.2 Addressing Selection and Matching

The second concern with the proposed identification strategy is that matching between CLOs and firms may not be as good as random. In other words, CLOs with higher O&G exposure may be structurally different from CLOs with lower O&G exposure. Specifically, CLOs with higher O&G exposure may employ different hedging strategies than CLOs with lower O&G exposure. This may manifest as differences in observable characteristics of portfolio firms, as well as differences in the concentration of investment across industries and geographies.

I summarize the main findings of several tests that assess the magnitude of selection concerns. First, I find that portfolios are largely overlapping across CLOs. Second, I do not find that the capital covenant threshold varies with O&G exposure before the shock. Third, there are negligible differences in the distribution of investments across non-O&G industries before the shock. Fourth, there are negligible differences in the distribution of investments across states before the shock. Fifth, there are not material differences in firm characteristics across CLOs of differing O&G exposure. Sixth, the firm sensitivity to the oil price cannot predict CLO selection. Details of these tests are provided in Appendix Section B.

4.1.3 First Stage: O&G as a Measure of Risk

In this section, I study whether CLO exposure to O&G is a relevant proxy for the distance to the capital covenant thresholds. As stated before, the O&G price plunge was one of the three largest declines since World War II, and the longest-lasting since the supply-driven price plunge of 1986 (Stocker, Baffes and Vorisek (2018)). In the aftermath, many O&G firms experienced distress. I posit that CLOs with larger O&G exposure experience larger declines in asset values after the shock. This will increase the likelihood that CLOs breach their covenant thresholds.

Figure 4 shows a time series plot of the distance to the most stringent covenant threshold from 2009 through 2020. The most stringent capital covenant is identified as the capital covenant with the lowest threshold. The figure indicates that overall, CLOs experienced a tightening of the capital covenants during the O&G price plunge, demarcated by the dotted gray lines. During this period, covenants tightened, reaching lows that were last witnessed in the aftermath of the Great Financial Crisis of 2008.

I report summary statistics for the main variables used in this empirical analysis in Table 1. The median (mean) firm reports a median O&G exposure of 1.74% (2.06%), before the shock. The 25^{th} and 75^{th} percentile values are 0.0085% and 2.96%, respectively. The standard deviation associated with firms' O&G share is 1.97%. The median (mean) CLO has 1.05% (2.00%) of the portfolio invested in O&G, before the shock. The 25^{th} and 75^{th} percentile values are 0% and 2.84%, respectively.[20] The standard deviation associated with the CLO O&G share is 4.25%. Variation in O&G exposure may seem limited. However, as the median CLO operates within 4% of the covenant threshold, even small portfolio shocks can exert pressure at the CLO level.[21]

Table 2 studies the relation between a CLO's exposure to the O&G industry and its distance from the ID threshold. The empirical specification is the following.

$$\begin{aligned} ln(\frac{\text{Covenant Result}}{\text{Covenant Threshold}})_{c,t} &= \beta_0 + \beta_1(\text{CLO O\&G Exposure})_c + \beta_2(\text{Oil Shock})_t \\ &+ \beta_3(\text{CLO O\&G Exposure}_c \times \text{Oil Shock}_t) + \gamma_0' X_c + \epsilon_{c,t} \qquad (6) \end{aligned}$$

c denotes the CLO, t denotes the time, and X denotes the vector of controls, consisting of age, size, defaulted share, and CCC-share. Covenant Result is the reported value of the covenant. Covenant Threshold is the threshold associated with the covenant. CLO O&G Exposure$_c$ is the O&G share of CLO c, reported before the shock occurs, and Oil Shock$_t$ is an indicator variable that takes a value of 1 after the O&G price plunge, and 0 otherwise.

Differences in specialization, risk aversion, taste, reputation, sophistication, and style are accounted for through manager and CLO fixed effects. I use a within manager estimator in columns 1-4, and a within CLO estimator in columns 5 and 6. CLO controls are included in columns 2-4, including CLO age (columns 2-4), CLO size (columns 3-4), and share of CCC loans and defaulted loans (column 4).[22] Further, I include time fixed effects to account for aggregate shocks – year fixed effects in columns 2 and 5, and month-year fixed effects in columns

[20] Thomson Reuters reported in 2015 that while US CLOs have an average exposure of 3% to O&G companies, a significant number of funds hold more than 10% of assets from the O&G sector. Over 50% of CLOs have an exposure to O&G above 3%. Moreover, funds with significant energy exposure traded at lower levels than managers with lower energy holdings or did not trade. Further, the O&G sector had the highest share in total distressed collateral of US CLOs, and the percentage of loans trading below 90¢/$ (typical threshold for discount obligations) increased to the highest level in October 2015. Specifically, Moody's Analytics finds that the average mark of the O&G loans in CLO portfolios were around 80 ¢/$ and lowest priced loans were marked below 40 ¢/$. For example, the average O&G loan prices for Vantage Drilling Company, Samson Resources Corporation, Sabine Oil & Gas, Ascent Resources, LLC. were 39.4 ¢/$, 15.9 ¢/$, and 20.7 ¢/$, 26.5 ¢/$. These loans were held across a number of CLOs. Approximately 22% of the US loan exposure to O&G is marked below 70 ¢/$, 11% is below 60 ¢/$ and 8% is below 50 ¢/$.

[21] Whether the shock is large or small is unknown ex ante. As Kundu (2022*b*) finds, the realization of default is not necessary to drive sales. Indeed, CLOs preemptively sell distressed loans several months before default is even realized.

[22] The control variables are measured prior to the price plunge and, therefore, absorbed by CLO fixed effects in columns 5 and 6.

3, 4, and 6. CLO fixed effects are added in columns 5 and 6. The results indicate that a 1 pp increase in the O&G share before the shock is associated with a 0.22% to 0.52% decline in the distance to the ID threshold, after the shock.[23] This estimate is economically meaningful, statistically significant, and stable across all specifications. The estimate is nontrivial, as the median CLO operates within 4% of its ID threshold (Table 1). I further examine the relation between a CLO's exposure to the O&G industry and the likelihood that it violates the ID covenant for the first time in at least six months in Appendix Table C.4. I find that a 1 pp increase in the O&G share before the shock is associated with a 3.10 pp to 4.51 pp increase in the likelihood that a CLO violates the ID covenant for the first time in at least six months.

While Figure 4 and Table 2 indicate that CLO covenants tighten significantly during the O&G price plunge, it is unclear if O&G loans actually deteriorated during the O&G price plunge. To address this, I compare the distribution of O&G loan ratings before and after the O&G price plunge. Appendix Figure C.5 indicates that there is a marked shift in the credit quality of O&G loans, before and after the O&G price plunge. Specifically, before the shock, approximately 40% of O&G loans report a double-B rating, 5% of O&G loans report a rating of Caa1 or below, and remaining loans report a single-B rating. After the shock, the share of double-B loans falls to 30% and over 10% of O&G loans report a rating of Caa1 or below. Hence, a comparison of the ratings of O&G loans, before and after the shock, indicates that the credit quality of O&G loans markedly worsens after the shock. Furthermore, I compute the percent of CLO O&G defaulted loans before and after the O&G price plunge. 3% of CLO defaulted loans are O&G loans after plunge, compared to 0.09% before.

Overall, these findings suggest that the O&G shock provides a quasi-exogenous source of variation that affects CLO covenants. Hence, O&G is a relevant proxy for portfolio risk.

4.1.4 Parallel Trends

This section examines whether any relationship between O&G exposure and firm outcomes may be driven by pre-trends, prior to the oil and gas price plunge. I study the relationship between: *(1)* the price of a secondary loan issued by a non-O&G firm and the non-O&G firm's O&G exposure through CLOs, and, *(2)* the distance to the ID threshold and CLO O&G exposure. For identification, the parallel trends assumption states that these relationships would have followed common trends both before and after the price plunge, in the absence of the price plunge. I study whether there is evidence of different trajectories for CLOs with different O&G exposures before and after the price plunge. These results are presented in Figure 5.

[23] The distance to the most stringent capital covenant threshold is measured as the as the ratio of the covenant result to the covenant threshold.

I plot the estimated coefficients of β_i and the associated 95% confidence intervals from the following regression specifications.

In Figure 5a, the regression specification is:

$$P_{i,f,t} = \sum_{\substack{k=-24 \\ k=k+6 \\ k\neq 0}}^{30} \beta_k \mathbb{1}_{k\leq t<k+6} \times (\text{Firm O\&G Exposure})_f + \sum_{\substack{k=-24 \\ k=k+6 \\ k\neq 0}}^{30} \delta_k \mathbb{1}_{k\leq t<k+6}$$
$$+ \theta_1 \text{Firm O\&G Exposure}_f + \alpha_{f,g} + \alpha_y + \epsilon_{i,f,t}. \tag{7}$$

In Figure 5b, the regression specification is:

$$ID_{c,t} = \sum_{\substack{k=-24 \\ k=k+6 \\ k\neq 0}}^{30} \beta_k \mathbb{1}_{k\leq t<k+6} \times (\text{CLO O\&G Exposure})_c + \sum_{\substack{k=-24 \\ k=k+6 \\ k\neq 0}}^{30} \delta_k \mathbb{1}_{k\leq t<k+6}$$
$$+ \theta_1 \text{CLO O\&G Exposure}_c + \alpha_m + \alpha_y + \epsilon_{c,t}. \tag{8}$$

where $P_{f,t}$ is the secondary loan price (per \$100), $ID_{c,t}$ is the distance to the ID threshold ($ln(\frac{\text{Covenant Result}}{\text{Current Threshold}})$), c denotes the CLO, m denotes the manager, f denotes the (non-O&G) portfolio firm or issuer ($f \in c$), g denotes the transaction type, t indexes the date, and y denotes the year. Firm O&G Exposure$_f$ measures the weighted average of O&G share of firm f across all CLOs before the shock occurs. CLO O&G Exposure$_c$ is the O&G share of CLO c before the shock occurs. $\mathbb{1}_{k\leq t<k+6}$ is an indicator variable that takes a value of 1 if the time period corresponds to the six-month time period signified by k. Leads and lags of the shock are included, as well as their respective interactions with the measures of O&G exposure. I exclude the last pre-treatment month to avoid perfect multicollinearity.

Figure 5a presents the relation between a firm's O&G exposure and the secondary price of its loans, in six-month increments around the shock in Figure 5a. Figure 5b presents the relation between a CLO's O&G exposure and its distance to the ID threshold, in six-month increments around the shock.

The β_i estimates prior to the shock are akin to placebo treatments; each of the β_i coefficients is a placebo test for whether the treatment has an effect. Under the parallel trends assumption, no effect should occur before the treatment occurs. The findings exhibited in Figure 5 are consistent with the assumption that prior to the shock, the relationships between a firm's O&G exposure and the secondary price of its loans, and, a CLO's O&G exposure and its distance to the ID threshold, are statistically indistinguishable from the last pre-treatment period – the 95% confidence intervals include the null in the period before the shock. Interestingly, Figure 5b indicates that before the shock, CLOs with greater exposure to O&G operate farther away from the Interest Diversion threshold, relative to CLOs with lower exposure to O&G. This is consistent with the findings of Appendix Figure C.6 and Appendix Figure C.7 which compare the ratings and yields of O&G loans to non-O&G loans, before the shock. Appendix Figure C.6 indicates that O&G loans exhibit higher ratings than non-O&G loans; 40% of O&G loans report a double-B rating compared to 21% of non-O&G loans. Appendix Figure C.7 indicates that the O&G loans yield higher returns, relative to non-O&G loans for each rating category that O&G loans are active in. These findings reflect the boom and bust nature of O&G.

After the O&G price plunge, these relationships between a firm's O&G exposure and the secondary price of its loans, and, a CLO's O&G exposure and its distance to the ID threshold exhibit a marked change – the magnitude of β_i becomes economically meaningful, stable, and statistically significant. Hence, I reject the hypothesis that these relationships are driven by pre-trends. As the shock does not exhibit similar effects before the shock, any variation after the event is attributed to the price plunge itself.

Furthermore, the depression in loan prices is temporary, as secondary loan prices exhibit a slow recovery towards their pre-plunge prices. The secondary loan price reaches a trough 18 months after the price plunge. Thereafter, the point estimate attenuates in magnitude and the confidence intervals widen over time. These results suggest that the dislocation in the secondary loan price persists for approximately 18 months. This is consistent with the linear projections presented later in Section 6.2. Evidence of reversal supports the fire sale mechanism; if the results are driven by firm fundamentals, there would not be any reversal.

5 Main Results

This section reports the main findings of the paper. I first provide evidence of CLO sales. I then demonstrate that these sales have extensive implications for asset prices across security markets as well as real economic activity. I argue that CLO sales are driven by contractual arbitrage – a practice in which CLO managers sell risky loans with higher market values than accounted values to loosen the capital covenants. As it is difficult to identify, ex ante, which firms are risky and most vulnerable to fire sales, this section focuses on all loans held by constrained CLOs. In Section 6, I investigate contractual arbitrage and narrow my focus to loans which are most likely to be subject to this mechanism.

5.1 Fire Sales of Non-O&G Loans

This section compares loan sales based on firm O&G exposure, around the O&G price plunge. Trades are examined at the transaction, CLO-issuer, and issuer levels to identify systematic sales.

5.1.1 Trading Effects

I begin by studying the relation between firm O&G exposure and the transaction amount around the O&G price plunge to identify CLO sales in Table 3. The transaction amount is negative if the transaction is a sale, and positive if it is a purchase. In column 1, I do not include any fixed effects. In columns 2-6, I add additional fixed effects including manager, rating-industry, issuer-loan type, year, and month-year fixed effects. After saturating the model with high dimensional fixed effects, the point estimate remains negative, statistically significant, and economically meaningful. Specifically, across all estimates, I find that a 1 pp increase in a firm's exposure to O&G is associated with a \$148K to \$251K (0.1103 to 0.1865 standard deviations) decline in the transaction amount, after the shock. Hence, the transaction amount declines in firms' exposure to O&G, after the shock.

To study if these patterns hold at a coarser level, I estimate the relation between firm O&G exposure and the total amount transacted at the CLO-issuer level around the O&G price plunge. For each issuer in a given CLO, I aggregate across all transactions. These results are presented in Appendix Table C.5. In column 1, I do not include any fixed effects. In columns 2-6, I add additional fixed effects including manager, rating-industry, CLO-issuer, year, and month-year fixed effects. I find that a 1 pp increase in a firm's exposure to O&G is associated with a \$228K to \$435K (0.1244 to 0.2377 standard deviations) decline in the net transaction amount at the CLO-issuer level after the shock. These results remain statistically significant at the issuer-level as well; Appendix Table C.6 reports that a 1 pp increase in a firm's exposure to O&G is associated with a \$581K to \$1.02M (0.0168 to 0.0295 standard deviations) decline in the net transaction amount at the issuer-level, after the shock.

However, a reduction in the transaction amount and net transaction amount at the CLO-issuer and issuer levels are not necessarily tantamount to increased sales. Decreased purchases may also yield similar results. To disentangle whether the effect is driven by an increase in sales or a decrease in purchases, I conduct a subsample analysis. I study how the net transaction amount at the issuer level differs for purchases and sales around the O&G price plunge. These results are presented in Appendix Table C.7. The results in columns 4-6 corroborate the hypothesis that CLO selling pressure increases in the O&G exposure, after the shock. Concretely, a 1 pp increase in a firm's exposure to O&G is associated with a \$1.39M to \$1.87M (0.0815 to 0.1095 standard deviations) increase in net sales, after the shock. Columns 1-3 indicate that the purchase amount increases in the O&G exposure, albeit the estimates are statistically insignificant. The positive relation between purchases and O&G exposure counter the conjecture that the effect is driven by a decrease in purchases.

Hence, these tests provide a priori evidence that the amount of selling increases after the shock in the degree of constraint, as reflected by O&G exposure, after the shock.

5.2 Implications for Asset Prices

This section investigates the price impact of fire sales. I study how firm exposure to O&G through CLOs exerts price pressure on the securities issued by these firms. I begin by studying the effect on secondary loan prices. I then study how dislocations in the secondary loan market can pass through to other securities such as primary loans. I find evidence of limited substitution to corporate bonds.

The identifying assumption for the subsequent analysis is that issuer fixed effects fully control for issuer demand throughout the sample period. This is plausible given the small T dimension of the panel. A weaker identifying assumption is that changes in firm demand are sticky, relative to changes in supply. When applicable, I account for non-price terms associated with the securities' contracts as controls, i.e., maturity, secured status, seniority, etc. Time fixed effects are included to control for common shocks. I further conduct two falsification exercises in Section 7.5, confirming that the findings are not driven by changes in firm fundamentals or bank constraints.

5.2.1 Secondary Loans

This section studies how the secondary loan price (per \$100 of notional par), varies with a firm's exposure to O&G around the O&G price plunge in Table 4. In column 1, I do not include any fixed effects. This column indicates that a 1 pp increase in a firm's exposure to O&G is associated with a decline in the secondary loan price by \$1.81 (per \$100 par), after the shock.[24]

[24] Before the shock, a 1 pp increase in a firm's exposure to O&G is associated with an *increase* in the secondary loan price by \$1.86 (per \$100 par). The nearly equal and opposite signs reflect the boom and bust cycles of O&G – consistent with the trading patterns before and after the shock in Table 3. This is further illustrated in Figure 5 and Appendix Figures C.6 and C.7 which show that before the shock, O&G loans outperformed their non-O&G counterparts. Loan purchases are higher when O&G prices are higher, as shown in Appendix Tables C.5, C.6 and C.7. Hence, debt securities issued by innocent bystanders exhibit higher price volatility when CLOs have larger exposure to more volatile sectors, such as O&G. This is further demonstrated in Appendix Figure C.10 which presents the findings from an alternative specification, using the log-transformed oil price instead of an indicator for the price plunge. The figure shows that as the O&G price is higher, firms with greater O&G exposure experience greater net purchases, higher secondary loan prices and lower all-in-spread drawn.

In columns 2-6, I add additional fixed effects including manager, rating-industry, issuer-loan-type, year, and month-year. The inclusion of these fixed effects is intended to account for variation across loan characteristics and time, in order to better identify the effect of CLO covenant tightness on asset prices. Based on columns 2-6, I find that a 1 pp increase in a firm's exposure to O&G is associated with a decline in the secondary loan price by 61 bps to 180 bps (0.61 to 1.80 percent of par).[25] The point estimates are economically meaningful and statistically significant across all specifications. I show that the results are robust to the natural log transformation of the transaction price in Appendix Table C.8, given the skewness of trading prices – a 1 pp increase in a firm's exposure to O&G is associated with a decline in the secondary loan price by 0.81% to 2.54%. Hence, after the shock, secondary loans issued by non-O&G firms with greater exposures to O&G, trade at lower prices, relative to non-O&G firms with lesser exposures to O&G.

5.2.2 Impact on Primary Loans

I study whether the dislocation in the secondary loan spread passes through to primary loans. Table 5 studies how the spread associated with refinancing primary institutional loans varies with O&G exposure. A term loan is deemed to be an *institutional* loan if it is not a term loan A facility. The outcome variable is the all-in-spread drawn, defined as the total annual spread above LIBOR for each dollar drawn from a loan.[26] In columns 1-6, I sequentially add fixed effects to account for variation in non-price contract terms that may confound the relationship between the loan price and CLO covenant tightness. These include issuer, secured status, purpose, distribution method, seniority, loan type, country of syndication, year, and month-year fixed effects. Across columns 1-5, I find that a 1 pp increase in a firm's exposure to O&G is associated with an increase in the primary loan spread by 18 to 22 bps (0.18 to 0.22 pp), after the shock. This represents a change of 4.18 to 5.10 percent of the average loan spread. In spite of the relatively small sample, I find strong significance across all specifications. This implies that firms that refinance after the shock will face higher term loan spreads if they had greater exposure to the O&G industry through CLOs prior to the shock.

Further, I study how the non-price terms of loan contracts vary with O&G exposure, after the shock to study whether there are adjustments in other dimensions. Appendix Table C.9

Papers such as Aggarwal, Akhigbe and Mohanty (2012) and Mohanty et al. (2013) distinguish the effects of oil price increases from oil price decreases and find that equity risk is more sensitive to oil price decreases than increases. Several papers document the macroeconomic effects of oil price changes, including Hamilton (2003); Kilian (2009); Baumeister and Peersman (2013); Baumeister and Hamilton (2019); Känzig (2021).

[25] A 1 pp increase in a firm's exposure to O&G is associated with a decline in the secondary loan price by \$0.61 to \$1.81 (per \$100 par), after the shock.

[26] The all-in-spread drawn consists of the upfront fee, annual fee, utilization fee, and spread above LIBOR.

reports the relation between firm O&G exposure and loan maturity around the price plunge. I find that a 1 pp increase in a firm's exposure to O&G is associated with a decrease in loan maturity by four to five months, after the shock. This point estimate is negative, statistically significant, economically meaningful, and stable across all specifications. Appendix Table C.10 reports the relation between firm O&G exposure and the loan amount. A 1 pp increase in a firm's exposure to O&G is associated with a decrease in the loan amount by 4.67% to 7.66%, after the shock. Although the point estimates associated with the loan amount are negative, economically meaningful and stable across all specifications, they are not statistically significant.

5.2.3 Impact on Corporate Bonds

The limited investor base for syndicated loans creates segmented markets, inhibiting arbitrage (e.g., Shleifer and Vishny (1992); Shleifer and Vishny (1997); Gabaix, Krishnamurthy and Vigneron (2007); Mitchell, Pedersen and Pulvino (2007*a*)); Chernenko and Sunderam (2012)). Further, a limited share of leveraged loan issuers have access to the bond market, hindering substitution to other sources of external financing. This section provides evidence that substitution to bond financing is imperfect for the segment of issuers with access to bond financing.

In Appendix Table C.11, I examine the sensitivity of bond credit spreads to firm O&G exposure around the O&G price plunge. I include issuer and bond-type fixed effects across all columns. In columns 2-6, I account for various dimensions of bond heterogeneity including the time to maturity, security-level, rating, investment-grade status, and defaulted status, as well as time fixed effects to control for common shocks. I find that a 1 pp increase in a firm's exposure to O&G is associated with an increase in the bond credit spread by 28 to 36 bps (0.28 to 0.36 pp), after the shock. This represents a change of 8.35 to 10.74 percent of the average bond credit spread. Furthermore, I find that bond liquidity deteriorates in firms' exposure to O&G, after the shock. Appendix Table C.12 reports that a 1 pp increase in a firm's exposure to O&G is associated with an increase in the bid-ask spread by 0.0208 to 0.0241 bps, after the shock. This represents a change of 4.42 to 5.13 percent of the average bond bid/ask spread. Thus, the bond market does not offer better financing, hindering perfect substitution between markets.

5.3 Implications for Firms

Thus far, it has been established that firms' exposure to O&G through CLOs have material effects on the prices of various securities. This section investigates how credit market dislocations may erode the liquidity positions of exposed firms and affect firm real activity.

5.3.1 Impact on Firm Liquidity

As firms' effective cost of capital increases, the terms with which they can obtain external funds may be unfavorable. This may induce firms to draw down their existing lines of credit more aggressively. This section investigates how an important component of corporate liquidity management – the amount of credit available through lines of credit – is affected by firm O&G exposure around the O&G price plunge.

Table 6 reports the results. Columns 1-3 report the relation between the change in the unused line of credit and firms' O&G exposure around the O&G price plunge. Columns 4-6 report the relation between the change in the drawn line of credit and firm O&G exposure around the O&G price plunge. I include issuer fixed effects across all columns, year fixed effects in columns 2 and 4, and industry and quarter-year fixed effects in columns 3 and 6. I find that a 1 pp increase in a firm's exposure to O&G is associated with a 0.11 pp (0.0325 standard deviations) decline in the quarterly change in the unused line of credit and a 0.10 pp (0.0375 standard deviations) increase in the quarterly change in the drawn line of credit. Thus, as firms' effective cost of capital increases, firms draw down their existing lines of credit more aggressively.

5.3.2 Impact on Firm Real Activity

This section examines the sensitivity of firms' financial and real activity to O&G through CLOs. As the liquidity obtained from lines of credit may be insufficient to fully substitute from other forms of credit, firms may be driven to making operational changes. Furthermore, even if firms have access to credit, it may be unprofitable for them to invest in new projects with a higher cost of capital.

Table 7 examines how firms' exposure to O&G through CLOs affect various financial and real outcomes of firms. I estimate the effect of firms' exposure to O&G on long-term debt growth in column 1, cash flow in column 2, acquisitions in column 3, investment in column 4, R&D growth in column 5, and employment growth in column 6.[27] I include issuer, industry, and quarter-year fixed effects across all columns. I find that a 1 pp increase in a firm's

[27]The construction of these variables is described in Appendix Section D.

exposure to O&G is associated with a 1.11 pp (0.0430 standard deviations) decline in long-term debt growth, a 0.50 pp (0.0304 standard deviations) decline in cash flow, a 0.65 pp (0.0007 standard deviations) decline in acquisitions, a 0.40 pp (0.0378 standard deviations) decline in investment, a 2.75 pp (0.0866 standard deviations) decline in R&D growth, and a 0.35 pp (0.0447 standard deviations) decline in employment growth, after the shock. These estimates are economically meaningful and statistically significant. Overall, the findings indicate that CLO constraints spillover to real economic activity.

5.4 Discussion on Magnitude

This section discusses the magnitude of the effects. First, I study whether trades in the leveraged loan market have a larger impact on prices than more liquid debt markets. Second, I study whether firms are more exposed to cross-firm spillovers through CLO structures than bond mutual funds or banks. Lastly, I compare the sensitivity of investment to the cost of capital in this setting, relative to other settings.

I begin by measuring the illiquidity of the leveraged loan market, using an Amihud-type price impact measure (Amihud (2002)). The Amihud measure relates the price impact to the volume of a trade. I hypothesize that firms with greater exposure to O&G experience a larger liquidity premium as reflected by the Amihud measure, after the shock. A higher Amihud measure is indicative of higher illiquidity, and implies that the price moves to a greater extent for a given volume of trades. In Appendix Table C.13, I examine the relation between a firm's exposure to O&G and an Amihud price impact measure. I construct the Amihud price impact measure by the ratio of the absolute value of the loan discount (bps) to the net sale amount in millions (negative for purchases). I find that a 1 pp increase in a firm's O&G exposure is associated with an increase of 180 bps/$mln to 404 bps/$mln increase in the Amihud price impact measure, after the shock. In other words, under a 1 pp increase in a firm's O&G exposure, selling $1 million of a loan shifts the price by 180 to 404 bps, after the shock. This is substantially higher than the Amihud measure for even the most illiquid corporate bonds during periods of financial crises. Between 2007 and 2009, Benmelech and Bergman (2018) report that the median Amihud measure is 57.7 bps with 25$^{\text{th}}$ and 75$^{\text{th}}$ percentile values of 18 bps and 159 bps, respectively. Friewald, Jankowitsch and Subrahmanyam (2012) report a similar range between October 2004 and December 2008 – the median Amihud measure is 38 bps with 25$^{\text{th}}$ and 75$^{\text{th}}$ percentile values of 10 bps and 130 bps, respectively; the 95$^{\text{th}}$ measure is 260.7 bps. Hence, an equal-sized trade in the leveraged loan market exerts a larger impact on prices than in more liquid debt markets.

Next, I study whether firms are more exposed to cross-firm spillovers through CLO structures than bond mutual funds or banks. Zhu (2021) finds that a one standard deviation increase in the bondholder flow is associated with a 5.55 bps decrease in the yield spread. Comparatively, I find that a one standard deviation increase in O&G exposure is associated with an increase of 55-71 bps in the bond credit spread.[28] In the bank lending setting, Chodorow-Reich (2014) finds that employment at precrisis clients of lenders at the 10th percentile of bank health fell by 4 pp to 5 pp more than clients at the 90th percentile. In contrast, I find that the employment of issuers at the 10th percentile of CLO O&G exposure fell by 1.66 pp more than issuers at the 90th percentile. Hence, the effect through CLOs is two to three times smaller than that of banks. These comparisons suggest that firms are more exposed to cross-firm spillovers through CLO structures than other arm's-length intermediaries, but less than banks.

Further, I compare the sensitivity of investment to the cost of capital in this setting to other settings. The extant literature emphasizes two aspects of the cost of capital: user costs of capital and liquidity costs. The effective cost of capital in the CLO setting reflects both of these components. I compare the effective cost of capital in the CLO setting to the user cost of capital in Gilchrist and Zakrajšek (2007) and Almeida et al. (2009).[29] These studies are well-suited for comparison, as they consider the cost of debt rather than equity. Almeida et al. (2009) find that the terms of long-term financial contracts can have significant implications for firms' financial and real policies when they face an adverse shock. The authors find that firms whose long-term debt was largely maturing after the third quarter of 2007 -– when there was a substantial increase in the cost of long-term financing -– cut their investment-to-capital ratio by 2.5 pp more than otherwise similar firms whose debt matured after 2008. Gilchrist and Zakrajšek (2007) find that a 100 bps increase in the user cost of capital implies a 50 to 75 bps decline in the investment rate during a relatively stable economic period from 1987 to 2005.[30] I find that a 1 pp increase in a firm's cost of capital is associated with a decline in investment

[28]The assumption in this comparison is that a one standard deviation increase in a firm's O&G exposure is comparable to a one standard deviation increase in the bondholder flow. Even if this is not the case, the cross-firm spillovers through CLO structures is larger than bond mutual funds, as long as a one standard deviation increase in a firm's O&G exposure is equivalent to less than a 10-13 standard deviation increase in bondholder flow.

[29]There is a long literature that examines the sensitivity of investment to the cost of capital. The neoclassical theory of investment and flexible neoclassical models established a relation between the cost of capital and investment (Jorgenson (1996); Hall and Jorgenson (1967)). Later, Brainard and Tobin (1968), Tobin (1969); Abel (1979); Hayashi (1982) developed the q-theory of investment. Empirically, in aggregate US data, the unconditional correlation between the cost of capital and investment is low, as well as the relation between average q and investment (Cummins, Hassett and Oliner (2006)). There are several challenges with empirically estimating the relation between investment and cost of capital in the long-run and short-run. These issues include the convexity of adjustment costs, credit constraints, measurement errors, data frequency, and aggregation choices (Dixit and Pindyck (1994); Caballero and Engel (1999); Fazzari, Hubbard and Petersen (1988); Erickson and Whited (2000); Erickson and Whited (2006)).

[30]Other papers that study the effect of the cost of debt on investment in aggregate and firm levels include Philippon (2009), Gilchrist and Zakrajšek (2012), Kothari, Lewellen and Warner (2014), and Frank and Shen (2016).

by 2 pp. This estimate is higher for financially constrained firms – smaller, younger, private firms that face greater informational and refinancing frictions, as presented in Appendix Table C.14 and Appendix Table C.15. These estimates are higher than the "plain-vanilla" user cost of capital, reflecting a high liquidity cost, discussed earlier in this section. Liquidity costs are an important component in the cost of capital (Chen, Goldstein and Jiang (2010); Ortiz-Molina and Phillips (2014); Feroli et al. (2014)). For example, Feroli et al. (2014) and Chen, Goldstein and Jiang (2010) both document that fund flows can generate a feedback loop between flows and prices that is more pronounced in funds with illiquid assets. Further, Chen, Goldstein and Jiang (2010) show that redemption pressure in these funds can potentially lead to excessive liquidation of their positions.

Overall, my findings suggest that disruptions in the leveraged loan market have non-trivial effects on financial markets and firm activity. The baseline estimates may be understated for two main reasons. First, the baseline analysis considers all non-O&G firms, though not all non-O&G firms are equally likely to be innocent bystanders. Section 6.1 shows that firms that are more likely to be innocent bystanders experience larger effects. Second, I conduct my analysis for a relatively benign macroeconomic episode when financial markets are calm and relatively liquid. I replicate the baseline result in Section 7.7, using the COVID-19 shock for external validity and demonstrate the potential effects when markets are illiquid.

6 Mechanism: Contractual Arbitrage and CLO Portfolio Effects

This section investigates the underlying mechanism behind CLO fire sales, contractual arbitrage. Contractual arbitrage describes the practice in which CLO managers sell risky loans which exhibit higher market values than accounted values to avail of the differences in the measurement of the covenants. I present direct evidence that riskier firms experience larger effects. I then assess the persistence of the effects.

6.1 Evidence of Contractual Arbitrage

The piecewise nature of the accounting of covenants has unintended effects on asset prices and corporate outcomes. When a CLO's assets experience adverse credit events such as downgrades or defaults, its capital covenants tighten. The capital covenants effectively measure CLO leverage – the ratio of the assets to liabilities. In most cases, assets are marked at book value. However, if a loan experiences default, puts the CLO in excess of its CCC/Caa1 limit, or is a discount obligation, the loan is marked to the lower of market value and recovery value, the lowest of the market values of the CCC/Caa1 bucket, or the purchase price until the loan trades above a threshold (typically 90 ¢/\$) for more than 30 days, respectively. Hence, adverse credit events can induce a departure from historical cost accounting and tighten a CLO's capital covenants.

CLOs can alleviate their capital covenants through contractual arbitrage – selling loans that exhibit higher market values than accounted values. For example, if the share of loans rated CCC/Caa1 or below exceeds its stipulated limit, all excess loans are marked at the *lowest* market value of all loans in this segment. The CLO manager can maximize improvements to the capital covenants by selling loans rated CCC/Caa1 or below with higher market values than accounted values.[31] CLOs can similarly exploit the difference between market and projected recovery values for defaulted loans, and, the purchase price and market values for discount obligations.[32] Hence, nonlinearities in the accounting of covenants may be exploited to loosen these covenants.

I examine the distribution of prices for distressed loans to better understand whether the conditions for a sale via contractual arbitrage are likely to be met. Figure 6 presents the cumulative distribution function (CDF) and probability density function (PDF) of CCC/Caa1 loan prices during the same period. The figures indicate that most CCC/Caa1 loans report a market price above 90 ¢/\$. The average price of a CCC/Caa1 loans is 85 ¢/\$; the 25th and 75th percentile values are 80 ¢/\$ and 99 ¢/\$. However, the cheapest CCC/Caa1 loan held in each CLO is priced at 58 ¢/\$ on average; the 25th and 75th percentile values are 34 ¢/\$ and 85 ¢/\$. Hence, the vast majority of CCC/Caa1 loans are priced above the lowest CCC/Caa1 loan price in each CLO. The CDF and PDF of defaulted loans are reported in Appendix Figure C.8, providing further evidence that the market prices of distressed loans frequently exceed the projected recovery rate on bank loans.[33]

Next, I examine how the likelihood of selling risky loans varies with firm O&G exposure around the O&G price plunge. Panel A of Table 8 examines how the likelihood of selling a loan that trades above par varies with firm O&G exposure around the price plunge. The outcome variable takes a value of 1 if the loan that is sold trades above \$100 per \$100 of par, and 0, otherwise. Panel B of Table 8 examines how the likelihood of selling a loan that trades below par varies with firm O&G exposure around the price plunge. The outcome variable takes a value of 1 if the loan that is sold trades below \$90 per \$100 of par (typical threshold for discount

[31] Appendix Section A provides an example of this mechanism.

[32] Note, in the case of defaulted loans, often rating agencies provide corporate ratings in lieu of individual loan ratings. As leveraged loans are senior secured loans, the loan recovery rate may be higher than the recovery rate of of a company as a whole, hence, these loans may exhibit higher market values than accounted values.

[33] Chen, Wang and Zhang (2019) report that the overall recovery rate associated with leveraged loans is 59.5%. According to Appendix Figure C.8, almost 30% of defaulted loans report a market price above 60 ¢/\$ in the sample period.

obligations), and 0, otherwise. I include combinations of rating-industry, issuer-loan type, year, and month-year fixed effects in columns 1-5 to account for time-invariant heterogeneity associated with the loans as well as common shocks. The results indicate that the likelihood that a CLO sells risky loans increases in the tightness of their covenants. In other words, upon experiencing a negative shock, CLOs are more likely to sell loans that trade below par than above par.[34] Hence, these results rule out an alternative hypothesis which posits that CLOs can generate improvements to par by selling loans that trade above par.[35]

The widespread sales of riskier loans result in compositional changes to CLO portfolios, consistent with derisking. I conduct several tests to study these compositional changes. First, I study whether the interest rate associated with individual loans held in CLO portfolios changes with firm O&G exposure around the shock in Table 9. I use a within CLO-issuer-loan type estimator that controls for loan tenor and the interest rate index, as well as common shocks through month-year fixed effects. The results indicate that CLOs hold the lower-yielding loans issued by firms with higher O&G exposure.[36] Second, I directly test whether the incidence and amount of risky loans changes with the degree of CLO constraint. The relation between a firm's O&G exposure and the incidence of defaulted loans around the O&G price plunge is reported in Table 10. The outcome variable takes a value of 1 if the loan has defaulted, and 0, otherwise.[37] The results indicate that CLOs are less likely to hold defaulted loans issued by firms with higher O&G firms.[38] I further show that these findings are consistent at the fund level. Table 11 presents the relation between a CLO's exposure to O&G and its share of defaulted loans around the O&G price plunge.[39] Overall, these results suggest that covenants induce CLOs to appropriately derisk as they approach their covenant thresholds.[40]

[34] A 1 pp increase in a firm's exposure to O&G is associated with a decrease in the probability of selling loans above par by 4% to 11% (0.1086 to 0.2642 standard deviations), after the shock. A 1 pp increase in a firm's exposure to O&G is associated with an increase in the probability of selling loans below par by 2% to 4% (0.0786 to 0.1681 standard deviations), after the shock.

[35] Moreover, because loans are floating rate and frequently refinanced, it is uncommon for loans to trade above par for an extended period of time. Furthermore, Appendix Section E.2 demonstrates that replicating the par gains generated by contractual arbitrage by selling non-distressed loans at a price above par can involve a greater volume of transactions. Other alternative mechanisms include injecting equity in the CLO by deleveraging the debt stack or increasing reinvestment activities to increase the par value of portfolio. These alternative strategies are *consequences* of violating the ID and OC covenants and are costly to managers. See Kundu (2022*b*) for evidence that the effective costs of covenant breaches can be larger than the costs of fire sales.

[36] The most conservative specification, column 7, indicates that a 1 pp increase in a firm's exposure to O&G is associated with a decline in the interest rate by 9 bps (0.05 standard deviations), after the shock.

[37] 82% of all defaulted loans have a rating of CCC/Caa1 or below; the non-CCC/Caa1 loans are mostly concentrated among single-B rated loans.

[38] A 1 pp increase in a firm's share of O&G is associated with a 0.18 pp to 0.43 pp (0.0145 to 0.0362 standard deviations) decline in the probability that a loan is defaulted, after the shock.

[39] A 1 pp increase in a CLO's share of O&G is associated with a decline in the share of defaulted loans by 0.55 pp to 0.60 pp (0.0544 to 0.0601 standard deviations), after the shock.

[40] An alternative hypothesis may be that CLOs "gamble for resurrection" by shifting their industry composition to the riskiest sector. I study this possibility by comparing the change in industry composition (non-O&G industries)

Consistent with the motives established by contractual arbitrage, CLO managers derisk and sell distressed loans upon experiencing a tightening of their covenants. Therefore, it is predicted that the financial and real effects are pronounced for the segment of distressed firms. I define a firm as *distressed* if it has defaulted on a loan in the sample period and is otherwise *non-distressed*. Table 12 compares the effects on the secondary loan price, all-in-spread drawn, and investment for distressed and non-distressed firms. The estimates indicate that distressed firms drive the declines in the secondary loan price, the all-in-spread drawn, and investment.[41] In contrast to the estimates produced for non-distressed firms, the point estimates for distressed firms are economically meaningful – more than five times as large as the effects experienced by non-distressed firms – and statistically significant.[42]

Together, these findings illustrate how motives of contractual arbitrage can create fire sale risk.

6.2 What Causes Persistence?

Why do not other investors step in to eliminate excess returns? The most natural buyers of leveraged loans – other CLOs – may be unable to absorb excess supply, due to similar binding constraints due to portfolio overlap; 90% of CLOs are exposed to at least one of the top 50 borrowers and more than 80% of CLOs are exposed to the top five borrowers (Board of Governors (2019)). "Outsiders" or non-specialists may have valuations below that of CLOs, which can lead to depressed prices (Shleifer and Vishny (1992)). The limited investor base and illiquidity of the secondary loan market suggest that large-scale redemptions may produce potentially large, persistent price dislocations.[43] Moreover, banks, insurance, and pension funds may not be able to absorb the excess supply because of regulatory and risk-based capital constraints. In addition, less regulated financial institutions, including hedge funds and mutual funds that specialize in distressed loans, may face limits to arbitrage (Shleifer and Vishny (1997)).[44] Hence, persistence may arise from financial frictions which can amplify the

among CLOs with high O&G exposure, before and after the shock. This change is shown in Appendix Figure C.9. The percent change in any given industry before and after the shock is $\leq$0.02%. Hence, this test suggests that gambling for resurrection is not a primary motive of CLO managerial decisions.

[41] A 1 pp increase in a distressed firm's exposure to O&G is associated with a decline of 2.32 pp in the secondary loan price (per $100 par), a 56 bps increase in the all-in-spread drawn, and a 1.28 pp decline in investment, after the shock.

[42] The statistical significance of the differences between these two sets of estimates is assessed in Appendix Table C.16.

[43] The small pool of potential buyers' combined purchases may be insufficient to offset the price decline.

[44] Performance-based arbitrage may be ineffective when arbitrageurs, including less regulated entities, fear further mispricing and are fully invested.

depth and duration of deviation.[45]

I assess the persistence of the shock to establish the plausibility of the link between financial market dislocations and real effects. I conduct several Jordà style linear projections for assessing the persistence of the initial shock, as shown in Figure 7. The coefficients in these figures are estimated from the following regression:

$$
\begin{aligned}
Y_{f,t+h} - Y_{f,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure}_f \times \text{Post}_t) + \beta_2\text{Firm O\&G Exposure}_f \\
+ \beta_3\text{Post}_t + \alpha_f + \alpha_y + \epsilon_{f,t}. \qquad (9)
\end{aligned}
$$

The outcome variables ($Y_{f,t}$) I study are the secondary loan prices, bond yields, leverage, and capital expenditures. t denotes the quarter-year, h denotes the steps (quarters) of the projection, f denotes the (non-O&G) portfolio firm or issuer ($f \in c$), and y denotes the year. The x-axis indicates the quarters since the shock. The y-axis indicates the point estimate associated with the β_1 estimate along with the associated 95% confidence intervals.

The linear projections are shown in Figure 7. Figures 7a and 7b show the response of the secondary loan price and bond credit spread to the shock. Figures 7c and 7d show the response of leverage and investment to the shock. The findings show that asset prices fall and spreads rise for four quarters after the initial shock. Following that, an inflection occurs, at which point prices begin to rise and spreads begin to fall, reverting towards zero after seven quarters. This pattern is consistent with the parallel trends shown in Figure 5; the secondary loan price reaches a trough approximately 18 months after the price plunge, and exhibits a slow reversion thereafter. Further, I find that the firm characteristics respond after a lag. Leverage does not respond until four quarters after the initial shock, and begins to reverse after seven quarters. Investment starts to fall two months after the initial shock, and continues to fall until the seventh quarter, at which point investment reverts towards zero. These findings indicate that while asset prices start declining from the outset of the shock, firm outcomes respond after a delay. All variables exhibit a consistent reversal.

Thus, market dislocations persist for long enough for real effects to materialize. These findings suggest that a temporary episode of distress can damage firms for a longer-term – an externality of "short-termist" damage control.

[45] Encumbrances to liquidity provision can arise from search costs or slow-moving capital (e.g., Duffie, Gârleanu and Pedersen (2007); He and Krishnamurthy (2012); Duffie and Strulovici (2012); Acharya, Shin and Yorulmazer (2009); Brunnermeier and Pedersen (2009)).

7 Robustness

I conduct a series of tests to ensure the robustness of the findings. First, I employ a cross-sectional approach, demonstrating that the level effects corroborate the difference effects used in the baseline empirical analysis. Second, I apply an IV strategy to show that CLO covenants are the source of cross-firm spillovers. Third, I conduct two falsification tests to dispel the concern that the findings may reflect changes in firm fundamentals or bank constraints. Fourth, I report the results of a placebo test that addresses whether the results may be driven by omitted variable bias. Fifth, I verify that the findings are robust to alternative specifications, measures, definitions, and data sources. Lastly, I validate the proposed mechanism, using the COVID-19 shock.

7.1 Cross-Sectional Strategy

This paper employs a Bartik-style difference-in-differences design to estimate the causal effect of covenant tightness. The advantage of this empirical technique is that it exploits both time-series and cross-sectional variation to measure the differences between treatment and control groups over time. This empirical design mitigates the effects of selection bias and omitted variable bias that afflict cross-sectional studies. To supplement the baseline analysis, I use a cross-sectional approach to estimate the effect in levels, based on the findings of Section 4 – the change in oil prices was unexpected and matching between firms and CLOs is unrelated to exposure to oil prices. I restrict the cross-sectional approach to the period following the O&G shock. As before, the main variable of interest is firm O&G exposure. The findings are reported in Appendix Table C.17. The estimates indicate that there is a negative relation between a O&G exposure and the distance to the ID covenant, loan transaction amount, loan transaction price, and the all-in-spread drawn.[46] Thus, the level effects reflected in the cross-sectional estimates corroborate the difference effects reflected in the baseline empirical specification.

7.2 Instrumental Variable Strategy

The objective of the paper is to show that CLO covenants induce cross-firm spillovers. The main empirical specification is a reduced-form IV strategy that exploits cross-sectional variation in firms' exposure to the O&G industry as well as the timing of the O&G price plunge. O&G is a measure of covenant tightness. Overall, the results of this reduced-form strategy indicate that CLO covenants can induce cross-firm spillovers. However, this evidence is in-

[46] A limitation of this analysis is that I cannot include CLO fixed effects in column 1 or issuer fixed effects in columns 2 through 4.

direct. Appendix Table C.18 presents direct evidence that covenants are the source of cross-firm spillovers. Column 1 presents the OLS regression results from regressing the transaction amount on a measure of exposure to the CLO ID covenant. Firm exposure to the CLO covenant is measured similarly to firm O&G exposure – the weighted average of the distance to the ID threshold across all CLOs. This naïve regression is plagued by issues of endogeneity, namely, firms' exposure to the CLO covenant is likely related to the characteristics of the firms that CLOs hold in their portfolios. Column 2 presents the reduced-form IV result. Columns 3 and 4 present the results from a 2SLS strategy. The identification assumptions underlying the 2SLS strategy are relevance – after the O&G price plunge, firms with greater exposure to O&G operate closer to the covenant thresholds – and exclusion – the instruments do not affect the transaction amount through any other channel other than the CLO covenants. All specifications include issuer-loan type and month-year fixed effects. I find that the relation between the firms' exposure to the CLO covenant and the transaction amount are statistically significant at the 1% level. Hence, the 2SLS results support the reduced-form IV strategy employed in the paper.

7.3 Mismeasurement of O&G Exposure

I investigate whether the results are sensitive to the construction of O&G exposure. In Appendix Table C.19, I verify the results are robust to alternative measures of firm exposure to O&G. I present the results from running the regression specifications of column 5 of Table 3, column 5 of Table 4 and column 4 of Table 5 under alternate constructions of firm exposure. In columns 1-3, a firm's exposure is measured as the equal-weighted average O&G share across all CLOs. In columns 4-6, a firm's exposure is measured as the loan-frequency equal-weighted average O&G share across all CLOs.[47] In columns 7-9, a firm's exposure is measured as the loan-frequency value-weighted average O&G share across all CLOs. Lastly, in columns 9-12, a firm's exposure is measured as the loan-amount value-weighted average O&G share across all CLOs. The results are robust to these alternative measures of firm exposure.

Lastly, I consider how the results differ under an alternative empirical specification in which I directly use the log-transformed oil price instead of an indicator for the price plunge. I plot the marginal effects – the slope of various outcome variables on price, while holding the value of the O&G share constant between 0 and 1 in Appendix Figure C.10. As the O&G price is higher, firms with greater O&G exposure experience higher net purchases, higher secondary loan prices and a lower all-in-spread drawn. Conversely, when the O&G price is lower,

[47] Note, this differs from the definition used in columns 1-3 in which there is one entry for each issuer held in a CLO (collapsing across loans).

firms with greater O&G exposure experience lower net purchases, lower secondary loan prices and higher all-in-spread drawn. The plots of Appendix Figure C.10 are consistent with these hypotheses.

7.4 Cross-Sectional and Distributional Effects with Holdings Data

Thus far, this paper has used transactions data to present evidence that the amount of selling increases in the O&G exposure of CLOs, after the shock. This section employ holdings data to estimate the percent of the float the sales amount to, across all CLO portfolios.

I study the relationship between firms' exposure to the O&G industry and the growth in firms' CLO debt around the O&G price plunge. I collapse holdings across CLO portfolios and aggregate it to the firm level to estimate the relation between a firm's O&G exposure and the growth of its CLO debt around the O&G price plunge. Appendix Table C.20 reports the results. The relation between a firm's O&G exposure and the growth of its CLO debt is negative and stable across all columns.[48]

Next, I exploit cross-sectional variation in the holdings data to study the distributional effects across firms of varying vulnerability. Firm vulnerability is constructed through two measures: *(1)* firm exposure to O&G, and *(2)* dependence on CLOs. Taken together, these measures reflect the relative importance of CLO covenants to firms. Appendix Table C.21 reflect two key findings. First, consistent with contractual arbitrage, the relation between firms' exposure to the O&G industry and the growth in firms' CLO debt is negative, economically large, and statistically significant among firms with high O&G exposure and high dependence on CLOs, as shown in column 4. This estimate is almost twice as large as the baseline estimate of Appendix Table C.20. Second, firms that exhibit low O&G exposure or low dependence on CLOs are virtually unaffected, thereby, providing a useful falsification test that validates that firms that are more exposed to CLO covenants and more dependent on CLOs for financing are most vulnerable to fire sales.

7.5 Do the Findings Reflect Changes in Firms' Fundamentals or Bank Constraints?

The hypothesis that the findings reflect changes in firm fundamentals or changes in bank constraints is ruled out through two falsification tests.

The first falsification test studies whether the findings are driven by changes in firm demand. Banks typically retain term loans A and revolving lines of credit on their balance

[48] A 1 pp increase in a firm's exposure to O&G is associated with a 3% decline in the growth of CLO debt, after the O&G price plunge.

sheet. If the findings are driven by changes in demand, the all-in-spread drawn should also increase for these facilities in response to changes in demand. If the findings are driven by CLO covenant tightness, the all-in-spread drawn should not change with firm O&G exposure, after the shock. The results are presented in Appendix Table C.22. I do not find any robust evidence of an increase in the all-in-spread drawn for revolving lines of credit and term loans A.

The second falsification test studies whether firms' exposure to the CLO covenant may be confounded by firms' exposure to bank constraints. This test examines how a firm's all-in-spread undrawn for revolving lines of credit varies with its O&G exposure. If firms' exposure to bank constraints are correlated with their exposure to the CLO covenant via O&G, the all-in-spread undrawn should change with firms' O&G exposure, after the shock. The results of this exercise are presented in Appendix Table C.23. I do not find any robust evidence of a change in the all-in-spread undrawn for revolving lines of credit.

Lastly, any systemic effect of the O&G price plunge is reflected in the *Post* variable.

7.6 Placebo Tests and Omitted Variable Bias

This section examines the role of omitted variable bias (OVB). As long as the structure of omitted variables is identical across firms, a null result of the placebo test reflects a negligible role of OVB in driving the results.

I conduct a placebo test, randomizing the O&G share from a uniform distribution and running 1,000 Monte-Carlo simulations of the regression specifications in column 5 of Table 3, column 5 of Table 4 and column 4 of Table 5, respectively. A histogram of the point estimates of the interaction term are presented in Appendix Figure C.11. The outcome variable is the transaction amount in Appendix Figure C.11a, secondary loan price in Appendix Figure C.11b, and the all-in-spread drawn in Appendix Figure C.11c. The "true" point estimates lie outside of the figures. Specifically, the t-statistics for tests of the null hypothesis are -0.1022, -0.7503 and 0.7690 in Appendix Figures C.11a, C.11b, and C.11c, respectively. Hence, the null hypothesis that the mean is equal to zero cannot be rejected in any case. This confirms that OVB does not drive the results; firm exposure to O&G is important for the findings.

7.7 External Validity

This section examines whether the proposed mechanism can be externally validated. I focus on a relatively benign macroeconomic period: 2013-2015. During this period, financial markets were calm and relatively liquid. Although the effects from a financially tranquil period are temperate, it raises concerns of the potential effects when markets are illiquid, during times of stress. As 90% of CLOs are exposed to the top 50 US borrowers, and 80% are exposed to the top five borrowers, the effects may be especially damaging if borrowers simultaneously default and impose negative externalities on other unrelated firms held in CLO portfolios (Financial Stability Board (2019)). Therefore, I replicate the baseline analysis using the COVID-19 shock, to study how the magnitude changes under more adverse shocks. The identifying assumption for this analysis is that COVID-19 is not an aggregate shock, but rather a series of industry-wide shocks across several vulnerable industries.

The time period for this analysis is from January 1, 2020 to May 6, 2020. I limit the analysis to this time period as Foley-Fisher, Gorton and Verani (2020) highlights a structural break in the standard deviation of AAA-rated CLO prices after May 6, coinciding with the timing of several announcements, including the announcement of the Primary Corporate Credit Facility (PMCCF) and Secondary Market Corporate Credit Facility (SMCCF), and modifications to the LCR and SLR. The *Post* variable takes a value of 0 before March 1, 2020, and 1, afterwards. I study how the point estimate changes under different industry proxies for the ID covenant, as shown in Appendix Table C.24.[49] In Appendix Table C.25, I validate that CLO exposure to these most vulnerable industries affects the distance to the ID threshold.

As in the baseline analysis, I study how the secondary loan price varies for firms that are not in the affected industry, as designated by the column header. These columns indicate that a 1 pp increase in the exposure is associated with a \$0.69 to \$1.68 decline (per \$100 par) in the secondary loan price, after the shock. The estimate across all columns is larger in magnitude than that of the baseline table. Hence, price pressure is expected to be larger during crisis periods.

8 Conclusion

This paper demonstrates how contracting frictions in the CLO market can amplify diffuse, idiosyncratic, and sectoral shocks. CLO covenants tighten in response to adverse shocks. The piecewise nature of the accounting associated with CLO covenants induces CLO managers to sell unrelated, riskier loans in their portfolios to alleviate their covenants. This type of contractual arbitrage poses systemic concerns. Given the illiquidity of corporate debt markets, including the secondary loan market, large sales may have substantial financial and real effects. Hence, fire sales originating from the CLO market may exacerbate credit crunches, by propagating shocks through capital markets.

[49]For a complete description of the industries, I refer readers to Moody's 35 Industry Categories

By nature of their closed-end structure, CLOs are thought to be immune to fire sales due to stable funding. This work shows that covenants – the remediation designed to address the agency problem within the closed-end structure – can generate price pressure, and potentially amplify fire sale risk and increase the social costs associated with fire sales. Hence, differences in fund organizational structure cannot fully eliminate the underlying risks. However, the impact of CLO contractual reform on the provision of credit, ex-ante and ex-post, remains ambiguous. The joint consideration of fund organizational structure and welfare remains an avenue for future research for deepening our understanding of the role of covenants as both a latent source of amplification and a remediation designed to address the agency problem.

References

Abbassi, Puriya, Rajkamal Iyer, José-Luis Peydró, and Francesc R Tous. 2016. "Securities Trading by Banks and Credit Supply: Micro-evidence from the Crisis." *Journal of Financial Economics*, 121(3): 569–594.

Abel, Andrew B. 1979. *Investment and the Value of Capital.* Dissertations-G.

Acharya, Viral, Hyun Song Shin, and Tanju Yorulmazer. 2009. "A Theory of Slow-Moving Capital and Contagion." *CEPR Discussion Papers*, 7147.

Aggarwal, Raj, Aigbe Akhigbe, and Sunil K Mohanty. 2012. "Oil price shocks and transportation firm asset prices." *Energy Economics*, 34(5): 1370–1379.

Almeida, Heitor, Murillo Campello, Bruno Laranjeira, and Scott Weisbenner. 2009. "Corporate debt maturity and the real effects of the 2007 credit crisis." National Bureau of Economic Research.

Amihud, Yakov. 2002. "Illiquidity and stock returns: cross-section and time-series effects." *Journal of financial markets*, 5(1): 31–56.

Amiti, Mary, and David E Weinstein. 2018. "How Much do Idiosyncratic Bank Shocks affect Investment? Evidence from Matched Bank-Firm Loan Data." *Journal of Political Economy*, 126(2): 525–587.

Arezki, Rabah, and Olivier Blanchard. 2014. "Seven Questions about the Recent Oil Price Slump." The IMF Blog.

Ashton, Keith. 2020. "Investing in CLOs." Ares.

Baffes, John, M. Ayhan Kose, Franziska Ohnsorge, and Marc Stocker. 2015. "The Great Plunge in Oil Prices: Causes, Consequences, and Policy Responses." World Bank Group Development Economics.

Baumeister, Christiane, and Gert Peersman. 2013. "Time-varying Effects of Oil Supply Shocks on the US Economy." *American Economic Journal: Macroeconomics*, 5(4): 1–28.

Baumeister, Christiane, and James D Hamilton. 2019. "Structural interpretation of vector autoregressions with incomplete identification: Revisiting the role of oil supply and demand shocks." *American Economic Review*, 109(5): 1873–1910.

Benmelech, Efraim, and Nittai Bergman. 2018. "Debt, information, and illiquidity." National Bureau of Economic Research.

Benmelech, Efraim, and Nittai K Bergman. 2011. "Bankruptcy and the collateral channel." *The Journal of Finance*, 66(2): 337–378.

Benmelech, Efraim, Jennifer Dlugosz, and Victoria Ivashina. 2012. "Securitization Without Adverse Selection: The Case of CLOs." *The Journal of Financial Economics*, 106(1): 91–113.

Benmelech, Efraim, Nittai Bergman, and Amit Seru. 2021. "Financing Labor." *Review of Finance*, 25(5): 1365–1393.

Bergman, Nittai K, Rajkamal Iyer, and Richard T Thakor. 2020. "The effect of cash injections: Evidence from the 1980s farm debt crisis." *The Review of Financial Studies*, 33(11): 5092–5130.

Bernanke, Ben, and Alan Blinder. 1988. "Credit, Money, and Aggregate Demand." *The American Economic Review*, 78(2): 435–439.

Bernanke, Ben, and Mark Gertler. 1989. "Agency Costs, Net Worth, and Business Fluctuations." *The American Economic Review*, 79(1): 14–31.

Board of Governors. 2019. "Financial Stability Report – November 2019." Federal Reserve.

Brainard, William C, and James Tobin. 1968. "Pitfalls in Financial Model Building." *The American Economic Review*, 58(2): 99–122.

Brunnermeier, Markus, and Lasse Heje Pedersen. 2009. "Market liquidity and funding liquidity." *Review of Financial Studies*, 22(6): 2201–2238.

Caballero, Ricardo J, and Eduardo MRA Engel. 1999. "Explaining Investment Dynamics in US Manufacturing: a Generalized (S, s) Approach." *Econometrica*, 67(4): 783–826.

Chava, Sudheer, and Amiyatosh Purnanandam. 2011. "Effect of Banking Crisis on Bank-Dependent Borrowers." *The Journal of Financial Economics*, 99(1): 116–135.

Chava, Sudheer, and Michael R Roberts. 2008. "How Does Financing Impact Investment? The Role of Debt Covenants." *The Journal of Finance*, 63(5): 2085–2121.

Chen, Qi, Itay Goldstein, and Wei Jiang. 2010. "Payoff complementarities and financial fragility: Evidence from mutual fund outflows." *Journal of Financial Economics*, 97(2): 239–262.

Chen, Xiaowei, Gang Wang, and Xiangting Zhang. 2019. "Modeling recovery rate for leveraged loans." *Economic Modelling*, 81: 231–241.

Chernenko, Sergey, and Adi Sunderam. 2012. "The Real Consequences of Market Segmentation." *The Review of Financial Studies*, 25(7): 2041–2069.

Chodorow-Reich, Gabriel. 2014. "Employment Effects of Credit Market Disruptions: Firm-level Evidence from the 2008-09 Financial Crisis." *The Quarterly Journal of Economics*, 129(1): 1–60.

Cummins, Jason G., Kevin A. Hassett, and Stephen D. Oliner. 2006. "Investment Behavior, Observable Expectations, and Internal Funds." *American Economic Review*, 96(3): 796–810.

Diamond, Douglas W, and Raghuram G Rajan. 2011. "Fear of Fire Sales, Illiquidity Seeking, and Credit Freezes." *The Quarterly Journal of Economics*, 126(2): 557–591.

Dixit, Avinash K, and Robert S Pindyck. 1994. *Investment under uncertainty.* Princeton university press.

Duffie, Darrell, and Bruno Strulovici. 2012. "Capital Mobility and Asset Pricing." *Econometrica*, 80(6): 2469–2509.

Duffie, Darrell, Nicolae Gârleanu, and Lasse Heje Pedersen. 2007. "Valuation in Over-the-Counter Markets." *Review of Financial Studies*, 20(5): 1865–1900.

Erickson, Timothy, and Toni M Whited. 2000. "Measurement error and the relationship between investment and q." *Journal of Political Economy*, 108(5): 1027–1057.

Erickson, Timothy, and Toni M Whited. 2006. "On the accuracy of different measures of q." *Financial Management*, 35(3): 5–33.

Fazzari, Steven, R Glenn Hubbard, and Bruce Petersen. 1988. "Investment, financing decisions, and tax policy." *The American economic review*, 78(2): 200–205.

Feroli, Michael, Anil K Kashyap, Kermit L Schoenholtz, and Hyun Song Shin. 2014. "Market tantrums and monetary policy." *Chicago Booth Research Paper*, , (14-09).

Financial Stability Board. 2019. "Vulnerabilities associated with Leveraged Loans and Collateralised Loan Obligations." Bank of International Settlements.

Foley-Fisher, Nathan, Gary B Gorton, and Stéphane Verani. 2020. "Adverse Selection Dynamics in Privately-Produced Safe Debt Markets." National Bureau of Economic Research Working Paper 28016.

Frank, Murray Z, and Tao Shen. 2016. "Investment and the weighted average cost of capital." *Journal of Financial Economics*, 119(2): 300–315.

Friewald, Nils, Rainer Jankowitsch, and Marti G Subrahmanyam. 2012. "Illiquidity or Credit Deterioration: A Study of Liquidity in the US Corporate Bond Market during Financial Crises." *Journal of financial economics*, 105(1): 18–36.

Gabaix, Xavier, Arvind Krishnamurthy, and Olivier Vigneron. 2007. "Limits of arbitrage: Theory and evidence from the mortgage-backed securities market." *The Journal of Finance*, 62(2): 557–595.

Gertler, Mark, and Simon Gilchrist. 1994. "Monetary Policy, Business Cycles, and the Behavior of Small Manufacturing Firms." *The Quarterly Journal of Economics*, 109(2): 309–340.

Gilchrist, Simon, and Egon Zakrajšek. 2007. "Investment and the cost of capital: New evidence from the corporate bond market."

Gilchrist, Simon, and Egon Zakrajšek. 2012. "Credit Spreads and Business Cycle Fluctuations." *American Economic Review*, 102(4): 1692–1720.

Hall, Robert E, and Dale W Jorgenson. 1967. "Tax Policy and Investment Behavior." *The American Economic Review*, 57(3): 391–414.

Hamilton, James. 2014. "Oil prices as an Indicator of Global Economic Conditions." Econbrowser.

Hamilton, James D. 2003. "What is an Oil Shock?" *Journal of econometrics*, 113(2): 363–398.

Hayashi, Fumio. 1982. "Tobin's Marginal q and Average q: A Neoclassical Interpretation." *Econometrica*, 213–224.

He, Zhiguo, and Arvind Krishnamurthy. 2012. "A Model of Capital and Crises." *Review of Economic Studies*, 79(2): 735–777.

Holmstrom, Bengt, and Jean Tirole. 1997. "Financial Intermediation, Loanable Funds, and the Real Sector." *The Quarterly Journal of Economics*, 112(3): 663–691.

Huber, Kilian. 2018. "Disentangling the Effects of a Banking Crisis: Evidence from German Firms and Counties." *The American Economic Review*, 108(3): 868–98.

International Monetary Fund. 2020. "Global Financial Stability Report: Markets in the Time of COVID-19." International Monetary Fund.

Irani, Rustom M, and Ralf R Meisenzahl. 2017. "Loan Sales and Bank Liquidity Management: Evidence from a US Credit Register." *The Review of Financial Studies*, 30(10): 3455–3501.

Irani, Rustom M, Rajkamal Iyer, Ralf R Meisenzahl, and Jose-Luis Peydro. 2021. "The Rise of Shadow Banking: Evidence from Capital Regulation." *The Review of Financial Studies*, 34(5): 2181–2235.

Ivashina, Victoria, and David Scharfstein. 2010. "Bank Lending during the Financial Crisis of 2008." *Journal of Financial Economics*, 97(3): 319–338.

Iyer, Rajkamal, José-Luis Peydró, Samuel da Rocha-Lopes, and Antoinette Schoar. 2014. "Interbank Liquidity Crunch and the Firm Credit Crunch: Evidence from the 2007–2009 Crisis." *The Review of Financial Studies*, 27(1): 347–372.

Jensen, Michael C., and William H. Meckling. 1976. "Theory of the firm: Managerial behavior, agency costs and ownership structure." *The Journal of Financial Economics*, 3(4): 306–360.

Jordà, Òscar. 2005. "Estimation and Inference of Impulse Responses by Local Projections." *The American Economic Review*, 95(1): 161–182.

Jorgenson, Dale Weldeau. 1996. *Investment: Capital Theory and Investment Behavior.* Vol. 1, Mit Press.

Känzig, Diego R. 2021. "The Macroeconomic Effects of Oil Supply News: Evidence from OPEC Announcements." *American Economic Review*, 111(4): 1092–1125.

Kashyap, Anil K, and Jeremy C Stein. 2000. "What Do a Million Observations on Banks Say about the Transmission of Monetary Policy?" *The American Economic Review*, 90(3): 407–428.

Kashyap, Anil K, Owen A Lamont, and Jeremy C Stein. 1994. "Credit Conditions and the Cyclical Behavior of Inventories." *The Quarterly Journal of Economics*, 109(3): 565–592.

Kashyap, Anil, Raghuram Rajan, Jeremy Stein, et al. 2008. "Rethinking capital regulation." *Maintaining stability in a changing financial system*, 43171.

Khwaja, Asim Ijaz, and Atif Mian. 2008. "Tracing the Impact of Bank Liquidity Shocks: Evidence from an Emerging Market." *The American Economic Review*, 98(4): 1413–42.

Kilian, Lutz. 2009. "Not all Oil Price shocks Are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market." *American Economic Review*, 99(3): 1053–69.

Kothari, SP, Jonathan Lewellen, and Jerold B Warner. 2014. *The Behavior of Aggregate Corporate Investment.* Simon Graduate School of Business, University of Rochester.

Krane, Jim, and Mark Agerton. 2015. "Effects of Low Oil Prices on U.S. Shale Production: OPEC Calls the Tune and Shale Swings." James A. Baker III Institute for Public Policy of Rice University.

Kundu, Shohini. 2022*a*. "The Anatomy of Corporate Securitizations and Contract Design." *Journal of Corporate Finance*, 102195.

Kundu, Shohini. 2022*b*. "Financial Covenants and Fire Sales in Closed-End Funds." *Management Science (forthcoming)*.

Kundu, Shohini, and Nishant Vats. 2021. "Banking Networks and Economic Growth: From Idiosyncratic Shocks to Aggregate Fluctuations." University of California, Los Angeles - Anderson School and Management and University of Chicago Booth School of Business.

Kundu, Shohini, Seongjin Park, and Nishant Vats. 2021. "The Geography of Bank Deposits and the Origins of Aggregate Fluctuations." University of California, Los Angeles - Anderson School and Management and University of Chicago Booth School of Business.

Loumioti, Maria, and Florin P Vasvari. 2019. "Consequences of CLO Portfolio Constraints." The University of Texas at Dallas and London Business School.

Manconi, Alberto, Massimo Massa, and Ayako Yasuda. 2012. "The Role of Institutional Investors in Propagating the Crisis of 2007–2008." *Journal of Financial Economics*, 104(3): 491–518.

McCracken, Ross. 2015. "Energy Economist: Shale oil's response to prices may call for industry re-evaluation." S&P Global Platts Insight.

Mitchell, Mark, and Todd Pulvino. 2012. "Arbitrage Crashes and the Speed of Capital." *Journal of Financial Economics*, 104(3): 469–490.

Mitchell, Mark, Lasse Heje Pedersen, and Todd Pulvino. 2007*a*. "Slow Moving Capital." *The American Economic Review*, 215–220.

Mitchell, Mark, Lasse Heje Pedersen, and Todd Pulvino. 2007*b*. "Slow Moving Capital." *American Economic Review*, 97(2): 215–220.

Mohanty, Sunil K, Aigbe Akhigbe, Tawfeek A Al-Khyal, and Turki Bugshan. 2013. "Oil and Stock Market Activity when Prices Go Up and Down: the Case of the Oil and Gas Industry." *Review of Quantitative Finance and Accounting*, 41(2): 253–272.

Ortiz-Molina, Hernán, and Gordon M Phillips. 2014. "Real Asset Illiquidity and the Cost of Capital." *Journal of Financial and Quantitative Analysis*, 49(1): 1–32.

Ottonello, Pablo, and Thomas Winberry. 2020. "Financial Heterogeneity and the Investment Channel of Monetary Policy." 88(6): 2473–2502.

Paravisini, Daniel. 2008. "Local Bank Financial Constraints and Firm Access to External Finance." *The Journal of Finance*, 63(5): 2161–2193.

Peek, Joe, and Eric S. Rosengren. 2000. "Collateral Damage: Effects of the Japanese Bank Crisis on Real Activity in the United States." *The American Economic Review*, 90(1): 30–45.

Philippon, Thomas. 2009. "The Bond Market's q." *The Quarterly Journal of Economics*, 124(3): 1011–1056.

Schnabl, Philipp. 2012. "International Transmission of Bank Liquidity Shocks: Evidence from an Emerging Market." *The Journal of Finance*, 67(3): 897–932.

Shleifer, Andrei, and Robert W Vishny. 1992. "Liquidation values and Debt Capacity: A Market Equilibrium Approach." *The Journal of Finance*, 47(4): 1343–1366.

Shleifer, Andrei, and Robert W Vishny. 1997. "The Limits of Arbitrage." *The Journal of Finance*, 52(1): 35–55.

Shleifer, Andrei, and Robert W Vishny. 2010. "Unstable banking." *Journal of financial economics*, 97(3): 306–318.

Stein, Jeremy C. 2013. "The Fire-Sales Problem and Securities Financing Transactions." Federal Reserve Bank of New York Workshop on Fire Sales as a Driver of Systemic Risk in Triparty Repo and other Secured Funding Markets, New York, New York.

Stocker, Marc, John Baffes, and Dana Vorisek. 2018. "What Triggered the Oil Price Plunge of 2014-2016 and Why it Failed to Deliver an Economic Impetus in Eight Charts." World Bank Blogs.

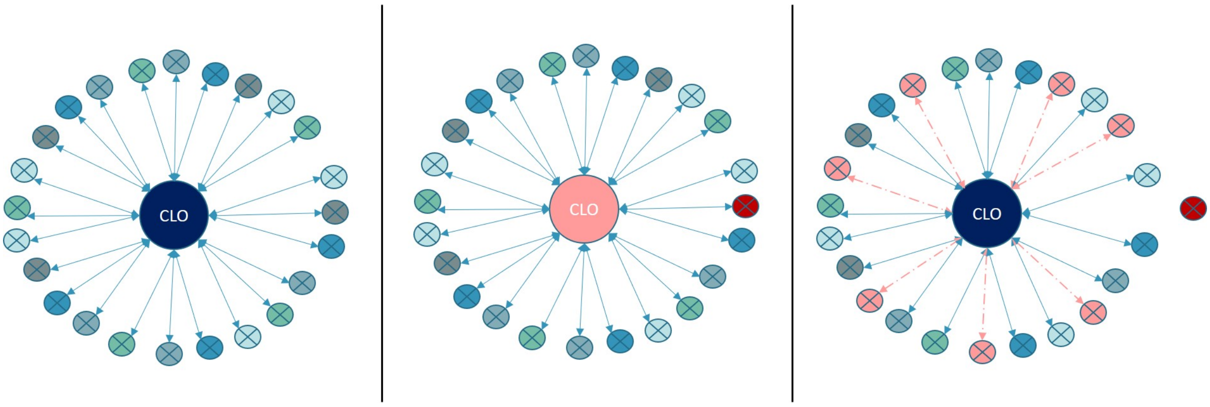
Tobin, James. 1969. "A General Equilibrium Approach to Monetary Theory." *Journal of Money, Credit and Banking*, 1(1): 15–29.

Zhu, Qifei. 2021. "Capital Supply and Corporate Bond Issuances: Evidence from Mutual Fund Flows." *Journal of Financial Economics*.

9 Figures and Tables

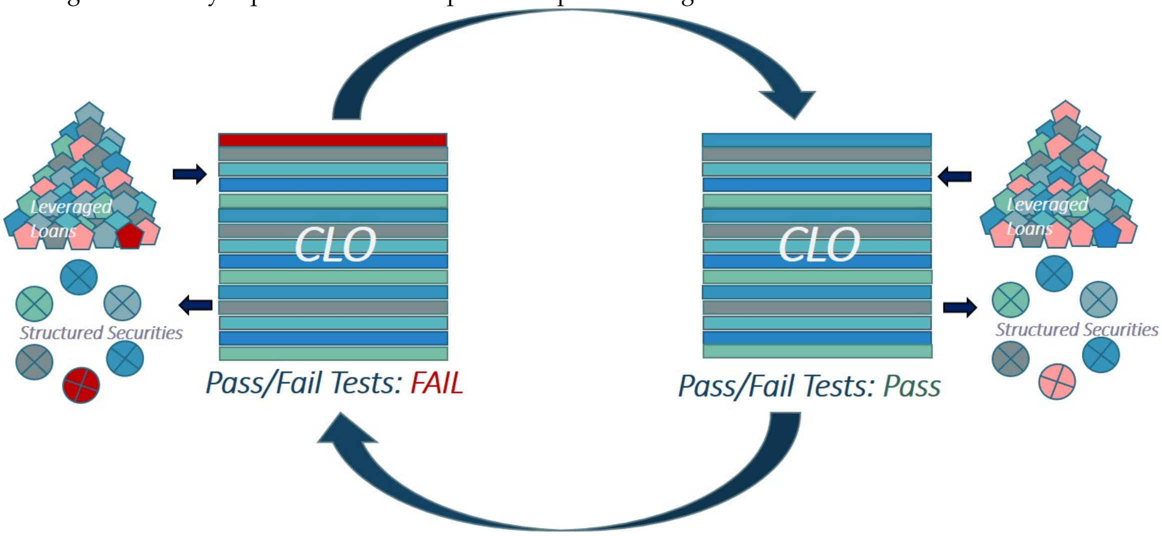
9.1 Figures

Figure 1: Research Setup: Potential for Financial Contagion



(a) Network of Firms and CLOs

Notes: The diagram consists of the three figures which represent CLO portfolios. The center circle of each diagram represents a CLO while the outer circles represent firms. The spokes represent connections between firms and CLOs. Firms are connected to each other through the intermediary, the CLO. The left figure shows a CLO portfolio without any distressed or defaulted assets. The middle figure shows that if a firm experiences distress (red color), the CLO may become constrained (pink color). The right figure shows that to alleviate constraints, the CLO may divest itself of the distressed firm, hence, there is no longer a spoke connected to it. The CLO may also sell other loans in the portfolio to generate more slack in the constraint (dashed spokes). The constrained issuers of these leveraged loans may experience distress upon widespread selling.



(b) Cycle of Distress

Notes: The figure demonstrates the link between CLO portfolio constraints and the quality of leveraged loans. The CLO is in violation of its covenant constraints, because of a loan that is near-default (left figure). To comply with the covenant, the CLO may generate slack in the covenant by divesting itself of the loan in distress and selling other, unrelated loans. This may allow the CLO to fulfill the covenants (right figure). However, in the process, as CLOs fire sales of assets may increase the cost of financing to innocent bystanders which may lead firms further into distress (left-figure).

(a) Unconstrained (b) Constrained

Figure 2: Thought Experiment

Notes: The figure illustrates the thought experiment belying the empirical strategy. There are two CLOs: CLO A and CLO B. CLO A does not hold any firms operating in the Oil & Gas industry ("Unconstrained"). CLO B has a sizeable exposure to firms in the O&G industry ("Constrained"). When the O&G price plunge occurs, CLO A is unaffected. CLO B is operating closer to its covenant thresholds, as many O&G portfolio firms may be distress. The yellow circle denotes a similar firm held by both CLOs. The objective is to study how the two yellow firms may differ based on ownership.

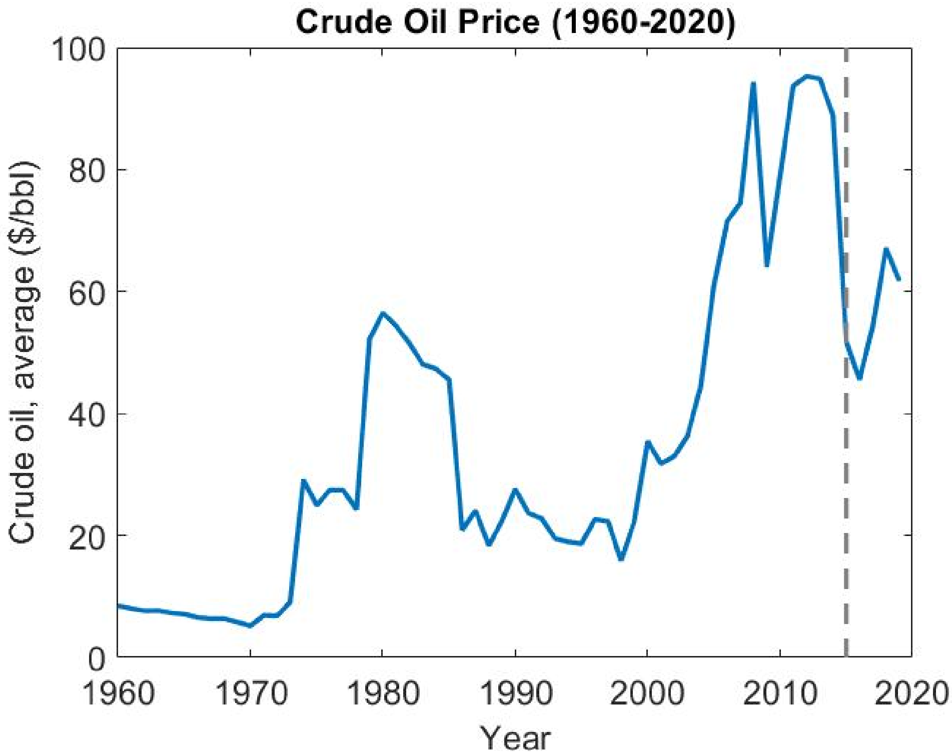


Figure 3: Crude Oil Price (1960-2020)

Notes: The figure shows the crude oil price from 1960-2020. The price is reported as the annual average $ per barrel. The x-axis reports the year. The y-axis reports the price. The dotted gray line denotes the price plunge. The monthly price around the price plunge is plotted in Figure C.2.

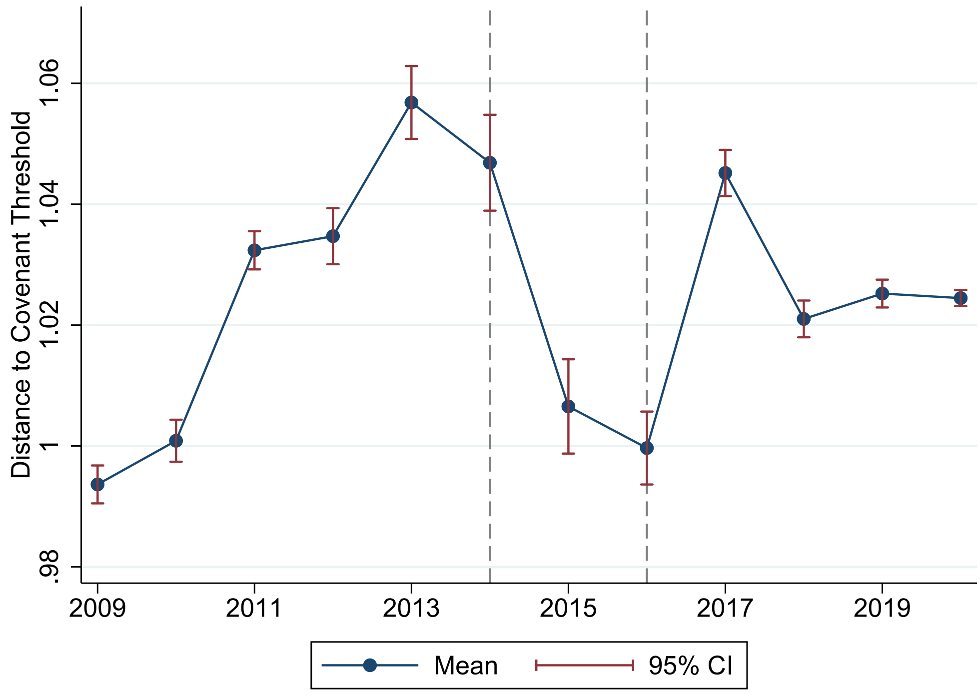
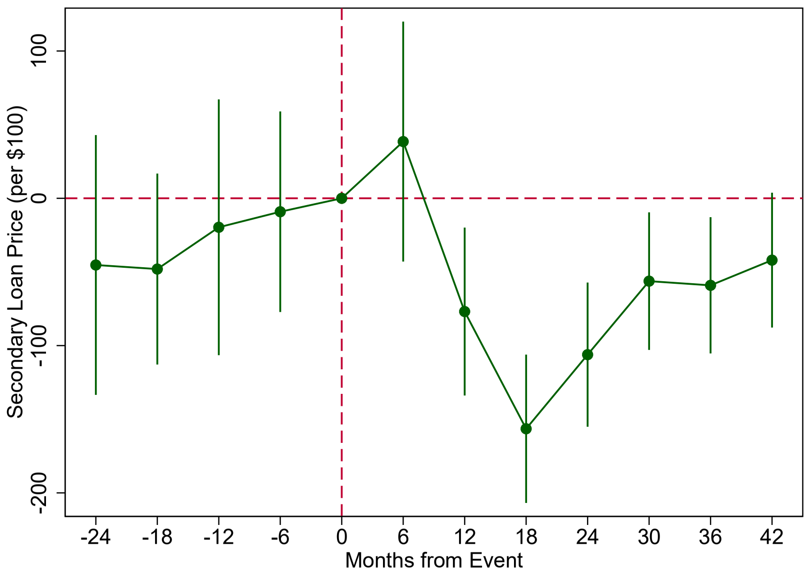
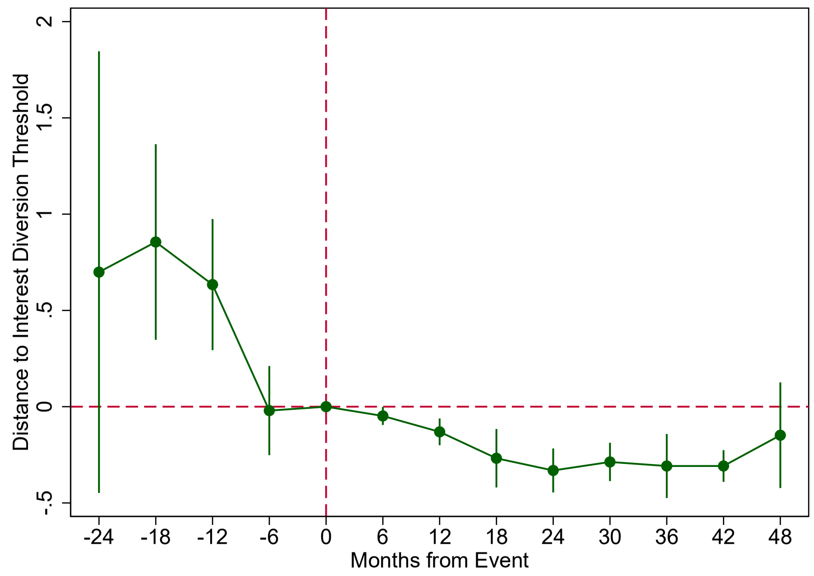


Figure 4: Time Series of Distance to Capital Covenant (2009-2020)

Notes: The figure shows the distance to the most stringent capital covenant from 2009 through 2020. The most stringent capital covenant is identified as the capital covenant with the lowest threshold. The distance to the most stringent capital covenant threshold is measured as the as the ratio of the covenant result to the covenant threshold. The dotted gray line denotes the price plunge. The x-axis reports the year. The y-axis reports the distance to the covenant threshold.



(a) Secondary Loan Price



(b) Distance to Interest Diversion Threshold

Figure 5: Assessment of Pre-Trends: Secondary Loan Price and Distance to Interest Diversion Threshold

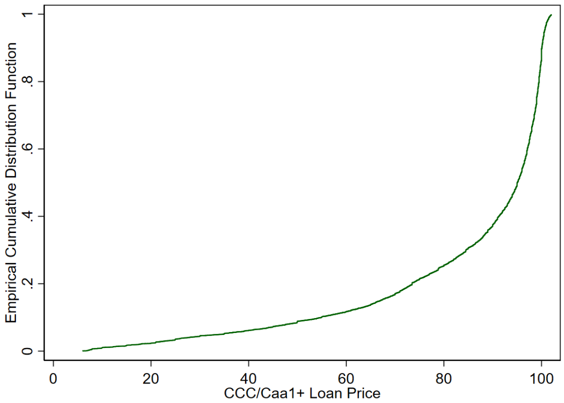
Notes: The figures present pre-trends. The baseline specifications of Figures 5a and Figure 5b take the following respective forms:

$$P_{i,f,t} = \sum_{\substack{k=-24 \\ k=k+6 \\ k\neq 0}}^{42} \beta_k \mathbb{1}_{k\leq t<k+6} \times (\text{Firm O\&G Exposure})_f + \sum_{\substack{k=-24 \\ k=k+6 \\ k\neq 0}}^{42} \delta_k \mathbb{1}_{k\leq t<k+6} + \theta_1 \text{Firm O\&G Exposure}_f + \alpha_{f,g} + \alpha_y + \epsilon_{i,f,t}$$

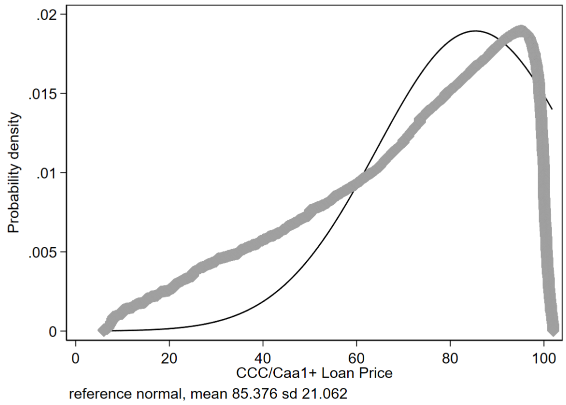
$$ID_{c,t} = \sum_{\substack{k=-24 \\ k=k+6 \\ k\neq 0}}^{42} \beta_k \mathbb{1}_{k\leq t<k+6} \times (\text{CLO O\&G Exposure})_c + \sum_{\substack{k=-24 \\ k=k+6 \\ k\neq 0}}^{42} \delta_k \mathbb{1}_{k\leq t<k+6} + \theta_1 \text{CLO O\&G Exposure}_c + \alpha_m + \alpha_y + \epsilon_{c,t}$$

where $P_{f,t}$ is the secondary loan price (per $100), $ID_{c,t}$ is the distance to the Interest Diversion threshold ($ln(\frac{\text{Covenant Result)}}{\text{Current Threshold}})$), c denotes the CLO, m denotes the manager, i denotes the loan, f denotes the (non-O&G) portfolio firm or issuer ($f \in c$), t indexes the date, g denotes the transaction type, and y denotes the year. Firm O&G Exposure$_f$ measures the weighted average of O&G share of firm f across all CLOs before the shock occurs. CLO O&G Exposure$_c$ is the O&G share of CLO c before the shock occurs. $\mathbb{1}_{k\leq t<k+6}$ is an indicator variable that takes a value of 1 if the time period corresponds to the six-month time period signified by k. Leads and lags of the shock are included, as well as their respective interactions with the O&G exposure measures. I exclude the last pre-treatment month to avoid perfect multicollinearity. The x-axis represents months around the O&G price plunge. The y-axis represents the secondary loan price per $100 of non-O&G issuers (Figure 5a) and distance to the Interest Diversion threshold (Figure 5b). Standard errors are two-way clustered by CLO × issuer and month-year in Figure 5a. Standard errors are two-way clustered by CLO and month-year in Figure 5b.

Figure 6: Distributions of CCC/Caa1 Loan Prices



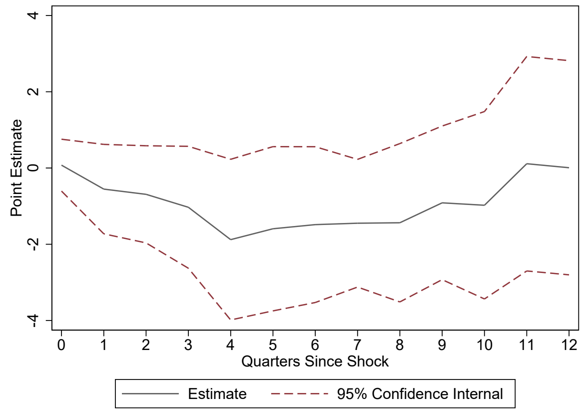
(a) CDF of CCC/Caa1 Loan Prices



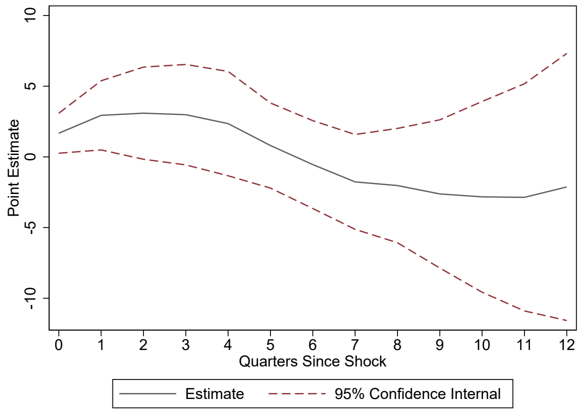
(b) PDF of CCC/Caa1 Loan Prices

	N	p25	p50	p75	Mean	Std. Dev.
CLO Min. CCC/Caa1+ Price	8,272	33.7120	62.5190	84.5000	58.6273	28.7113
CCC/Caa1+ Loan Price	125,274	79.5000	95.0500	99.0000	85.3762	21.0624

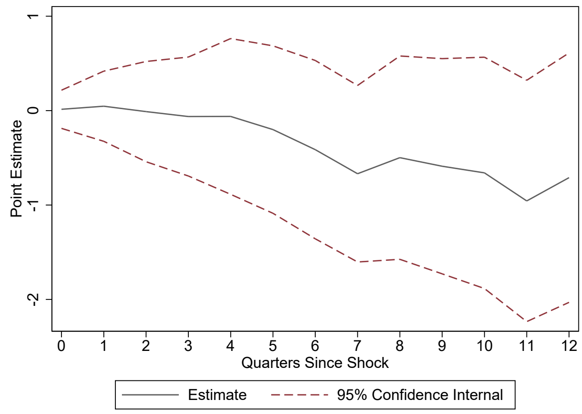
Notes: The figure presents the cumulative distribution function (CDF) and probability density function (PDF) of CCC/Caa1 loan prices. CCC/Caa1 refer to loans that have a rating of CCC/Caa1 or below. Figure 6a presents the CDF of CCC/Caa1 loan prices. Figure 6b presents the PDF of CCC/Caa1 loan prices. The table presents *(1)* the distribution of the CCC/Caa1 loan with the lowest market price in a CLO in each month, *(2)* the distribution of CCC/Caa1+ loan prices.



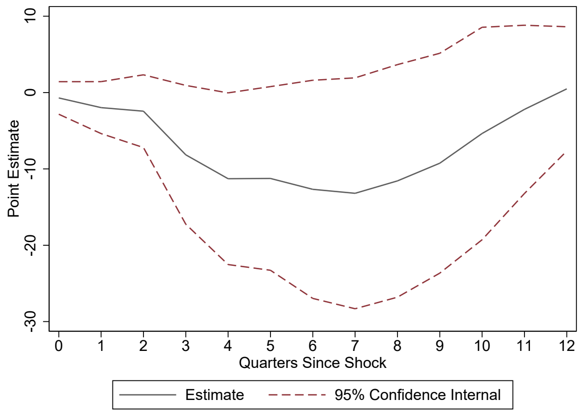
(a) Secondary Loan Price



(b) Bond Yield



(c) Leverage



(d) Investment

Figure 7: Heterogeneous Dynamics in Response to O&G Shock: Jordà Linear Projections

Notes: The figure plots the coefficients and the associated 95% confidence intervals of the interaction term from the following Jordà (2005) style projection regression: $Y_{f,t+h} - Y_{f,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure}_f \times \text{Post}_t) + \beta_2\text{Firm O\&G Exposure}_f + \beta_3\text{Post}_t + \alpha_f + \alpha_y + \epsilon_{f,t}$ where $Y_{f,t}$ is natural log-transformed secondary loan price (top left), natural log-transformed bond yield (top right), leverage (bottom left), capital expenditures (bottom right) at quarter-year t, h denotes the steps (quarters) of the projection, f denotes the (non-O&G) portfolio firm or issuer ($f \in c$), and y denotes the year. Firm O&G Exposure$_f$ measures the weighted average of O&G share of firm f across all CLOs before the shock occurs. The x-axis indicates the quarters since the shock. The y-axis indicates the point estimate associated β_1 estimate. Standard errors are clustered by CLO in Figure 7a. Standard errors are clustered by issuer in Figures 7b, 7c. and 7d.

9.2 Tables

Table 1: Summary Statistics

	N	Q1	Median	Q3	Mean	Std. Dev.
Dist. to ID Constraint ($\frac{\text{Covenant Result}}{\text{Covenant Threshold}}$)	2,076	1.0334	1.0410	1.0513	1.0525	0.0457
Issuer O&G Exposure	6,638	0.0085	0.0174	0.0296	0.0206	0.0197
CLO O&G Exposure	728	0.0000	0.0105	0.0284	0.0200	0.0425
Transaction Amount	767,099	-333,333	174,694	964,286	306,403	1,344,868
Net Transaction Amount (CLO-Issuer)	492,242	-440,000	400,000	1,196,000	477,491.8	1,831,333
Net Transaction Amount (Issuer)	43,370	-1,875,345	748,110	4,588,151	5,419,449	34,569,201
Transaction Price	129,439	99.0000	99.7500	100.0000	97.6138	9.4910
All-in-Spread drawn (Term Loans)	1,515	325.0000	400.0000	500.0000	431.2657	185.8061
Facility Maturity (Term Loans)	1,529	59.0000	72.0000	84.0000	67.7620	19.9434
ln(Facility Amount) (Term Loans)	1,557	18.6030	19.3568	20.0499	19.2968	1.1747
Bond Credit Spread (%)	10,074	1.3643	2.2835	3.5152	3.3514	5.0587
Bond Avg Bid/Ask Spread (%)	16,211	0.0020	0.0033	0.0059	0.0047	0.0101
ΔUnused Line	2,097	-0.0056	0.0000	0.0041	0.0002	0.0325
Δ Drawn Line	2,092	0.0000	0.0000	0.0000	0.0007	0.0254
Debt Growth (Long-term)	2,876	-0.0161	-0.0010	0.0257	0.0207	0.2203
Cash Flow	2,864	0.0911	0.1297	0.1871	0.1437	0.1609
Real Sales Growth	3,106	-0.0008	0.0000	0.0006	-0.0001	0.0028
R&D Growth	961	0.0000	0.0000	0.0255	0.0075	0.1424
Acquisitions	2,895	0.0000	0.0000	0.0042	0.0277	0.1408
Investment/Capital	2,985	-0.0090	0.0030	0.0236	0.0185	0.0932
ln(CapEx)	2,951	2.3889	3.6350	4.9624	3.6293	2.0316
ln(Employment)	2,958	0.8771	1.6605	2.8332	1.8675	1.2196
Interest Rate (%)	2,436,473	3.6938	4.2500	5.5000	4.7169	1.9335
Defaulted Share	9,961	0.0000	0.5455	1.9578	3.7893	12.5261

Notes: The table presents summary statistics for the outcome variables of interest used in this paper. The columns, left to right, denote the variable of interest, number of observations, 25^{th} percentile value, median, 75^{th} percentile value, mean, and standard deviation in Columns 2-7.

Table 2: Distance to Interest Diversion Covenant and O&G Exposure

	Distance to ID Threshold					
	(1)	(2)	(3)	(4)	(5)	(6)
O&G Share × Post	-0.5176***	-0.4221***	-0.4793***	-0.5138***	-0.2271***	-0.2161**
	(0.1418)	(0.1409)	(0.1133)	(0.1145)	(0.0824)	(0.0829)
O&G Share	-0.1790	-0.0404	0.1079	0.4484*		
	(0.4010)	(0.2760)	(0.1875)	(0.2571)		
Post	0.0211***	0.0110			0.0093***	
	(0.0070)	(0.0066)			(0.0033)	
CLO Controls		✓	✓	✓		
CLO FE					✓	✓
Manager FE	✓	✓	✓	✓		
Year FE		✓			✓	
Month-Year FE			✓	✓		✓
N	1,856	1,856	1,856	1,856	1,856	1,856
R^2	0.3569	0.3951	0.4301	0.4640	0.8424	0.8491

Standard errors are two-way clustered by CLO and month-year in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between CLO O&G exposure and distance to the Interest Diversion covenant. The baseline regression specification takes the form $Y_{c,t} = \beta_0 + \beta_1(\text{CLO O\&G Exposure})_c + \beta_2(\text{Oil Shock})_t + \beta_3(\text{CLO O\&G Exposure}_c \times \text{Oil Shock}_t) + \gamma_0' X_c + \epsilon_{c,t}$ where $Y_{c,t}$ is the distance to the Interest Diversion constraint ($ln(\frac{\text{Current Performance}}{\text{Current Threshold}})$) of CLO c at time t, and X denotes the vector of controls, consisting of current CLO age (Columns 2-4) and CLO size (Columns 3-4), and CCC-share and defaulted-share (Column 4). CLO O&G Exposure$_c$ is the O&G share of CLO c before the shock occurs, while Oil Shock$_t$ is an indicator variable that takes a value of 1 if the O&G price plunge has occurred, and 0 otherwise. Standard errors are two-way clustered by CLO and month-year.

Table 3: Transaction-Level Trading Effects

	Transaction Amount ($ mn)					
	(1)	(2)	(3)	(4)	(5)	(6)
O&G Share × Post	-14.8359***	-14.8884***	-14.8744***	-25.0884***	-19.7271***	-20.7458***
	(3.9476)	(3.9785)	(3.7936)	(3.5876)	(3.7639)	(3.6870)
O&G Share	12.1741***	12.2735***	12.1685***	25.1241***		
	(3.2751)	(3.3001)	(3.2086)	(2.9362)		
Post	0.2135*	0.2986**			0.3551***	
	(0.1104)	(0.1209)			(0.1149)	
Manager FE			✓			
Rating-Industry FE				✓		
Issuer-Loan Type FE					✓	✓
Year FE		✓			✓	
Month-Year FE			✓	✓		✓
N	129,132	129,132	129,132	117,829	129,132	129,132
R^2	0.0041	0.0045	0.0357	0.0275	0.0758	0.0809

Standard errors are two-way clustered by CLO-issuer and trade date in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between firm O&G exposure and transaction amount for non-O&G firms. The baseline regression specification takes the form $Y_{i,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \gamma_0 X_c + \gamma_0 Z_f + \alpha_{f,l} + \alpha_{m,y} + \epsilon_{i,t}$ where $Y_{i,t}$ is the transaction amount of loan i at time t issued by firm f ($i \in f \in$ CLO c), l denotes the loan-type, X is a vector of CLO controls including manager, m, y denote the month and year respectively, and Z is a vector of firm controls including rating and industry. Firm O&G Exposure$_f$ measures the weighted average of O&G share of firm f across all CLOs before the shock occurs, while Oil Shock$_t$ is an indicator variable that takes a value of 1 if the O&G price plunge has occurred, and 0 otherwise. Standard errors are two-way clustered by CLO × issuer and trade date.

Table 4: Secondary Loan Price and O&G Exposure

	Transaction Price (per \$100 par)					
	(1)	(2)	(3)	(4)	(5)	(6)
O&G Share × Post	-180.8855***	-179.5377***	-165.6002***	-121.5321***	-73.2541**	-61.1373**
	(67.5569)	(67.3133)	(58.0911)	(38.7072)	(29.9952)	(30.1474)
O&G Share	186.7747***	185.3052***	163.0803***	28.6556		
	(63.9352)	(63.7052)	(54.4846)	(35.3086)		
Post	5.3804***	5.0854***			1.7307*	
	(1.8375)	(1.9121)			(0.8881)	
Manager FE			✓			
Rating-Industry FE				✓		
Issuer-Loan Type FE					✓	✓
Year FE		✓			✓	
Month-Year FE			✓	✓		✓
N	57,593	57,593	57,587	52,583	57,593	57,593
R^2	0.0087	0.0088	0.0701	0.3955	0.6010	0.6098

Standard errors are two-way clustered by CLO-issuer and trade date in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between firm O&G exposure and secondary loan price for non-O&G firms. The baseline regression specification takes the form $Y_{i,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \gamma_0 X_c + \gamma_0 Z_f + \alpha_{f,l} + \alpha_{m,y} + \epsilon_{i,t}$ where $Y_{i,t}$ is the secondary loan price of loan i at time t issued by firm f ($i \in f \in$ CLO c), l denotes the loan-type, X is a vector of CLO controls including manager, m, y denote the month and year respectively, and Z is a vector of firm controls including rating and industry. Firm O&G Exposure$_f$ measures the weighted average of O&G share of firm f across all CLOs before the shock occurs, while Oil Shock$_t$ is an indicator variable that takes a value of 1 if the O&G price plunge has occurred, and 0 otherwise. Standard errors are two-way clustered by CLO × issuer and trade date.

Table 5: Primary Institutional Loan Spread and O&G Exposure

	All-in-Spread Drawn				
	(1)	(2)	(3)	(4)	(5)
O&G Share × Post	1873.1918**	1952.6702**	2168.5713**	2011.9126***	1805.9003**
	(784.2323)	(819.0005)	(850.9114)	(719.3401)	(751.5813)
Post	-67.9276**	-57.8516	-44.3801	-50.9940	
	(28.2325)	(36.7830)	(37.1538)	(31.6905)	
Maturity				0.4590	0.4758
				(0.3479)	(0.3444)
Issuer FE	✓	✓	✓	✓	✓
Secured FE		✓	✓	✓	✓
Purpose FE				✓	✓
Distribution Method FE				✓	✓
Seniority FE			✓	✓	✓
Loan Type FE			✓	✓	✓
Country of Syndication FE				✓	✓
Year FE		✓	✓	✓	
Month-Year FE					✓
N	567	567	567	567	567
R^2	0.6774	0.6805	0.9114	0.9215	0.9328

Standard errors are two-way clustered by issuer and month-year in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between firm O&G exposure and primary institutional loan spread for non-O&G firms. The baseline regression specification takes the form $Y_{i,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \beta_4\text{Maturity} + \gamma_0 X_i + \alpha_{m,y} + \alpha_f + \epsilon_{i,t}$ where $Y_{i,t}$ is the all-in-spread drawn (bps) of loan i at time t, issued by firm f ($i \in f \in$ CLO c), and X is the vector of non-time varying controls associated with loan i including secured status, purpose, distribution method, seniority, loan type, and country of syndication, and m, y denote the month and year respectively. Firm O&G Exposure$_f$ measures the weighted average of O&G share of firm f across all CLOs before the shock occurs, while Oil Shock$_t$ is an indicator variable that takes a value of 1 if the O&G price plunge has occurred, and 0 otherwise. Standard errors are two-way clustered by issuer and month-year.

Table 6: Firm Liquidity and O&G Exposure

	Credit Line					
	ΔUnused			ΔUsed		
	(1)	(2)	(3)	(4)	(5)	(6)
O&G Share × Post	-0.1123*	-0.1122*	-0.1126*	0.1011**	0.1008**	0.1004**
	(0.0571)	(0.0571)	(0.0577)	(0.0495)	(0.0496)	(0.0500)
Post	0.0031*	0.0024		-0.0023	-0.0039*	
	(0.0018)	(0.0024)		(0.0018)	(0.0022)	
Issuer FE	✓	✓	✓	✓	✓	✓
Industry FE			✓			✓
Year FE		✓			✓	
Quarter-Year FE			✓			✓
N	2,088	2,088	2,088	2,083	2,083	2,083
R^2	0.0499	0.0505	0.0565	0.0532	0.0539	0.0591

Standard errors are two-way clustered by issuer and month-year in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between firm O&G exposure and changes in liquidity for non-O&G firms. The baseline regression specification takes the form $Y_{f,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \alpha_{q,y} + \alpha_f + \alpha_I + \epsilon_{f,t}$ where $Y_{f,t}$ are various measures of liquidity for firm f at time t ($f \in$ CLO c), I denotes the industry, and q, y denote the quarter and year respectively. Firm O&G Exposure$_f$ measures the weighted average of O&G share of firm f across all CLOs before the shock occurs, while Oil Shock$_t$ is an indicator variable that takes a value of 1 if the O&G price plunge has occurred, and 0 otherwise. Liquidity is defined as $\Delta ln(\frac{\text{Unused}}{\text{Total Firm Liquidity}})$ in Columns 1-3, and $\Delta ln(\frac{\text{Drawn}}{\text{Total Firm Liquidity}})$ in Columns 4-6, where *Total Firm Liquidity* is defined as the sum of the total line of credit and cash and cash equivalents. Standard errors are clustered by issuer.

Table 7: Firm Adjustments and O&G Exposure

	Debt Growth	Cash Flow	Acquisitions	Investment	R&D Growth	Emp. Growth
	(1)	(2)	(3)	(4)	(5)	(6)
O&G Share × Post	-1.1162*	-0.4994*	-0.6497**	-0.3997*	-2.7501***	-0.3543**
	(0.6523)	(0.2577)	(0.3111)	(0.2224)	(0.9311)	(0.1726)
Issuer FE	✓	✓	✓	✓	✓	✓
Industry FE	✓	✓	✓	✓	✓	✓
Quarter-Year FE	✓	✓	✓	✓	✓	✓
N	2,867	2,860	2,883	2,981	518	2,899
R^2	0.1117	0.8981	0.3236	0.1736	0.0586	0.1974

Standard errors are clustered by issuer in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between firm O&G exposure and firm characteristics for non-O&G firms. The baseline regression specification takes the form $Y_{f,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \alpha_{q,y} + \alpha_f + \alpha_I + \epsilon_{f,t}$ where $Y_{f,t}$ are various firm characteristics for firm f at time t ($f \in$ CLO c), I denotes the industry, and q, y denote the quarter and year respectively. Firm O&G Exposure$_f$ measures the weighted average of O&G share of firm f across all CLOs before the shock occurs, while Oil Shock$_t$ is an indicator variable that takes a value of 1 if the O&G price plunge has occurred, and 0 otherwise. The dependent variables are long-term debt growth (Column 1), cash flow (Column 2), acquisitions (Column 3), investment (Column 4), R&D growth (Column 5), and employment growth (Column 6). Standard errors are clustered by issuer.

Table 8: Selling Propensity by Secondary Loan Price Relative to Par and O&G Exposure

	Panel A: $\mathbb{1}_{(\text{loan price}>100)}$				
	(1)	(2)	(3)	(4)	(5)
O&G Share × Post	-4.4748**	-4.5895**	-10.8858***	-10.1198***	-8.2741***
	(2.2264)	(2.2445)	(1.6793)	(1.7474)	(1.6686)
O&G Share	5.1143**	5.1387**	10.5889***		
	(2.0667)	(2.0828)	(1.6086)		
Post	0.0337	-0.0213		0.0800	
	(0.0601)	(0.0623)		(0.0535)	
Rating-Industry FE			✓		
Issuer-Loan Type FE				✓	✓
Year FE		✓		✓	
Month-Year FE			✓		✓
N	57,594	57,594	52,584	57,594	57,594
R^2	0.0107	0.0144	0.1687	0.2567	0.3234

	Panel B: $\mathbb{1}_{(\text{loan price}>100)}$				
	(1)	(2)	(3)	(4)	(5)
O&G Share × Post	4.2994***	4.2892***	2.8659***	2.3389***	2.0049**
	(1.4838)	(1.4859)	(0.8775)	(0.7916)	(0.7943)
O&G Share	-4.1703***	-4.1625***	0.0552		
	(1.3750)	(1.3784)	(0.7277)		
Post	-0.1214***	-0.1217***		-0.0696***	
	(0.0401)	(0.0424)		(0.0235)	
Rating-Industry FE			✓		
Issuer-Loan Type FE				✓	✓
Year FE		✓		✓	
Month-Year FE			✓		✓
N	57,594	57,594	52,584	57,594	57,594
R^2	0.0062	0.0062	0.3238	0.5565	0.5656

Standard errors are two-way clustered by CLO-issuer and trade date in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between firm O&G exposure and propensity to sell loans issued by non-O&G firms by price categorization. The baseline regression specification takes the form $\mathbb{1}_{(price \lesseqgtr p)_{i,t}} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \alpha_{f,l} + \gamma_0 Z_f + \alpha_{m,y} + \epsilon_{i,t}$ where $\mathbb{1}_{(price \lesseqgtr p)_{i},t}$ is an indicator that takes a value 1 if the transacted price of secondary loan price issued by firm f at time t ($i \in f \in$ CLO c) is greater than \$100 (per \$100 par) in Panel A, and below \$90 (per \$100 par) in Panel B, Z is a vector of firm controls including rating and industry, m, y denote the month and year respectively, l denotes the loan-type. Firm O&G Exposure$_f$ measures the weighted average of O&G share of firm f across all CLOs before the shock occurs, while Oil Shock$_t$ is an indicator variable that takes a value of 1 if the O&G price plunge has occurred, and 0 otherwise. Standard errors are two-way clustered by CLO × issuer and trade date.

Table 9: Interest Rate of Loans and O&G Exposure

	Interest Rate						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
O&G Share × Post	-8.5242***	-8.5850***	-8.8786***	-9.5662***	-9.4623***	-8.9912***	-8.8636***
	(2.5064)	(2.4112)	(2.2225)	(2.1779)	(2.5493)	(2.5278)	(2.4733)
Post	0.2378***	0.2276***	0.1947***	0.2136***	0.2201***		
	(0.0693)	(0.0674)	(0.0641)	(0.0620)	(0.0732)		
Tenor							0.0004***
							(0.0000)
Issuer FE	✓	✓	✓	✓			
Manager FE		✓					
CLO FE			✓	✓			
CLO-Issuer FE					✓		
Loan Type FE				✓	✓		
CLO-Issuer-Loan Type FE						✓	✓
Year FE	✓	✓	✓	✓	✓		
Month-Year FE						✓	✓
Index FE	✓	✓	✓	✓	✓	✓	✓
N	2,477,250	2,477,250	2,477,250	2,477,250	2,477,250	2,477,250	2,477,250
R^2	0.7300	0.7326	0.7371	0.8291	0.9148	0.9440	0.9459

Standard errors are two-way clustered by CLO-issuer and month-year in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between firm O&G exposure and the interest rate of loans issued by non-O&G firms. The baseline regression specification takes the form $\text{Interest Rate}_{i,c,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \gamma_0 Z_i + \gamma_0 X_c + \alpha_{l,f,c} + \alpha_{m,y} + \epsilon_{i,c,t}$ where where $\text{Interest Rate}_{i,t}$ denotes the interest rate (%) of loan i issued by firm f and held in CLO c at time t ($f \in$ CLO c), l denotes the loan-type, m, y denote the month and year respectively, r denotes the index name, Z is a vector of loan controls including loan type and issuer, and X is a vector of CLO controls including manager and CLO indicator variables. Firm O&G Exposure_f measures the weighted average of O&G share of firm f across all CLOs before the shock occurs, while Oil Shock_t is an indicator variable that takes a value of 1 if the O&G price plunge has occurred, and 0 otherwise. Standard errors are two-way clustered by CLO × issuer and month-year.

Table 10: CLO Defaulted Loans and O&G Exposure

	$\mathbb{1}_{\text{defaulted loan}}$						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
O&G Share × Post	-0.3688***	-0.3819***	-0.3553***	-0.4344***	-0.2935***	-0.1740*	-0.1780**
	(0.1101)	(0.1089)	(0.0976)	(0.0964)	(0.0956)	(0.0894)	(0.0875)
Post	0.0069**	0.0072**	0.0089***	0.0113***	0.0090***		
	(0.0027)	(0.0027)	(0.0024)	(0.0024)	(0.0025)		
Tenor							-0.0000***
							(0.0000)
Issuer FE	✓	✓	✓	✓			
Manager FE		✓					
CLO FE			✓	✓			
CLO-Issuer FE					✓		
Loan Type FE				✓	✓		
CLO-Issuer-Loan Type FE						✓	✓
Year FE	✓	✓	✓	✓	✓		
Month-Year FE						✓	✓
N	3,363,184	3,363,184	3,363,184	3,363,184	3,363,184	3,363,184	3,363,184
R^2	0.6012	0.6034	0.6110	0.6171	0.7906	0.8144	0.8145

Standard errors are two-way clustered by CLO-issuer and month-year in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between firm O&G exposure and transaction amount for non-O&G firms. The baseline regression specification takes the form $\mathbb{1}_{(\text{defaulted loan})i,c,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \gamma_0 X_c + \alpha_{l,f,c} + \alpha_{m,y} + \epsilon_{i,c,t}$ where $\mathbb{1}_{(\text{defaulted loan})i,t}$ denotes whether loan i issued by firm f and held by CLO c at time t has defaulted ($f \in$ CLO c), l denotes the loan type, m, y denote the month and year respectively, and X is a vector of CLO controls including manager and CLO indicator variables. $\mathbb{1}_{(\text{defaulted loan})i,t}$ is standardized. Firm O&G Exposure$_f$ measures the weighted average of O&G share of firm f across all CLOs before the shock occurs, while Oil Shock$_t$ is an indicator variable that takes a value of 1 if the O&G price plunge has occurred, and 0 otherwise. Standard errors are two-way clustered by CLO × issuer and month-year.

Table 11: CLO Defaulted Share and O&G Exposure

	Defaulted Share				
	(1)	(2)	(3)	(4)	(5)
O&G Share × Post	-54.6402**	-53.9716**	-53.9716**	-59.6632***	-58.4631**
	(20.4091)	(20.3927)	(20.5037)	(21.3325)	(27.1247)
Post	3.5181***	2.6031***	2.6031***	3.1842***	
	(0.8327)	(0.8830)	(0.8878)	(0.9732)	
CLO FE	✓	✓	✓		
Manager FE			✓		
Arranger FE			✓		
Trustee FE			✓		
Year FE		✓	✓		
CLO-Year FE				✓	✓
Manager-Year FE				✓	
Arranger-Year FE				✓	
Trustee-Year FE				✓	
Manager-Month Year FE					✓
Arranger-Month Year FE					✓
Trustee-Month Year FE					✓
N	8,522	8,522	8,522	8,522	8,522
R^2	0.6292	0.6307	0.6307	0.7860	0.8575

Standard errors are two-way clustered by CLO and month-year in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between CLO O&G exposure and percent of defaulted assets. The baseline regression specification takes the form $Y_{c,t} = \beta_0 + \beta_1(\text{CLO O\&G Exposure})_c + \beta_2(\text{Oil Shock})_t + \beta_3(\text{CLO O\&G Exposure}_c \times \text{Oil Shock}_t) + \alpha_{c,y} + \alpha_{g,m,y} + \alpha_{a,m,y} + \alpha_{t,m,y} + \epsilon_{c,t}$ where $Y_{c,t}$ is the percent of distressed loans in CLO c at time t, m, y denote the month and year respectively. The manager, arranger, and trustee associated with CLO c are denoted by g, a, and t, respectively. CLO O&G Exposure$_c$ is the O&G share of CLO c before the shock occurs, while Oil Shock$_t$ is an indicator variable that takes a value of 1 if the O&G price plunge has occurred, and 0 otherwise. Standard errors are two-way clustered by CLO and month-year.

Table 12: Comparison of Effects by Risk and O&G Exposure

	Secondary Loan Price		All-In-Spread Drawn		Investment	
	Non-Distressed	Distressed	Non-Distressed	Distressed	Non-Distressed	Distressed
	(1)	(2)	(3)	(4)	(5)	(6)
O&G Share × Post	33.7732	-232.3941***	1088.0890	5648.7368*	-0.2244	-1.2826**
	(29.5111)	(72.8425)	(732.2927)	(2883.8527)	(0.2214)	(0.5328)
Issuer-Loan Type FE	✓	✓				
Issuer FE			✓	✓	✓	✓
Primary Loan Controls			✓	✓		
Firm Controls					✓	✓
Month-Year FE	✓	✓	✓	✓		
Quarter-Year FE					✓	✓
N	29,892	27,701	347	198	2,158	417
R^2	0.3858	0.6534	0.9474	0.9396	0.1871	0.2175

Standard errors are clustered in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between firm O&G exposure and firm characteristics. The baseline regression specification takes the form $Y_{i,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \beta_4\text{Maturity}_{i,t} + \gamma_0 X_{i/f} + \alpha_{m/q,y} + \alpha_f + \epsilon_{i,t}$ where $Y_{i,t}$ is the secondary loan price per \$100 par in Columns 1 and 2, all-in-spread drawn in Columns 3 and 4, and investment growth in Columns 5 and 6 for firm f at time t ($f \in$ CLO c). X is the vector of non-time varying controls associated with loan i in columns 3 and 4, including secured status, purpose, distribution method, seniority, loan type, and country of syndication. X is the vector of non-time varying controls associated with firm f in columns 5 and 6, including industry and rating. *Maturity* denotes the maturity of loan i at time t. $m/q, y$ denote the month/quarter and year respectively. Firm O&G Exposure$_f$ measures the weighted average of O&G share of firm f across all CLOs before the shock occurs, while Oil Shock$_t$ is an indicator variable that takes a value of 1 if the O&G price plunge has occurred, and 0 otherwise. In Columns 2, 4, 6, I restrict the analysis to *distressed* firms which defaulted on a loan at some point in the sample period. The results for *non-distressed firms* are reported in Columns 1, 3, and 5. Standard errors are two-way clustered by CLO × issuer and month-year (Col. 1, 2), issuer and month-year (Col. 3, 4), and issuer (Col. 5, 6) in parentheses.

Appendix for:

"The Externalities of Fire Sales: Evidence from Collateralized Loan Obligations"

Appendix A Numerical Example

In this section, I illustrate how contractual arbitrage loosens the capital covenants. Let the initial book value of assets be 100 and the initial book value of liabilities be 100. Further, let τ the stipulated portfolio share of CCC/Caa1 loan be 7.5%. Assume that each loan is of equal amount. Now consider that distress settles in such that:

- Share of good risky assets, g, is 20%
- Share of of bad risky assets, b, is 10%
- Market price of good, risky assets, γ is 95 ¢/$
- Market price of bad, risky assets, β, is 20 ¢/$

Before distress settles in:

$$OC/ID = 1. \tag{A.1}$$

Afterwards, the total share of (good and bad) risky assets sums to 30%, exceeding the 7.5% threshold. Consequently, the capital covenant will tighten. Specifically, the OC/ID ratio will be:

$$OC/ID = \frac{(1-(0.3-0.075))100 + (0.3-0.075)0.20 \times 100}{100} \tag{A.2}$$

$$OC/ID = 0.82 \tag{A.3}$$

Now, if the CLO sells all of the good, risky assets, the OC/ID ratio will be:

$$OC/ID = \frac{(1-(0.3-0.075))100 + (0.10-0.075)0.20 \times 100 + (0.20)0.95 \times 100}{100} \tag{A.4}$$

$$OC/ID = 0.97 \tag{A.5}$$

This illustrative example demonstrates how a CLO can maximize improvements to the capital covenants by selling CCC/Caa1 or risky loans from their highest dollar market value to their lowest dollar market value. Similarly, if the agency-projected recovery rate of a defaulted loan is below its market value, or, if the purchase price of a discount obligation is below its current market valuation, the CLO can build par by selling the defaulted or discounted loan.

Appendix B Assessing Selection Concerns

This section assesses the magnitude of selection concerns, underlying the empirical strategy.

First, I find that portfolios are largely overlapping across CLOs. While the total value of outstanding CLOs increased from 2007 through 2019 – from $308 billion to $606 billion (International Monetary Fund (2020)) – the number of issuers across CLOs experienced a rather meager increase from 4,229 to 4,659 over the same time horizon. The median issuer's loans were held in 78 CLOs in the aftermath of the Great Financial Crisis of 2008 (Kundu (2022*a*)). CLO exposures are highly correlated; 90% of CLOs are exposed to the top 50 US borrowers, and 80% are exposed to the top five borrowers (Financial Stability Board (2019)).

Second, I do not find that the capital covenant threshold varies with O&G exposure before the shock. Loumioti and Vasvari (2019) contend that CLO test restrictiveness is related to (1) the size of CLO junior notes, positively, (2) favorability of market conditions and investor demand, negatively, and (3) CLO vintage (1.0/2.0/3.0), positively. In Appendix Table C.1, I study whether the ID threshold and sectoral exposure are related. Specifically, I examine the relationship between O&G exposure and the ID threshold before the shock. I use a within manager estimator to absorb all variation related to managerial style, risk appetite, specialization, taste, reputation and sophistication. I include CLO controls including age, size, CCC-share, and defaulted-share, in addition to arranger, trustee, and time fixed effects.[50] I do not find stable or statistically significant point estimates. These findings suggest that there is no relation between O&G exposure and the covenant threshold. Further, as the CLO covenant threshold cannot be renegotiated, it is unlikely to be endogenous to a CLO's subsequent investment decisions and trading behavior.

Third, there are negligible differences in the distribution of investments across non-O&G industries before the shock, as demonstrated in Appendix Figure C.3. I compare CLOs with high O&G exposure – CLOs with O&G exposure above the 75$^{\text{th}}$ percentile – to CLOs with low O&G exposure – CLOs with O&G exposure below the 25$^{\text{th}}$ percentile. The difference in the industry share between CLOs with high O&G exposure and CLOs with low O&G exposure is greatest for the O&G industry, followed by the Printing and Publishing industry, which exhibits a difference that is half of the difference in O&G. On average, the difference in the industry share of non-O&G industries is more than 34 times smaller than the difference in O&G between CLOs with high and low O&G exposure.[51]

Fourth, I compare the geographic concentration of investment for CLOs with high O&G exposure – CLOs with above-median O&G exposure – to CLOs with low O&G exposure – CLOs with below-median O&G exposure, before the shock in Appendix Figure C.4. The location of the firm is identified using the *State* identifier in DealScan. Geographic concentration is very similar between the two sets of CLO portfolios.[52]

Fifth, I draw comparisons of observable firm characteristics between CLOs with high O&G exposure and CLOs with low O&G exposure. I compare characteristics of firms that are held by CLOs with high O&G exposure – CLOs with above-median O&G exposure – to CLOs with low O&G exposure – CLOs with below-median O&G exposure, before the shock in Appendix Table C.2. The distribution of characteristics across firms held by CLOs with high O&G exposure is comparable to that of firms held by CLOs with low O&G exposure in

[50] I report robust standard errors – there is no time series variation and there is one observation per CLO.

[51] The industry Herfindahl-Hirschman Index (HHI) is 0.05409 for CLOs with high O&G exposure and 0.0552 for CLOs with low O&G exposure for non-O&G industries. The Euclidean distance between the two vectors of the industry share of firms held in CLOs with high and low CLO O&G exposure is 0.0473. The Kolmogorov-Smirnov test for equality of distribution functions fails to reject the null hypothesis, with a p-value of 1.00.

[52] The state Herfindahl-Hirschman Index (HHI) is 0.00501 for CLOs with high O&G exposure and 0.0493 for CLOs with low O&G exposure for non-O&G industries. The Euclidean distance between the two vectors of the state share of firms held in CLOs with high and low CLO O&G exposure is 0.0494. The Kolmogorov-Smirnov test for equality of distribution functions fails to reject the null hypothesis, with a p-value of 0.57.

several dimensions, including, size, Tobin's Q, leverage, market-to-book equity ratio, investment growth, investment, cash flow, and tangibility. There are not material differences in firm characteristics across CLOs of differing O&G exposure.

Sixth, I directly test whether firm sensitivity to oil price affects CLO selection. There may be a concern that CLOs with high O&G exposure hold other loans which covary negatively with the price of oil. In Appendix Table C.3, I study whether the covariance between firms' profitability and oil price can predict which type of CLO (high or low O&G exposure) a firm's debt will be held in, prior to the shock. I use a within manager-arranger-trustee estimator to absorb all variation related to management style, risk appetite, specialization, taste, reputation and sophistication. In addition, I include several CLO and issuer controls, as well as time fixed effects. I do not find robust or statistically significant evidence that the covariance between oil price and firm profitability can predict CLO selection. Further, the R^2 associated with the simple OLS regression in column 1 is virtually nil. Hence, I rule out concerns of portfolio hedging with respect to O&G exposure.

In summary, these results suggest the following. CLOs hold largely overlapping portfolios. Firm, sectoral and geographic characteristics of CLO portfolios with different O&G exposures are largely similar. There is no strong relationship between CLO O&G exposure and the covenant threshold, before the shock, nor is there evidence that CLOs hedge against O&G exposure with the remaining allocation of the portfolio. As the O&G price plunge was not a foreseeable event, the O&G shares may be viewed as a random assignment. In other words, a CLO portfolio may be considered a combination of two distinct portfolios: a portfolio of O&G loans, and, the "market" portfolio – a portfolio of non-O&G loans. Variation in O&G exposure depends on how managers weigh the trade-off between enhancing arbitrage and default risk (Ashton (2020)). This is consistent with the findings of Appendix Figure C.6 and Appendix Figure C.7, which indicate that O&G loans exhibited higher ratings than non-O&G loans yet yielded higher returns than non-O&G loans in each rating category.

Appendix C Figures and Tables

C.1 Figures

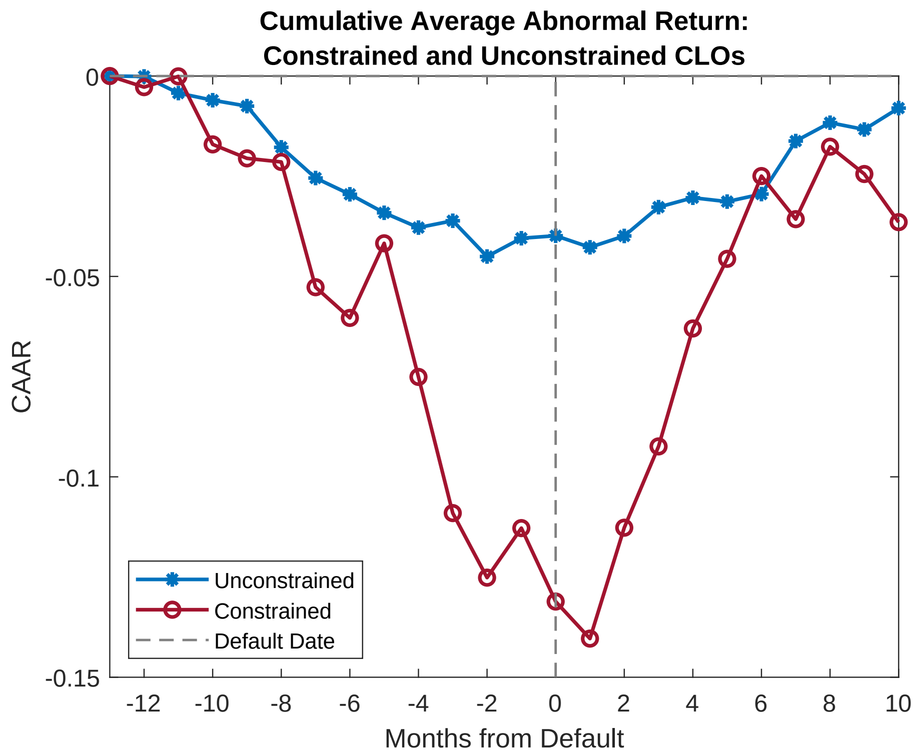


Figure C.1: CAAR: Constrained and Unconstrained CLOs (Kundu (2022*b*))

Notes: The figure compares the monthly cumulative average abnormal return (CAAR) for loans issued by borrowers with above/below median CLO debt held by constrained CLOs around default, as shown in Kundu (2022*b*). A borrower is *constrained* if its share of CLO debt (amount) held by constrained CLOs is greater than the median, and *unconstrained*, otherwise. Abnormal return is generated from the following regression: $ln(\frac{P_{i,t}}{P_{i,t-1}}) \approx \alpha + \beta Z_{i,t-1,t} + \gamma_0(Q_{i,t} - Q_{i,t-1}) + \gamma_1(Q_{i,t} ln(S_{i,t}) - Q_{i,t-1} ln(S_{i,t-1})) + \beta_{r,q} + \beta_{d,q} + \beta_{r,d,y} + \theta_m + \epsilon_{i,t-1,t}$ where P is the observed price, Z is a vector of fundamental value, Q is a purchase indicator, S is the trade size, i denotes the loan, r denotes the rating, d denotes the industry, t denotes the date, q denotes the quarter, m indexes the month-year, y denotes the year, and ϵ is the error.

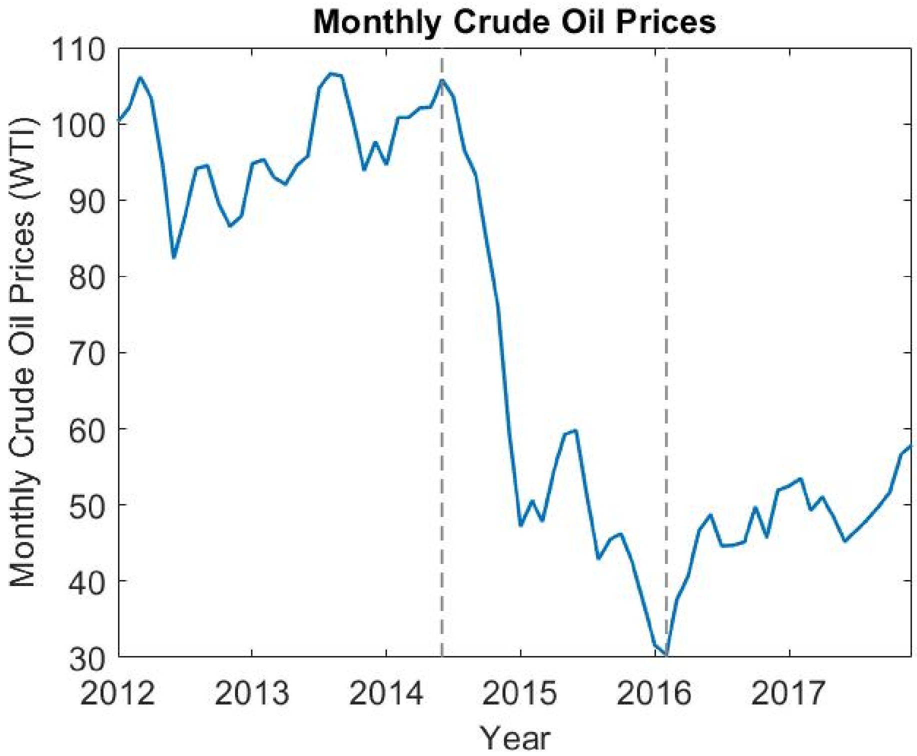


Figure C.2: Monthly Crude Oil Prices (2012-2018)

Notes: The figure shows the crude oil price from 2012-2018. The price is reported as the monthly average $ per barrel of crude oil (WTI). The x-axis reports the year. The y-axis reports the price. The dotted gray line denotes the price plunge period.

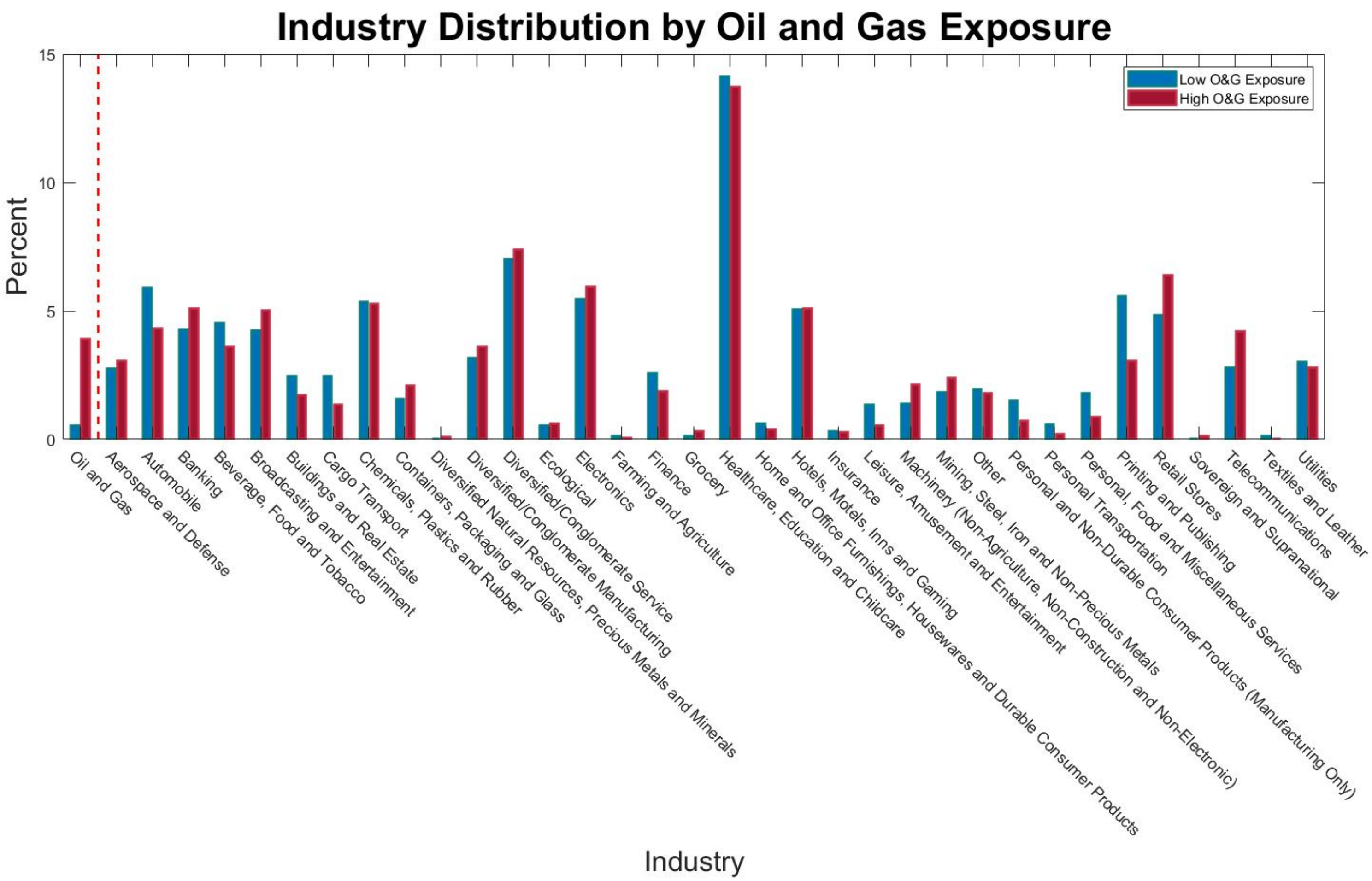
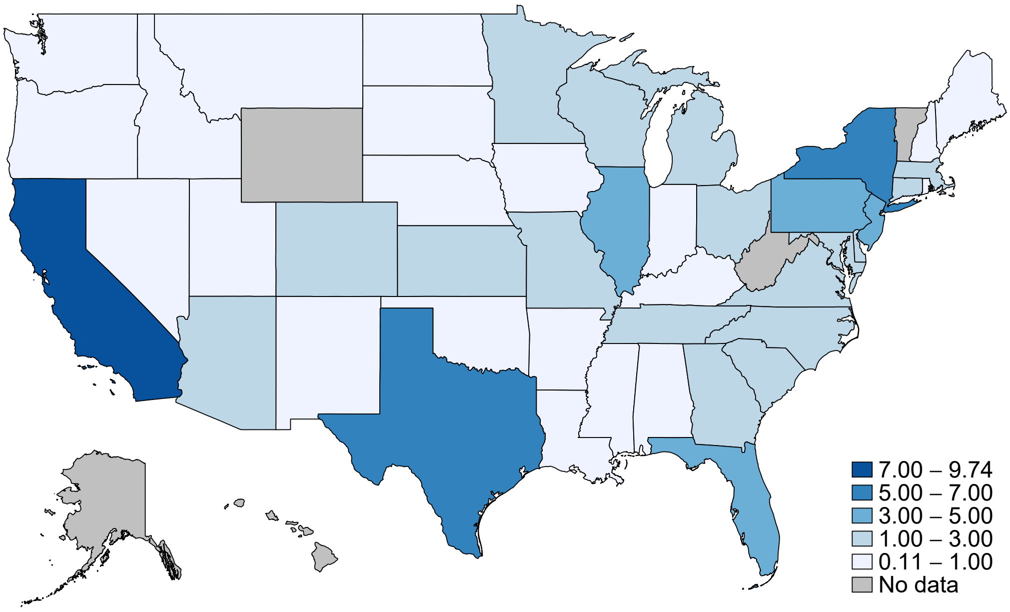
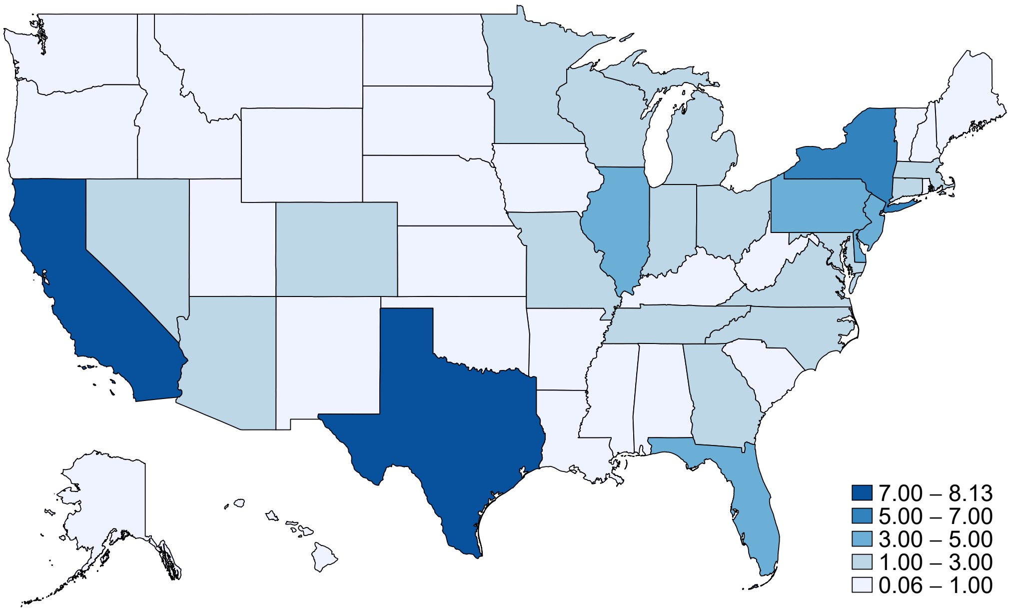


Figure C.3: Industry Composition by CLO O&G Exposure

Notes: This figure compares the industry distribution for CLOs with high O&G exposure to CLOs with low O&G exposure, before the shock. CLOs with O&G exposure above the 75^{th} percentile of all O&G exposures have *high* O&G exposure, while CLOs with O&G exposure below the 25^{th} percentile have *low* O&G exposure. The bar graph presents the industry share of loans for CLOs with low O&G exposure in blue, and high O&G exposure in red. The industry Herfindahl-Hirschman Index (HHI) is 0.0552 for CLOs with low O&G exposure and 0.05409 for CLOs with high O&G exposure (not accounting for O&G industry). The Euclidean distance between the two vectors of the industry share of firms held in CLOs with high and low CLO O&G exposure is 0.0473. The Kolmogorov-Smirnov test for equality of distribution functions fails to reject the null hypothesis, with a p-value of 1.00. Industries are listed across the y-axis. The y-axis denotes the percent of a CLO portfolio in a given industry.



(a) Low O&G Exposure



(b) High O&G Exposure

Figure C.4: Geographic Composition by CLO O&G Exposure

Notes: This figure compares the geographic concentration of non-O&G firms for CLOs with high O&G exposure to CLOs with low O&G exposure. CLOs with above-median O&G exposure have *high* O&G exposure while CLOs with below median O&G exposure have *low* O&G exposure. The plots present the share of firms headquartered in each state. Gray shading signifies that data is unavailable for that state. Darker blue shading reflects a greater share of firms in that state. The top figure shows the geographic distribution of firm headquarters for CLOs with low O&G exposure. The bottom figure shows the geographic distribution of firm headquarters for CLOs with high O&G exposure. For CLOs with low O&G exposure, the Herfindahl-Hirschman Index (HHI) is 0.0501, while it is 0.0493 for CLOs with high O&G exposure. The Euclidean distance between the two vectors of state share of firms held in CLOs with high and low CLO O&G exposure is 0.0494. The Kolmogorov-Smirnov test for equality of distribution functions fails to reject the null hypothesis, with a p-value of 0.57.

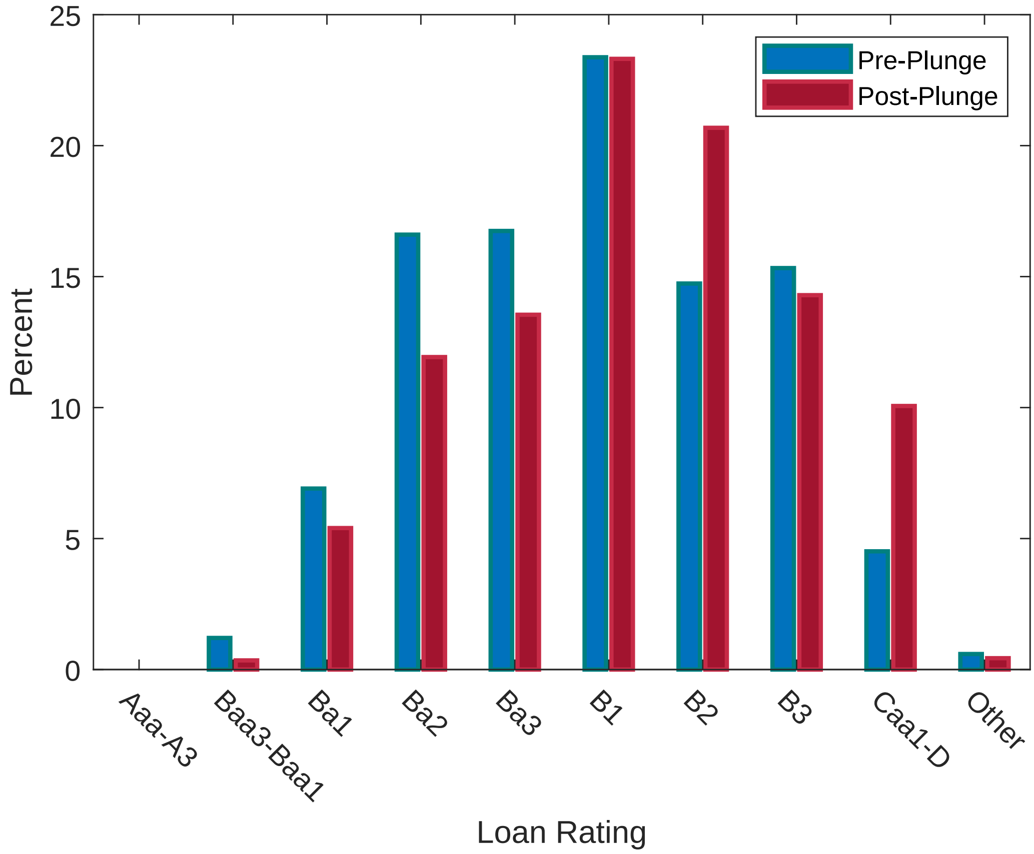
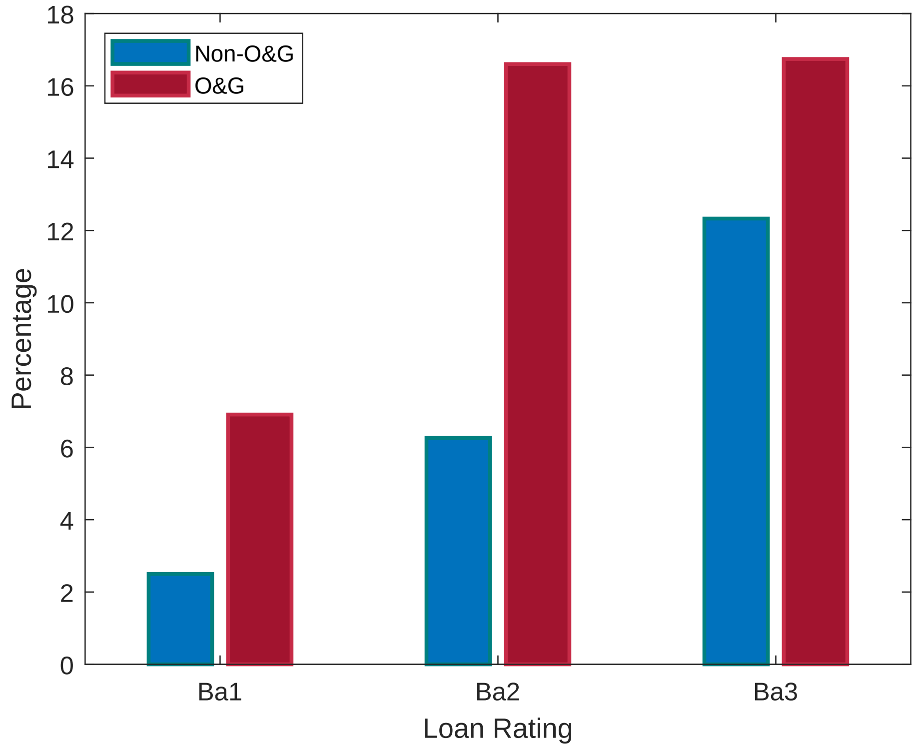
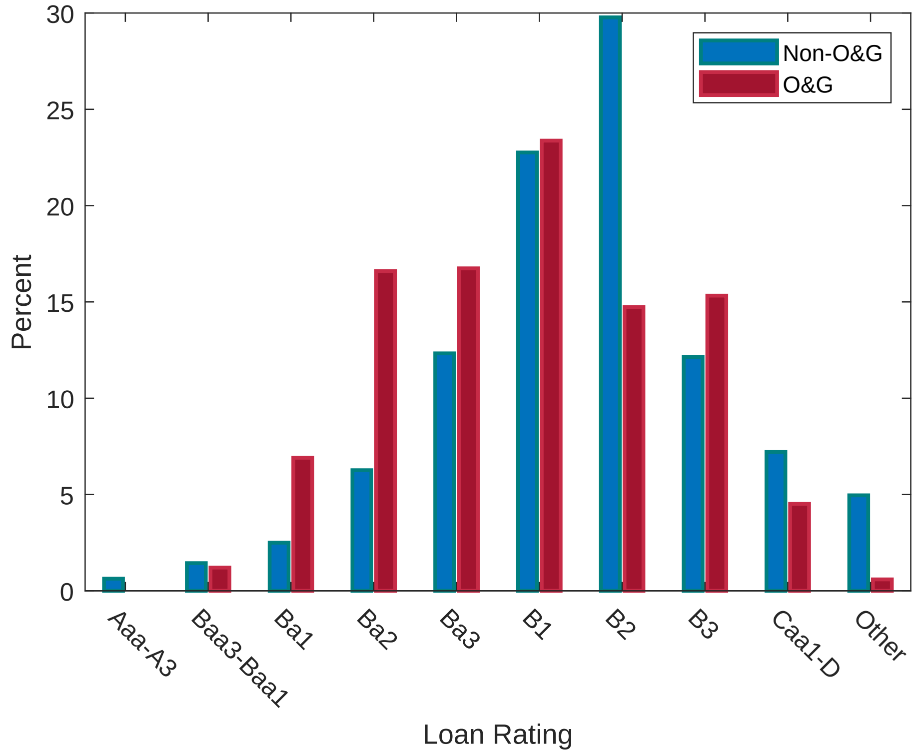


Figure C.5: O&G Ratings Pre- and Post- Plunge

Notes: The figure shows the distribution of loan ratings before and after the O&G price plunge. The x-axis indicates the Moody's loan rating. The y-axis indicates the frequency of O&G loans of each rating category. The blue bars indicate the frequency of O&G loans of the corresponding rating bin before the O&G price plunge. The red bars indicate the frequency of O&G loans of the corresponding rating bin after the O&G price plunge.



(a) Double-B Loan Ratings for O&G and Non-O&G Loans



(b) O&G and Non-O&G Loan Ratings

Figure C.6: Ratings Distribution of O&G and Non-O&G Loans

Notes: This figure compares the ratings distribution for O&G and non-O&G loans before the shock. Appendix Figure C.6a compares the frequency of double-B rated (Ba1, Ba2, and Ba3) loans among O&G and non-O&G loans before the shock. Appendix Figure C.6b compares the distribution of loan ratings for O&G and non-O&G loans before the shock. The x-axis denotes the loan rating. The y-axis denotes the percentage. The red bar indicates O&G loans. The blue bar indicates non-O&G loans.

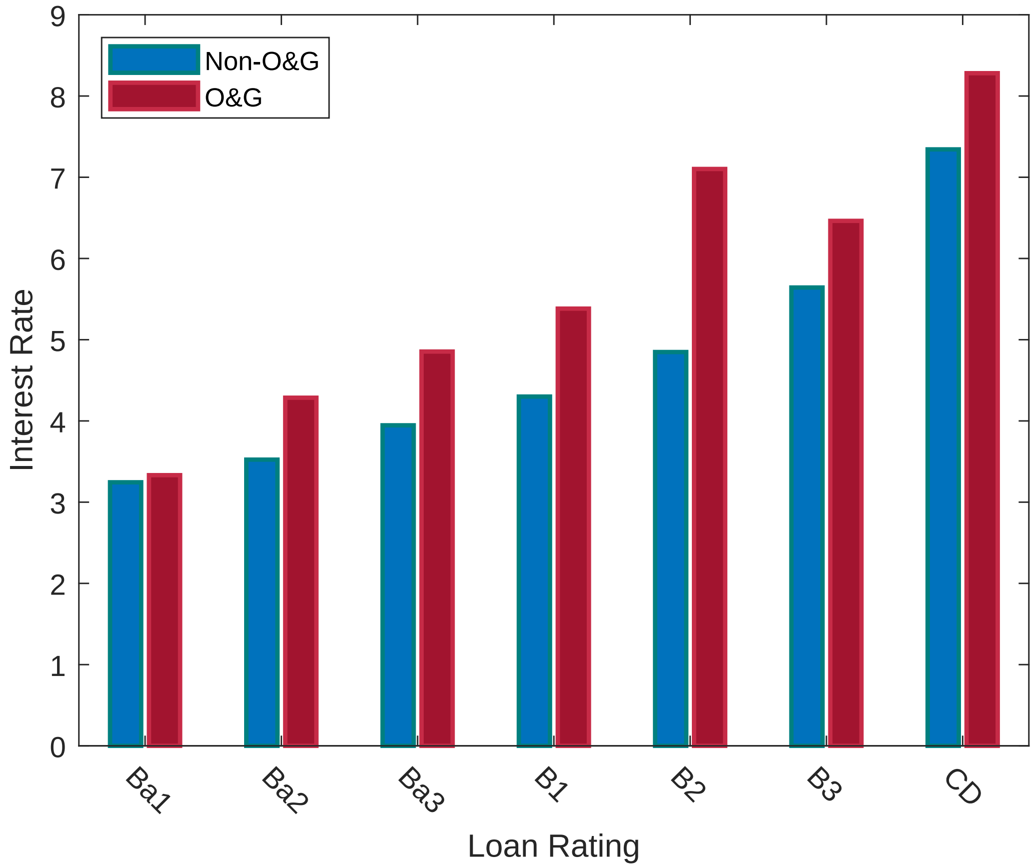
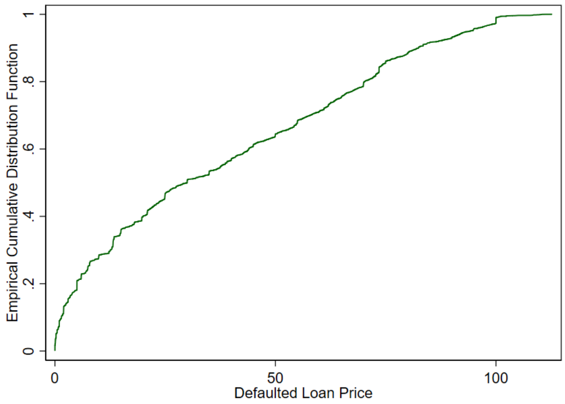
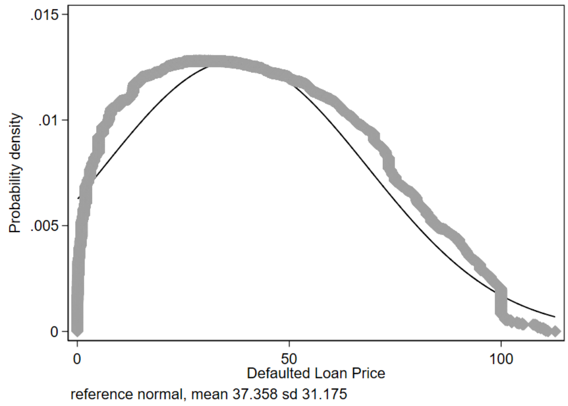


Figure C.7: O&G and Non-O&G Loan Yield

Notes: The figure shows the average interest rate associated with non-O&G loans and O&G loans by loan rating before the shock. The x-axis denotes the loan rating. The y-axis indicates the interest rate. The red bar indicates O&G loans. The blue bar indicates non-O&G loans.



(a) CDF of Defaulted Loan Prices



(b) PDF of Defaulted Loan Prices

Figure C.8: Distributions of Defaulted Loan Prices

Notes: The figure presents the cumulative distribution function (CDF) and probability density function (PDF) of defaulted loan prices. Appendix Figure C.8a presents the CDF of defaulted loan prices. Appendix Figure C.8b presents the PDF of defaulted loan prices.

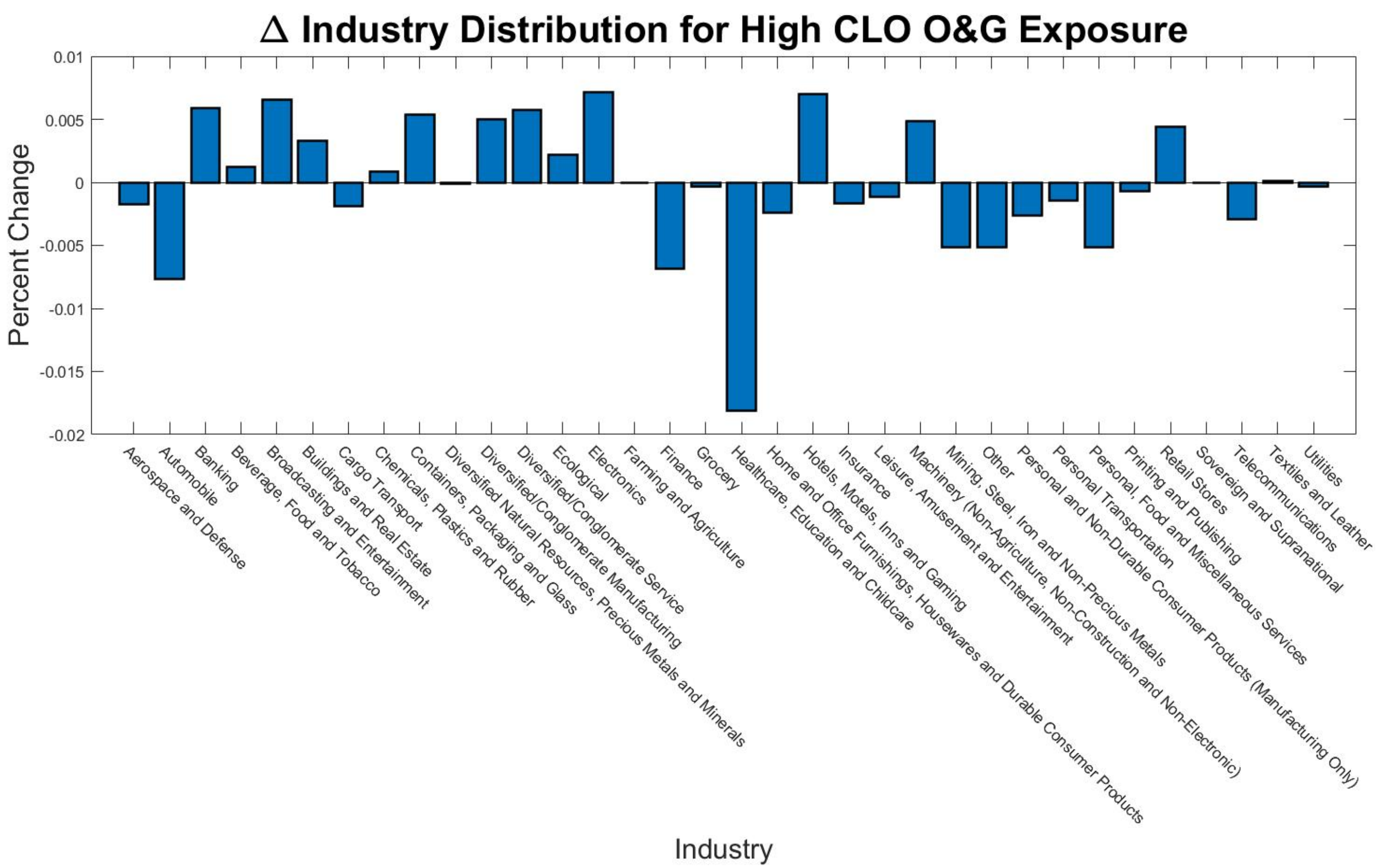
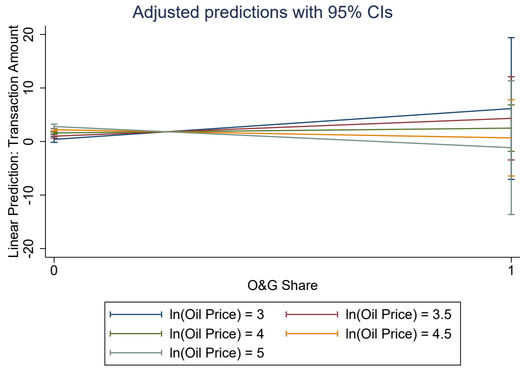
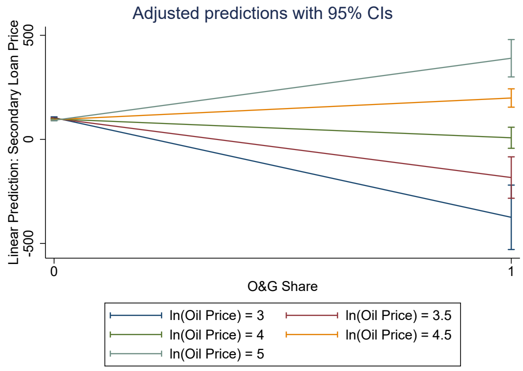


Figure C.9: Change in Industry Composition for Constrained CLOs

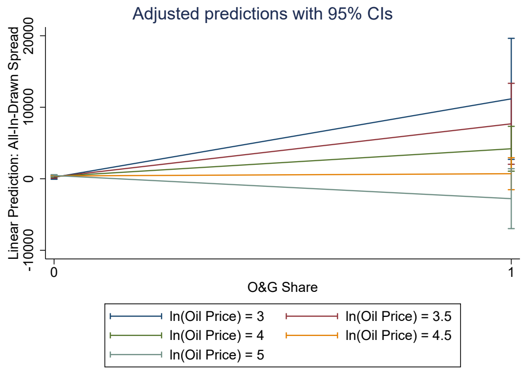
Notes: The figure presents the change in the industry share of loans before and after the shock for constrained CLOs – CLOs with high O&G exposure. CLOs with O&G exposure above the 75^{th} percentile of all O&G exposures have *high* O&G exposure. I list industries on the x-axis and percent change on the y-axis.



(a) Transaction Amount



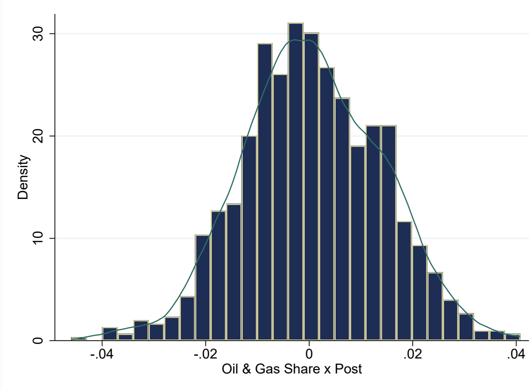
(b) Secondary Loan Price



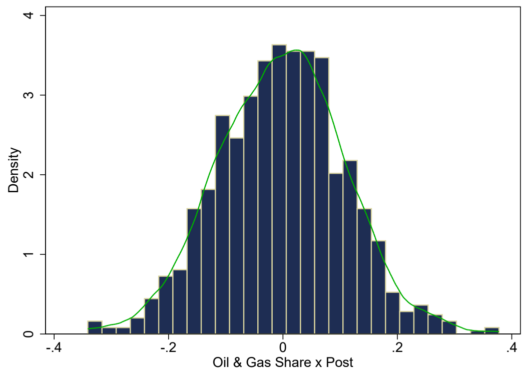
(c) All-in-Spread drawn

Figure C.10: Alternative Empirical Specification

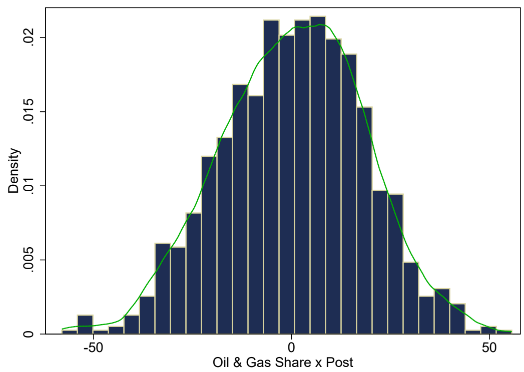
Notes: This figure plots the marginal effects – the slope of the secondary loan price (top) and all-in-spread drawn (bottom) on the price, while holding the value of the O&G share constant between 0 and 1. The regression specification takes the form $Y_{i,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2 ln(\text{Oil Price}_t)) + \beta_3(\text{Firm O\&G Exposure}_f \times ln(\text{Oil Price}_t)) + \alpha_y + \epsilon_{i,t}$ where $Y_{i,t}$ is the secondary loan amount (Appendix Figure C.10a) and secondary loan price (Appendix Figure C.10b) of loan i at time t issued by firm f ($i \in f \in$ CLO c), and y denotes the year for the top figure. The regression specification takes the form $Y_{i,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2 ln(\text{Oil Price}_t)) + \beta_3(\text{Firm O\&G Exposure}_f \times ln(\text{Oil Price}_t))) + \alpha_y + \epsilon_{i,t}$ where $Y_{i,t}$ is the all-in-spread drawn of loan i at time t, issued by firm f ($i \in f \in$ CLO c), and y denotes the year respectively in the bottom figure. Firm O&G Exposure$_f$ measures the weighted average of O&G share of firm f across all CLOs before the shock occurs. Temporal variation comes from the log oil price.



(a) Transaction Amount



(b) Secondary Loan Price



(c) All-in-Spread drawn

Figure C.11: Placebo Tests

Notes: I plot the histograms from 1,000 Monte-Carlo simulations of the baseline results using two placebo tests. I randomize the O&G share from a uniform distribution. β_3 is plotted from the following specifications: $Y_{f,t} = \beta_0 + \beta_1(\text{Placebo O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Placebo O\&G Exposure}_{f,t} \times \text{Oil Shock}_t) + \alpha_f + \alpha_{m,y} + \epsilon_{f,t}$ where $Y_{c,f,t}$ is the secondary loan amount (Appendix Figure C.11a), secondary loan price (Appendix Figure C.11b), f denotes the portfolio firm ($f \in$ CLO c), t indexes the time, m denotes the month, and y denotes the year, and $Y_{i,t} = \beta_0 + \beta_1(\text{Placebo O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Placebo O\&G Exposure}_f \times \text{Oil Shock}_t) + \beta_4\text{Maturity}_{i,t} + \gamma_0 X_i + \alpha_{m,y} + \alpha_f + \epsilon_{i,t}$ where $Y_{i,t}$ is the all-in-spread drawn (Appendix Figure C.11c) of loan i at time t, issued by firm f ($i \in f \in$ CLO c), and X is the vector of non-time varying controls associated with loan i including secured status, purpose, distribution method, seniority, loan type, and country of syndication, and m, y denote the month and year respectively. Oil Shock$_t$ is an indicator variable that takes a value of 1 if the O&G price plunge has occurred, and 0 otherwise. The t-statistics for Appendix Figures C.11a, C.11b and C.11c are 0.1022, -0.7503 and 0.7690, respectively, hence, the null hypothesis that the average difference is equal to zero cannot be rejected in any of the cases.

C.2 Tables

Table C.1: Interest Diversion Threshold and O&G Exposure

	ln(ID Threshold)			
	(1)	(2)	(3)	(4)
O&G Share	-0.1872	-0.0981	-0.2722	-0.3812
	(0.3406)	(0.4040)	(0.4389)	(0.4469)
CLO Controls		✓	✓	✓
Manager FE	✓	✓	✓	✓
Arranger FE				✓
Trustee FE				✓
Year FE		✓		
Month-Year FE			✓	✓
N	60	60	60	60
R^2	0.5727	0.6166	0.8118	0.9747

Robust standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between CLO O&G exposure and the Interest Diversion covenant threshold (ln(Current Threshold)) before the shock occurs. The baseline regression specification takes the form $Y_c = \beta_0 + \beta_1(\text{CLO O\&G Exposure})_c + \gamma_0' X_c + \epsilon_c$ where Y_c is the Interest Diversion covenant threshold of CLO c, and X denotes the vector of controls, consisting of current CLO age (Columns 1-4), CLO size (Columns 2-4), CCC-share and defaulted-share (Columns 3-4). CLO O&G Exposure$_c$ is the O&G share of CLO c measured when the CLO is first reported in the sample. Standard errors are robust.

Table C.2: CLO Comparison based on Observable Firm Characteristics

	Low O&G Exposure					
	N	Q1	Median	Q3	Mean	Std. Dev.
Size	1,431	6.3807	7.3028	8.9143	7.7381	2.0111
Tobin's Q	990	1.1037	1.3940	1.7702	1.5796	0.8715
Leverage	1,332	0.2747	0.4135	0.5828	0.4654	0.3678
Market-to-Book Ratio	1,146	0.4228	1.4718	3.2270	2.4440	15.0618
Investment Growth	1,202	0.0429	0.3937	0.6453	0.0486	0.9826
Investment	1,338	1.8339	3.2718	4.7791	3.3062	2.1519
Cash Flow	1,018	0.0863	0.1362	0.1851	0.1500	0.1522
Tangibility	1,264	0.1339	0.3529	0.5989	0.4611	0.4203
	High O&G Exposure					
	N	Q1	Median	Q3	Mean	Std. Dev.
Size	5,115	6.5671	7.5376	8.6334	7.6158	1.5024
Tobin's Q	3,735	1.0939	1.3542	1.8497	1.6564	1.0089
Leverage	4,763	0.2611	0.4156	0.5870	0.4495	0.3183
Market-to-Book Ratio	4,090	0.5429	1.4884	3.2773	2.8796	17.7412
Investment Growth	4,414	0.0538	0.3876	0.6348	0.0540	0.9809
Investment	4,880	1.9311	3.2139	4.5520	3.2086	2.0509
Cash Flow	3,673	0.0918	0.1346	0.1956	0.1564	0.1862
Tangibility	4,592	0.1330	0.4403	0.8494	0.5131	0.4318

Notes: This table compares characteristics of firms with high CLO O&G exposure to firms with low CLO O&G exposure, before the shock. CLOs with above-median O&G exposure have *high* O&G exposure while CLOs with below median O&G exposure have *low* O&G exposure. The characteristics of interest are: size, Tobin's Q, leverage, marke-to-book ratio, investment growth, investment, cash flow, and tangibility. The number of observations, first quartile, median, third quartile, mean, and standard deviation associated with each variable are in Columns 2-7, respectively.

Table C.3: CLO Selection by Covariance of Oil Price and Firm Profitability

	$\mathbb{1}_{\text{High CLO O\&G Share}}$				
	(1)	(2)	(3)	(4)	(5)
Covariance(Oil Price, Firm Profitability)	0.7980	-0.7324	-3.2345	0.8194	0.7756
	(9.0995)	(4.1633)	(4.6340)	(1.1214)	(0.8615)
Constant	0.7734***				
	(0.0244)				
CLO Controls			✓		✓
Issuer Controls				✓	✓
Manager-Arranger-Trustee FE				✓	✓
Rating-Industry FE			✓		✓
Manager FE		✓			
Year FE		✓	✓	✓	
Month-Year FE					✓
N	5,700	5,700	5,700	5,700	5,700
R^2	0.0000	0.3450	0.2381	0.8572	0.9234

Standard errors are two-way clustered by CLO and issuer in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between the covariance of firm profitability and oil price, and, an indicator of whether the CLO portfolio that holds firm f has a high share of O&G before the shock occurs. CLOs with above-median O&G exposure have *High* O&G exposure. The baseline regression specification takes the form: $\mathbb{1}_{(f \in c \text{ with high O\&G exposure})c,f} = \alpha + \beta(\text{Covariance(Oil Price, Profitability)})_f + \gamma_0 X_c + \gamma_1 Z_f + \alpha_{m,y} + \epsilon_{c,f}$ where $\mathbb{1}_{(f \in c \text{ with high O\&G exposure})c,f}$ indicates whether firm f is held in a CLO c with high O&G exposure, f denotes the portfolio firm ($f \in c$), t denotes the time – m and y denote the month and year respectively, X is a vector of CLO controls and Z is a vector of issuer controls. CLO controls include size, and, CCC-share and defaulted-share (Columns 3, 5). Issuer controls include size, tangibility, leverage, net worth, and market-to-book ratio (Columns 4-5). Standard errors are two-way clustered by CLO and issuer.

Table C.4: Interest Diversion Violation and O&G Exposure

	$\mathbb{1}_{Fail}$					
	(1)	(2)	(3)	(4)	(5)	(6)
O&G Share × Post	3.1017**	4.1211***	4.7000***	4.5095***	3.8504**	3.9075**
	(1.4811)	(1.4586)	(1.5690)	(1.5765)	(1.6956)	(1.7069)
O&G Share	-4.7686***	-4.5576**	-6.0045***	-5.0029***		
	(1.4938)	(1.6908)	(1.5809)	(1.7037)		
Post	0.1817**	0.0282			0.0185	
	(0.0694)	(0.0629)			(0.0696)	
CLO Controls		✓	✓	✓		
CLO FE					✓	✓
Manager FE	✓	✓	✓	✓		
Year FE		✓			✓	
Month-Year FE			✓	✓		✓
N	1,955	1,955	1,955	1,953	1,955	1,955
R^2	0.2334	0.2682	0.3137	0.3194	0.4355	0.4591

Standard errors are two-way clustered by CLO and month-year in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between CLO O&G exposure and the likelihood that a CLO violates the ID covenant for the first time in at least six months ($\mathbb{1}_{Fail}$) before the shock occurs. The baseline regression specification takes the form $Y_{c,t} = \beta_0 + \beta_1(\text{CLO O\&G Exposure})_c + \beta_2(\text{Oil Shock})_t + \beta_3(\text{CLO O\&G Exposure}_c \times \text{Oil Shock}_t) + \gamma_0' X_c + \epsilon_{c,t}$ where $Y_{c,t}$ is the distance to the Interest Diversion constraint ($ln(\frac{\text{Current Performance})}{\text{Current Threshold}})$ of CLO c at time t, and X denotes the vector of controls, consisting of current CLO age (Columns 2-4) and CLO size (Columns 3-4), and CCC-share and defaulted-share (Column 4). CLO O&G Exposure$_c$ is the O&G share of CLO c before the shock occurs, while Oil Shock$_t$ is an indicator variable that takes a value of 1 if the O&G price plunge has occurred, and 0 otherwise. Standard errors are two-way clustered by CLO and month-year

Table C.5: CLO-Level Trading Effects

	Transaction Amount ($ mn)					
	(1)	(2)	(3)	(4)	(5)	(6)
O&G Share × Post	-23.0196***	-22.7798***	-23.8230***	-28.1996***	-27.1063***	-43.5340***
	(5.1064)	(5.0771)	(4.9531)	(5.5716)	(6.1837)	(11.1474)
O&G Share	13.8889***	13.8734***	15.6038***	25.1883***	0.0000	0.0000
	(4.4329)	(4.3905)	(4.4970)	(5.6394)		
Post	0.1636	0.3658**			0.4181**	
	(0.1650)	(0.1668)			(0.1987)	
Manager FE			✓			
Rating-Industry FE				✓		
CLO-Issuer FE						✓
Year FE		✓			✓	
Month-Year FE			✓	✓		✓
N	55,203	55,203	55,203	50,766	55,203	55,203
R^2	0.0119	0.0140	0.0441	0.0420	0.0648	0.4329

Standard errors are two-way clustered by CLO-issuer and month-year in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between firm O&G exposure and net transaction amount for non-O&G firms. The baseline regression specification takes the form $Y_{c,f,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \gamma_0 X_c + \gamma_0 Z_f + \alpha_{c,f} + \alpha_{m,y} + \epsilon_{c,f,t}$ where $Y_{c,f,t}$ is the net transaction amount of firm f by CLO c at time t ($f \in$ CLO c), X is a vector of CLO controls including manager, m, y denote the month and year respectively, and Z is a vector of firm controls including rating and industry. Firm O&G Exposure$_f$ measures the weighted average of O&G share of firm f across all CLOs before the shock occurs, while Oil Shock$_t$ is an indicator variable that takes a value of 1 if the O&G price plunge has occurred, and 0 otherwise. Standard errors are two-way clustered by CLO × issuer and month-year.

Table C.6: Issuer-Level Trading Effects

	Transaction Amount ($ mn)				
	(1)	(2)	(3)	(4)	(5)
O&G Share × Post	-58.1887*	-57.8606*	-102.0939**	-81.5002*	-89.1884*
	(32.4655)	(32.3796)	(37.5455)	(45.6667)	(46.1777)
O&G Share	30.5873	30.4665	82.2324**		
	(24.7595)	(24.6332)	(32.9503)		
Post	1.1431	0.7313		1.2290	
	(1.0167)	(1.0651)		(1.4482)	
Issuer FE				✓	✓
Rating-Industry FE			✓		
Year FE		✓		✓	
Month-Year FE			✓		✓
N	12,464	12,464	10,813	12,322	12,322
R^2	0.0004	0.0005	0.0336	0.0743	0.0818

Standard errors are two-way clustered by issuer and month-year in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between firm O&G exposure and net transaction amount for non-O&G firms. The baseline regression specification takes the form $Y_{f,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \gamma_0 Z_f + \alpha_f + \alpha_{m,y} + \epsilon_{f,t}$ where $Y_{c,f,t}$ is the net transaction amount of firm f across all CLOs c at time t ($f \in$ CLO c), m, y denote the month and year respectively, and Z is a vector of firm controls including rating and industry. Firm O&G Exposure$_f$ measures the weighted average of O&G share of firm f across all CLOs before the shock occurs, while Oil Shock$_t$ is an indicator variable that takes a value of 1 if the O&G price plunge has occurred, and 0 otherwise. Standard errors are two-way clustered by issuer and month-year.

Table C.7: Issuer-Level Effects by Transaction Type

	Transaction Amount ($ mn)					
	Purchases			Sales		
	(1)	(2)	(3)	(4)	(5)	(6)
O&G Share × Post	9.9950	50.1559	23.7551	139.0308***	186.7392***	164.0521***
	(73.5180)	(86.3225)	(82.7701)	(45.1156)	(54.3656)	(49.9189)
O&G Share	-152.0746**			-239.4250***		
	(69.8333)			(53.1694)		
Post		-3.4810			-6.3194***	
		(2.9189)			(2.0273)	
Rating-Industry FE	✓			✓		
Issuer FE		✓	✓		✓	✓
Year FE		✓			✓	
Month-Year FE	✓		✓	✓		✓
N	8,384	9,418	9,418	7,911	8,875	8,875
R^2	0.0606	0.1213	0.1365	0.0920	0.1723	0.1955

Standard errors are two-way clustered by issuer and month-year in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between firm O&G exposure and total selling amount for non-O&G firms. The baseline regression specification takes the form $Y_{f,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \gamma_0 Z_f + \alpha_f + \alpha_{m,y} + \epsilon_{f,t}$ where $Y_{c,f,t}$ is the total selling amount of firm f across all CLOs c at time t ($f \in$ CLO c), m, y denote the month and year respectively, and Z is a vector of firm controls including rating and industry. Firm O&G Exposure$_f$ measures the weighted average of O&G share of firm f across all CLOs before the shock occurs, while Oil Shock$_t$ is an indicator variable that takes a value of 1 if the O&G price plunge has occurred, and 0 otherwise. Standard errors are two-way clustered by issuer and month-year.

Table C.8: Natural Log of Secondary Loan Price and O&G Exposure

	ln(Transaction Price per $100 par)					
	(1)	(2)	(3)	(4)	(5)	(6)
O&G Share × Post	-2.5372***	-2.5195***	-2.3232***	-1.5368**	-0.9656**	-0.8084*
	(0.9794)	(0.9757)	(0.8356)	(0.5983)	(0.4574)	(0.4600)
O&G Share	2.7005***	2.6803***	2.3369***	0.3129		
	(0.9310)	(0.9275)	(0.7874)	(0.5566)		
Post	0.0812***	0.0766***			0.0265*	
	(0.0268)	(0.0278)			(0.0136)	
Manager FE			✓			
Rating-Industry FE				✓		
Issuer-Loan Type FE					✓	✓
Year FE		✓			✓	
Month-Year FE			✓	✓		✓
N	57,593	57,593	57,587	52,583	57,593	57,593
R^2	0.0099	0.0100	0.0701	0.3958	0.5894	0.5958

Standard errors are two-way clustered by CLO-issuer and trade date in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between firm O&G exposure and secondary loan price for non-O&G firms. The baseline regression specification takes the form $Y_{i,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \gamma_0 X_c + \gamma_0 Z_f + \alpha_{f,l} + \alpha_{m,y} + \epsilon_{i,t}$ where $Y_{i,t}$ is the natural logarithm of secondary loan price of loan i at time t issued by firm f ($i \in f \in$ CLO c), l denotes the loan-type, X is a vector of CLO controls including manager, m, y denote the month and year respectively, and Z is a vector of firm controls including rating and industry. Firm O&G Exposure$_f$ measures the weighted average of O&G share of firm f across all CLOs before the shock occurs, while Oil Shock$_t$ is an indicator variable that takes a value of 1 if the O&G price plunge has occurred, and 0 otherwise. Standard errors are two-way clustered by CLO × issuer and trade date.

Table C.9: Primary Institutional Loan Maturity and O&G Exposure

	Maturity (Months)				
	(1)	(2)	(3)	(4)	(5)
O&G Share × Post	-402.9248**	-401.7083**	-405.7873**	-409.4155*	-460.2031**
	(185.9240)	(186.8647)	(187.4312)	(228.5919)	(222.3893)
Post	11.5017*	13.7653*	14.3364*	13.6066	
	(5.8430)	(7.5244)	(7.6126)	(8.4188)	
Issuer FE	✓	✓	✓	✓	✓
Secured FE		✓	✓	✓	✓
Purpose FE				✓	✓
Distribution Method FE				✓	✓
Seniority FE			✓	✓	✓
Loan Type FE			✓	✓	✓
Country of Syndication FE				✓	✓
Year FE		✓	✓	✓	
Month-Year FE					✓
N	582	582	582	582	582
R^2	0.5993	0.6008	0.6374	0.6895	0.7240

Standard errors are two-way clustered by issuer and month-year in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between firm O&G exposure and primary loan maturity for non-O&G firms. The baseline regression specification takes the form $Y_{i,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \gamma_0 X_i + \alpha_{m,y} + \alpha_f + \epsilon_{i,t}$ where $Y_{i,t}$ is the Maturity (months) loan spread of loan i at time t issued by firm f ($i \in f \in$ CLO c), and X is the vector of non-time varying controls associated with loan i including secured status, purpose, distribution method, seniority, loan type, and country of syndication, and m, y denote the month and year respectively. Firm O&G Exposure$_f$ measures the weighted average of O&G share of firm f across all CLOs before the shock occurs, while Oil Shock$_t$ is an indicator variable that takes a value of 1 if the O&G price plunge has occurred, and 0 otherwise. Standard errors are two-way clustered by issuer and month-year.

Table C.10: Primary Institutional Loan Amount and O&G Exposure

	ln(Loan Amount)				
	(1)	(2)	(3)	(4)	(5)
O&G Share × Post	-6.5846	-6.3589	-7.6556	-4.6737	-5.8864
	(7.5029)	(7.4790)	(7.9242)	(6.5940)	(7.9274)
Post	0.0032	0.1184	0.1482	0.1400	
	(0.2570)	(0.3110)	(0.3321)	(0.2718)	
Maturity				0.0196***	0.0205***
				(0.0033)	(0.0032)
Issuer FE	✓	✓	✓	✓	✓
Secured FE		✓	✓	✓	✓
Purpose FE				✓	✓
Distribution Method FE				✓	✓
Seniority FE			✓	✓	✓
Loan Type FE			✓	✓	✓
Country of Syndication FE				✓	✓
Year FE		✓	✓	✓	
Month-Year FE					✓
N	582	582	582	582	582
R^2	0.6228	0.6243	0.6653	0.7341	0.7514

Standard errors are two-way clustered by issuer and month-year in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between firm O&G exposure and primary institutional loan amount for non-O&G firms. The baseline regression specification takes the form $Y_{i,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \beta_4\text{Maturity}_{i,t} + \gamma_0 X_i + \alpha_{m,y} + \alpha_f + \epsilon_{i,t}$ where $Y_{i,t}$ is the ln(loan amount) of loan i at time t issued by firm f ($i \in f \in$ CLO c), and X is the vector of non-time varying controls associated with loan i including secured status, purpose, distribution method, seniority, loan type, and country of syndication, and m, y denote the month and year respectively. Firm O&G Exposure$_f$ measures the weighted average of O&G share of firm f across all CLOs before the shock occurs, while Oil Shock$_t$ is an indicator variable that takes a value of 1 if the O&G price plunge has occurred, and 0 otherwise. Standard errors are two-way clustered by CLO×issuer and trade date.

Table C.11: Bond Credit Spread and O&G Exposure

	Bond Credit Spread				
	(1)	(2)	(3)	(4)	(5)
O&G Share × Post	35.5512*	35.4183*	36.1588*	27.9393*	27.6554*
	(18.5585)	(18.4820)	(18.7908)	(14.4879)	(14.4997)
Post	-0.4466	-0.4590	-0.4721	-0.2478	
	(0.4029)	(0.4669)	(0.4621)	(0.3314)	
Time to Maturity				0.0450***	0.0459***
				(0.0099)	(0.0101)
Issuer FE	✓	✓	✓	✓	✓
Bond Type FE	✓	✓	✓	✓	✓
Security Level FE			✓	✓	✓
Rating FE				✓	✓
IG FE				✓	✓
Defaulted FE				✓	✓
Year FE		✓	✓	✓	
Month-Year FE					✓
N	9,876	9,876	9,876	9,876	9,876
R^2	0.5213	0.5298	0.5653	0.6904	0.6971

Standard errors are two-way clustered by issuer and month-year in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between firm O&G exposure and bond credit spread for non-O&G firms. Bond credit spread is measured relative to a treasury with corresponding maturity. The baseline regression specification takes the form $Y_{i,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \beta_4\text{Time to Maturity} + \gamma_0 X_{i,t} + \alpha_{m,y} + \alpha_f + \epsilon_{i,t}$ where $Y_{i,t}$ is the bond credit spread (%) of bond i at time t issued by firm f ($i \in f \in$ CLO c), and X is the vector of controls associated with bond i including bond type, security level, rating, investment-grade indicator, and defaulted status, and m, y denote the month and year respectively. Firm O&G Exposure$_f$ measures the weighted average of O&G share of firm f across all CLOs before the shock occurs, while Oil Shock$_t$ is an indicator variable that takes a value of 1 if the O&G price plunge has occurred, and 0 otherwise. Standard errors are two-way clustered by issuer and month-year.

Table C.12: Bond Liquidity and O&G Exposure

	Bond Liquidity				
	(1)	(2)	(3)	(4)	(5)
O&G Share × Post	0.0208**	0.0208**	0.0226**	0.0241**	0.0241**
	(0.0101)	(0.0100)	(0.0105)	(0.0094)	(0.0094)
Post	-0.0006**	-0.0004	-0.0005	-0.0004	
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	
Time to Maturity				0.0002***	0.0002***
				(0.0000)	(0.0000)
Issuer FE	✓	✓	✓	✓	✓
Bond Type FE	✓	✓	✓	✓	✓
Security Level FE			✓	✓	✓
Rating FE				✓	✓
IG FE				✓	✓
Defaulted FE				✓	✓
Year FE		✓	✓	✓	
Month-Year FE					✓
N	9,955	9,955	9,955	9,955	9,955
R^2	0.2739	0.2767	0.2876	0.3823	0.3887

Standard errors are two-way clustered by issuer and month-year in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between firm O&G exposure and bond liquidity for non-O&G firms. The baseline regression specification takes the form $Y_{i,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \beta_4\text{Time to Maturity}_{i,t} + \gamma_0 X_{i,t} + \alpha_{m,y} + \alpha_f + \epsilon_{i,t}$ where $Y_{i,t}$ is the bond liquidity (%) of bond i at time t issued by firm f ($i \in f \in$ CLO c), and X is the vector of controls associated with bond i including bond type, security level, rating, investment-grade indicator, and defaulted status, and m, y denote the month and year respectively. Bond liquidity is defined as the average bid-ask spread. Firm O&G Exposure$_f$ measures the weighted average of O&G share of firm f across all CLOs before the shock occurs, while Oil Shock$_t$ is an indicator variable that takes a value of 1 if the O&G price plunge has occurred, and 0 otherwise. Standard errors are two-way clustered by issuer and month-year.

Table C.13: Amihud Price-Impact Measure and O&G Exposure

	Amihud Price Impact					
	(1)	(2)	(3)	(4)	(5)	(6)
O&G Share × Post	40159.0***	40370.0***	39737.0***	23649.7***	18029.5**	18744.8**
	(9463.0588)	(9548.5090)	(9263.3140)	(8804.5855)	(8663.7959)	(8942.4308)
O&G Share	-36115.7***	-36395.7***	-36423.7***	-15012.9**		
	(8107.2503)	(8204.1772)	(7898.3872)	(6008.8737)		
Post	-1129.0***	-1269.8***			-529.4*	
	(277.2425)	(304.2915)			(279.4891)	
Manager FE			✓			
Rating-Industry FE				✓		
Issuer-Loan Type FE					✓	✓
Year FE		✓			✓	
Month-Year FE			✓	✓		✓
N	128,723	128,723	128,720	117,242	128,723	128,723
R^2	0.0025	0.0027	0.0215	0.1385	0.2532	0.2564

Standard errors are two-way clustered by CLO-issuer and trade date in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between firm O&G exposure and the Amihud Price Impact measure for non-O&G firms. The baseline regression specification takes the form $Y_{i,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \gamma_0 X_c + \gamma_0 Z_f + \alpha_{f,l} + \alpha_{m,y} + \epsilon_{i,t}$ where $Y_{i,t}$ is the Amihud Price Impact measure of loan i at time t issued by firm f ($i \in f \in$ CLO c), l denotes the loan-type, X is a vector of CLO controls including manager, m, y denote the month and year respectively, and Z is a vector of firm controls including rating and industry. Firm O&G Exposure$_f$ measures the weighted average of O&G share of firm f across all CLOs before the shock occurs, while Oil Shock$_t$ is an indicator variable that takes a value of 1 if the O&G price plunge has occurred, and 0 otherwise. The Amihud Price Impact measure is the ratio of the absolute value of the loan discount (bps) to the net sale amount in millions (negative for purchases). Standard errors are two-way clustered by CLO × issuer and trade date. Standard errors are two-way clustered by CLO × issuer and month-year.

Table C.14: Investment in the Cross-Section and O&G Exposure

	Investment							
	Bond Access		**Size**		**Age**		**Loan Refinancing**	
	Access	No Access	Large	Small	Old	Young	Early Refi	Late Refi
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
O&G Share × Post	0.0642	-1.0760***	-0.1154	-0.8878**	-0.3612	-0.7083*	-0.8722	-1.2152**
	(0.1926)	(0.4107)	(0.2320)	(0.4109)	(0.2950)	(0.4240)	(0.6195)	(0.5392)
Issuer FE	✓	✓	✓	✓	✓	✓	✓	✓
Industry FE	✓	✓	✓	✓	✓	✓	✓	✓
Quarter-Year FE	✓	✓	✓	✓	✓	✓	✓	✓
N	1,661	1,320	1,710	1,271	1,037	957	452	697
R^2	0.1645	0.1961	0.2050	0.1547	0.1553	0.1694	0.1854	0.2561

Standard errors are clustered by issuer in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between firm O&G exposure and investment for non-O&G firms by bond access, size, age, and loan refinancing. The baseline regression specification takes the form $I_{ft} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \alpha_{q,y} + \alpha_f + \alpha_d + \epsilon_{f,t}$ where I_{ft} denotes investment of firm f at time t ($f \in$ CLO c), d denotes the industry, and q, y denote the month and year respectively. Firm O&G Exposure$_f$ measures the weighted average of O&G share of firm f across all CLOs before the shock occurs, while Oil Shock$_t$ is an indicator variable that takes a value of 1 if the O&G price plunge has occurred, and 0 otherwise. I present the results from this baseline regression for various sub-samples. In Columns 1 and 2, I segment firms based on access to the bond market; firms with access to the bond market are in Column 1 and firms without access are in Column 2. In Columns 3 and 4, I segment firms based on size; firms designated as small are in Column 3 and firms designated as large are in Column 4. In Columns 5 and 6, I segment firms based on age; firms designated as young are in Column 5 and firms designated as old are in Column 6. In Columns 7 and 8, I segment firms without access to the bond-market based on timing of loan refinancing; early refinancing firms (refi before median date) without access to the bond market are in Column 7 and late refinancing firms (refi after median date) without access to the bond market are in Column 8. Standard errors are clustered by issuer.

Table C.15: Triple-Difference: Constrained Firms and Investment

	Investment	
	(1)	(2)
No Access × O&G Share × Post	-1.1457**	
	(0.4486)	
Small × O&G Share × Post		-0.7708*
		(0.4662)
No Access × Post	0.0216	
	(0.0132)	
Small × Post		0.0205
		(0.0143)
O&G Share × Post	0.0651	-0.1128
	(0.1912)	(0.2294)
Issuer FE	✓	✓
Industry FE	✓	✓
Quarter-Year	✓	✓
N	2,981	2,981
R^2	0.1760	0.1744

Standard errors are clustered by issuer in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between firm O&G exposure and investment growth for non-O&G firms by bond access and size. The baseline regression specification takes the form $I_{ft} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \beta_4(\text{Constrained}_f \times \text{Oil Shock}_t) + \beta_5(\text{Constrained}_f \times \text{Oil Shock}_t \times \text{Firm O\&G Exposure}_f) + \beta_6\text{Constrained}_f + \beta_7(\text{Constrained}_f \times \text{Firm O\&G Exposure}_f) + \alpha_{q,y} + \alpha_f + \alpha_d + \epsilon_{f,t}$ where I_{ft} denotes investment of firm f at time t ($f \in$ CLO c), d denotes the industry, and q, y denote the month and year respectively. Firm O&G Exposure$_f$ measures the weighted average of O&G share of firm f across all CLOs before the shock occurs, while Oil Shock$_t$ is an indicator variable that takes a value of 1 if the O&G price plunge has occurred, and 0 otherwise. In Column 1, a firm is *constrained* if it does not have access to the corporate bond market. In Column 2, a firm is *constrained* if it is small. Standard errors are clustered by issuer.

Table C.16: Triple-Difference: Risky Firms and Firm Outcomes

	Secondary Loan Price	All-In-Spread Drawn	Investment
	(1)	(2)	(3)
Risky × O&G Share × Post	-270.7383***	1494.2151	-1.0638*
	(77.1026)	(2159.2770)	(0.5515)
Risky × Post	6.6826***	-31.0497	0.0237
	(2.1269)	(61.7280)	(0.0161)
O&G Share × Post	36.3184	1631.8741*	-0.2234
	(29.6142)	(923.1815)	(0.2210)
Issuer-Loan Type FE	✓		
Issuer FE		✓	✓
Primary Loan Controls		✓	
Firm Controls			✓
Month-Year FE	✓	✓	
Quarter-Year FE			✓
N	57,593	567	2,575
R^2	0.6042	0.9330	0.1924

Standard errors are clustered in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between firm riskiness, firm O&G exposure, and firm outcomes for non-O&G firms. The baseline regression specification takes the form $Y_{i,f,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \beta_4(\text{Defaulted}_f \times \text{Oil Shock}_t) + \beta_5(\text{Defaulted}_f \times \text{Oil Shock}_t \times \text{Firm O\&G Exposure}_f) + \beta_6\text{Defaulted}_f + \beta_7(\text{Defaulted}_f \times \text{Firm O\&G Exposure}_f) + \beta_7(\text{Maturity}_{i,t}) + \gamma_0 X_{i/f} + \alpha_{m/q,y} + \alpha_f + \epsilon_{i,t}$ where $Y_{i,f,t})$ denotes the secondary loan price in Column 1, all-in-spread drawn in Column 2, and investment in Column 3 for firm f at time t (loan $i \in f \in$ CLO c), I denotes the industry, and q, y denote the month and year respectively. X is the vector of non-time varying controls associated with loan i in column 2, including secured status, purpose, distribution method, seniority, loan type, and country of syndication. X is the vector of non-time varying controls associated with firm f in column 3, including industry and rating. $Maturity_{i,t}$ denotes the maturity of loan i at time t. Firm O&G Exposure$_f$ measures the weighted average of O&G share of firm f across all CLOs before the shock occurs, while Oil Shock$_t$ is an indicator variable that takes a value of 1 if the O&G price plunge has occurred, and 0 otherwise. A firm is *distressed* if it defaulted on a loan at some point in the sample. Standard errors are two-way clustered by CLO × issuer and month-year (Col. 1), issuer and month-year (Col. 2), and issuer (Col. 3) in parentheses.

Table C.17: Empirical Design in Levels after O&G Shock

	ID Covenant	Transaction Amount	Transaction Price	All-in-Spread Drawn
	(1)	(2)	(3)	(4)
O&G Share	-1.7481*	-13.9002***	-72.9413***	1719.9542**
	(0.9704)	(1.6991)	(26.0487)	(787.1099)
Manager, Arranger, Trustee FE	✓			
CLO-Rating-Industry FE		✓	✓	
Primary Loan Controls				✓
Month-Year FE	✓	✓	✓	✓
N	1,089	67,242	29,603	354
R^2	0.6335	0.5249	0.7421	0.4960

Standard errors are clustered by CLO in column 1, CLO-issuer and trade date in columns 2 and 3, and issuer in column 4.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between firm O&G exposure and total selling amount for non-O&G firms. The baseline regression specification takes the form $Y_{c,m} = \beta_0 + \beta_1(\text{CLO O\&G Exposure})_f + Z_f + \alpha_{m,y} + \epsilon_{f,t}$ in column 1 and $Y_{f,m} = \beta_0 + \beta_1(\text{CLO O\&G Exposure})_f + Z_{lf} + \alpha_{m,y} + \epsilon_{f,t}$ in columns 2 through 4. CLO O&G Exposure$_c$ is the O&G share of CLO c measured when the CLO is first reported in the sample. Firm O&G Exposure$_f$ measures the weighted average of O&G share of firm f across all CLOs before the shock occurs. Z_c is a vector of time-invariant controls associated with the CLO and Z_f is a vector of time-invariant controls associated with the loan l. In column 4, primary loan controls include maturity, loan purpose, distribution method, seniority, secured, loan type, and country of syndication. Standard errors are clustered by CLO in column 1, CLO-issuer and trade date in columns 2 and 3, and issuer in column 4. Standard errors are two-way clustered by issuer and month-year.

Table C.18: Instrumental Variable Regression

	Transaction Amount (Net Purchase)			
			2SLS	
	OLS	IV	Second Stage	First Stage
	(1)	(2)	(3)	(4)
CLO Constraint	-0.5142		143.7380***	
	(2.8580)		(34.4075)	
O&G Share × Post		-19.2033***		-0.1336***
		(4.0731)		(0.0173)
Issuer-Loan Type FE	✓	✓	✓	✓
Month-Year FE	✓	✓	✓	✓
N	126,146	126,146	126,146	126,164
R^2	0.0741	0.0748		0.6117
KP LM Statistic			58.1476***	
KP Wald F Statistic			59.9309	

Standard errors are two-way clustered by CLO-issuer and trade date in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table reports the results of regressing the transaction amount ($ mn) on the natural log of the distance to the ID threshold. The 2SLS specification is of the form:

$$
\begin{aligned}
Y_{i,t} =& \beta_0 + \beta_1(\text{CLO Constraint})_{f,t} + \alpha_{f,l} + \alpha_{m,y} + \epsilon_{i,t} \\
\text{CLO Constraint}_{f,t} =& \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t \\
&+ \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \alpha_{f,l} + \alpha_{m,y} + \epsilon_{f,t}
\end{aligned}
$$

where $Y_{i,t}$ is the transaction amount (net purchase in $ mn) of loan i at time t issued by firm f ($i \in f \in$ CLO c), l denotes the loan-type, and m, y denote the month and year respectively. CLO Constraint$_{f,t}$ is a measure of firm exposure to CLO constraint. It is the weighted average of the distance to the ID threshold ($ln(\frac{\text{Current Performance}}{\text{Current Threshold}})$) across all CLOs c a firm f is held in at time t. Firm O&G Exposure$_f$ measures the weighted average of O&G share of firm f across all CLOs before the shock occurs, while Oil Shock$_t$ is an indicator variable that takes a value of 1 if the O&G price plunge has occurred, and 0 otherwise. Standard errors are two-way clustered by CLO × issuer and trade date.

Table C.19: Alternative Measures of Issuer Exposure to CLOs

	Equal Weights			Equal Weighting (Loan Frequency)			Value Weighting (Loan Frequency)			Value Weighting (Loan Amount)		
	Transaction Amount	Secondary Price	AISD	Transaction Amount	Secondary Price	AISD	Transaction Amount	Secondary Price	AISD	Transaction Amount	Secondary Price	AISD
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
O&G Share × Post	-20.3697***	-66.2332*	2051.6695***	-19.9165***	-82.5273**	2102.7887***	-14.6684***	-80.1203**	2024.8176***	-19.9284***	-82.6503**	2102.7887***
	(3.7280)	(34.1845)	(733.2065)	(3.8421)	(35.1134)	(737.3682)	(2.7987)	(34.4993)	(721.4302)	(3.8422)	(35.1149)	(737.3682)
Post	0.3700***	1.6175	-51.7958	0.3585***	2.0636**	-53.4040	0.2641***	2.0054*	-51.4677	0.3588***	2.0668**	-53.4040
	(0.1136)	(1.0083)	(32.3647)	(0.1163)	(1.0346)	(32.3613)	(0.0854)	(1.0237)	(31.5815)	(0.1163)	(1.0346)	(32.3613)
Issuer-Loan Type FE	✓	✓		✓	✓		✓	✓		✓	✓	
Issuer FE			✓			✓			✓			✓
Primary Loan Controls			✓			✓			✓			✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
N	129,132	57,593	567	129,132	57593	567	129,132	57,593	567	129,132	57,593	567
R^2	0.0758	0.5962	0.9215	0.0758	0.5963	0.9217	0.0758	0.5963	0.9215	0.0758	0.5963	0.9217

Standard errors are clustered by CLO×Issuer and trade date in Columns 1, 2, 4, 5, 7, 8, 10, 11 and by issuer and month-year in Columns 3, 6, 9, 12

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between firm O&G exposure and transaction amount (Columns 1, 4, 7, 10) secondary loan price (Columns 2, 5, 8, 11) and all-in-spread drawn (Columns 3, 6, 9, 12) for non-O&G firms. The regression specification takes the form $Y_{i,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \alpha_{f,l} + \alpha_y + \epsilon_{i,t}$ where $Y_{i,t}$ is the transaction amount ($ mns) (Columns 1, 4, 7, 10) and secondary loan price (Columns 2, 5, 8, 11) of loan i at time t issued by firm f ($i \in f \in$ CLO c), l denotes the loan-type, and y denotes the year in Columns 1, 3, 5, and 7. The regression specification takes the form $Y_{i,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \beta_4\text{Maturity}_{i,t} + \gamma_0 X_i + \alpha_y + \alpha_f + \epsilon_{i,t}$ where $Y_{i,t}$ is the all-in-spread drawn of loan i at time t, issued by firm f ($i \in f \in$ CLO c), and X is the vector of non-time varying controls associated with loan i including secured status, purpose, distribution method, seniority, loan type, and country of syndication, and y denotes the year respectively in Columns 3, 6, 9, and 12. In Columns 1-3, Firm O&G Exposure$_f$ measure the equal-weighted average of O&G share by issuer amount of firm f across all CLOs before the shock occurs. In Columns 4-6, Firm O&G Exposure$_f$ measure the equal-weighted average of O&G share by loan frequency of firm f across all CLOs before the shock occurs. In Columns 7-9, Firm O&G Exposure$_f$ measure the value-weighted average of O&G share by loan frequency of firm f across all CLOs before the shock occurs. In Columns 10-12, Firm O&G Exposure$_f$ measure the value-weighted average of O&G share by loan amount of firm f across all CLOs before the shock occurs. Oil Shock$_t$ is an indicator variable that takes a value of 1 if the O&G price plunge has occurred, and 0 otherwise. Standard errors are clustered by CLO×Issuer and trade date in Columns 1, 2, 4, 5, 7, 8, 10, 11 and by issuer and month-year in Columns 3, 6, 9, 12.

Table C.20: Aggregate Trading Effects

	Δln(Holdings)		
	(1)	(2)	(3)
O&G Share × Post	-2.7432*	-2.7835*	-2.9752*
	(1.5504)	(1.5483)	(1.5261)
Post	0.0429	0.0809	
	(0.0399)	(0.0603)	
Firm FE	✓	✓	✓
Year FE		✓	
Month-Year FE			✓
N	26,388	26,388	26,388
R^2	0.0380	0.0390	0.1081

Standard errors are two-way clustered by issuer and month-year in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between firm O&G exposure and total selling amount for non-O&G firms. The baseline regression specification takes the form $\Delta log(H_{f,t}) = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \alpha_f + \alpha_{m,y} + \epsilon_{f,t}$ where $\Delta log(H_{f,t})$ is the total change in CLO holdings of firm f at time t, m, y denote the month and year respectively. Firm O&G Exposure$_f$ measures the weighted average of O&G share of firm f across all CLOs before the shock occurs, while Oil Shock$_t$ is an indicator variable that takes a value of 1 if the O&G price plunge has occurred, and 0 otherwise. Standard errors are two-way clustered by issuer and month-year.

Table C.21: Aggregate Trading Effects by Firm Vulnerability

	Δln(Holdings)			
	Low O&G Share		**High O&G Share**	
	Low Dependence	High Dependence	Low Dependence	High Dependence
	(1)	(2)	(3)	(4)
O&G Share × Post	-0.2466	-0.0066	-0.8452	-5.5798***
	(0.9456)	(1.2320)	(2.0623)	(0.9398)
Issuer FE	✓	✓	✓	✓
Quarter-Year FE	✓	✓	✓	✓
N	5,864	6,934	2,643	1,949
R^2	0.1059	0.1426	0.1698	0.2075

Standard errors are two-way clustered by issuer and month-year in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between firm O&G exposure and total selling amount for non-O&G firms for four bins of firms: firms with low exposure to O&G and low dependence on CLOs (Column 1), firms with low exposure to O&G and high dependence on CLOs (Column 2), firms with high exposure to O&G and low dependence on CLOs (Column 3), and firms with high exposure to O&G and high dependence on CLOs (Column 4). A firm has low (high) exposure to O&G if its exposure is below (above) the 75^{th} percentile. A firm has low (high) dependence on CLOs if its share of total debt held by CLOs is below (above) the median. Total debt is measured before 2013, and is computed by cumulating DealScan loan data. The baseline regression specification takes the form $Y_{f,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \alpha_f + \alpha_{m,y} + \epsilon_{f,t}$ where $Y_{c,f,t}$ is the total selling amount of firm f across all CLOs c at time t ($f \in$ CLO c), m, y denote the month and year respectively. Firm O&G Exposure$_f$ measures the weighted average of O&G share of firm f across all CLOs before the shock occurs, while Oil Shock$_t$ is an indicator variable that takes a value of 1 if the O&G price plunge has occurred, and 0 otherwise. Standard errors are two-way clustered by issuer and month-year.

Table C.22: Falsification Test: Primary Non-Institutional Loan Spread and O&G Exposure

	All-in-Spread Drawn				
	(1)	(2)	(3)	(4)	(5)
O&G Share × Post	137.8844	132.0103	246.4978	197.1342	-142.2520
	(266.5643)	(273.1646)	(263.7165)	(194.2592)	(223.3746)
Post	-27.0198**	-15.0067	-18.1787	-14.3602	
	(11.5126)	(19.1854)	(17.3523)	(17.5971)	
Maturity				-1.9344**	-1.5368**
				(0.7311)	(0.6951)
Issuer FE	✓	✓	✓	✓	✓
Secured FE		✓	✓	✓	✓
Purpose FE				✓	✓
Distribution Method FE				✓	✓
Seniority FE			✓	✓	✓
Loan Type FE			✓	✓	✓
Country of Syndication FE				✓	✓
Year FE		✓	✓	✓	
Month-Year FE					✓
N	432	432	432	432	432
R^2	0.8486	0.8503	0.8763	0.8912	0.9141

Standard errors are two-way clustered by issuer and month-year in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between firm O&G exposure and primary non-institutional loan spread for non-O&G firms. The baseline regression specification takes the form $Y_{i,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \beta_4\text{Maturity}_{i,t} + \gamma_0 X_i + \alpha_{m,y} + \alpha_f + \epsilon_{i,t}$ where $Y_{i,t}$ is the all-in-spread drawn of loan i at time t issued by firm f ($i \in f \in$ CLO c), and X is the vector of non-time varying controls associated with loan i including secured status, purpose, distribution method, seniority, loan type, and country of syndication, and m, y denote the month and year respectively. Firm O&G Exposure$_f$ measures the weighted average of O&G share of firm f across all CLOs before the shock occurs, while Oil Shock$_t$ is an indicator variable that takes a value of 1 if the O&G price plunge has occurred, and 0 otherwise. Standard errors are two-way clustered by issuer and month-year.

Table C.23: Falsification Test: Primary Revolving Credit Undrawn Spread and O&G Exposure

	All-in-Spread Undrawn				
	(1)	(2)	(3)	(4)	(5)
O&G Share × Post	9.1183	13.5492	20.5996	1.7606	137.2510
	(33.7049)	(50.8815)	(48.1542)	(45.7783)	(89.8507)
Post	-3.2853**	-0.2432	-0.3888	0.4567	
	(1.3369)	(2.4524)	(2.4282)	(2.5537)	
Maturity				-0.1177	-0.1319
				(0.0748)	(0.1356)
Issuer FE	✓	✓	✓	✓	✓
Secured FE		✓	✓	✓	✓
Purpose FE				✓	✓
Distribution Method FE				✓	✓
Seniority FE			✓	✓	✓
Loan Type FE			✓	✓	✓
Country of Syndication FE				✓	✓
Year FE		✓	✓	✓	
Month-Year FE					✓
N	289	199	199	193	188
R^2	0.9339	0.9346	0.9359	0.9390	0.9617

Standard errors are two-way clustered by issuer and month-year in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between firm O&G exposure and primary undrawn spread associated with revolving credit facilities for non-O&G firms. The baseline regression specification takes the form $Y_{i,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \beta_4\text{Maturity}_{i,t} + \gamma_0 X_i + \alpha_{m,y} + \alpha_f + \epsilon_{i,t}$ where $Y_{i,t}$ is the all-in-spread undrawn of facility i at time t issued by firm f ($i \in f \in$ CLO c), and X is the vector of non-time varying controls associated with facility i including secured status, purpose, distribution method, seniority, loan type, and country of syndication, and m, y denote the month and year respectively. Firm O&G Exposure$_f$ measures the weighted average of O&G share of firm f across all CLOs before the shock occurs, while Oil Shock$_t$ is an indicator variable that takes a value of 1 if the O&G price plunge has occurred, and 0 otherwise. Standard errors are two-way clustered by issuer and month-year.

Table C.24: Secondary Loan Price and COVID-19 Exposure

Transaction Price (per $100 par)	(1) O&G	(2) Auto	(3) Retail	(4) Consumer Goods	(5) Transportation	(6) Cargo	(7) O&G and Auto	(8) Retail and Goods	(9) All (Col 1-6)
COVID-19 Share × Post	-91.0212***	-75.2506***	-142.4787***	-203.7944***	-84.1403***	-314.7237***	-167.9910***	-74.5372***	-69.2296***
	(20.0355)	(25.8422)	(10.3454)	(18.2773)	(18.2879)	(30.8661)	(10.3390)	(13.4084)	(6.8968)
Issuer-Loan Type FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Month-Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
N	134,845	134,712	134,289	138,503	138,429	136,564	134,193	130,989	121,379
R^2	0.7832	0.7896	0.7904	0.7933	0.7928	0.7926	0.7905	0.7791	0.7740

Standard errors are clustered by CLO in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between firm COVID-19 exposure and secondary loan price for non-COVID-19 exposed firms. COVID-19 exposure or share is represented by a firm's exposure to an industry, as specified by the column header. The baseline regression specification takes the form $Y_{i,t} = \beta_0 + \beta_1(\text{Firm COVID-19 Exposure})_f + \beta_2(\text{COVID-19 Shock})_t + \beta_3(\text{Firm COVID-19 Exposure}_f \times \text{COVID-19 Shock}_t) + \alpha_{f,l} + \alpha_{m,y} + \epsilon_{i,t}$ where $Y_{i,t}$ is the secondary loan price of loan i at time t issued by firm f ($i \in f \in$ CLO c), l denotes the loan-type, and m, y denote the month and year respectively. Firm COVID-19 Exposure$_f$ measures the weighted average of the vulnerable share of f across all CLOs before the shock occurs, while COVID-19 Shock$_t$ is an indicator variable that takes a value of 1 after the onset of the pandemic, and 0 otherwise. The vulnerable share is the share of O&G in Column 1, Automobiles in Column 2, Retail in Column 3, Durable Consumer Goods in Column 4, Transportation: Consumers in Column 5, Transportation: Cargo in Column 6, summation of O&G and Automobiles in Column 7, summation of Retail and Consumer Goods in Column 8, and summation of all vulnerable industries: O&G, Automobiles, Retail, Consumer Goods, Transportation: Consumers, and Transportation: Cargo in Column 9. Standard errors are clustered by CLO.

Table C.25: Distance to Interest Diversion Covenant and COVID-19 Exposure

	Distance to ID Threshold					
	(1)	(2)	(3)	(4)	(5)	(6)
COVID-19 Share × Post	-0.0761***	-0.0788***	-0.0789***	-0.0803***	-0.0959***	-0.0953***
	(0.0239)	(0.0236)	(0.0235)	(0.0222)	(0.0209)	(0.0214)
COVID-19 Share	-0.1970***	-0.1004*	-0.1003*	-0.0113		
	(0.0511)	(0.0505)	(0.0487)	(0.0500)		
Post	-0.0075**	-0.0073**			-0.0052*	
	(0.0027)	(0.0027)			(0.0024)	
CLO Controls		✓	✓	✓		
CLO FE					✓	✓
Manager FE	✓	✓	✓	✓		
Year FE		✓			✓	
Month-Year FE			✓	✓		✓
N	4,945	4,945	4,945	4,945	4,945	4,945
R^2	0.6051	0.6561	0.7294	0.7724	0.8197	0.8932

Standard errors are two-way clustered by CLO and month-year in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between CLO COVID-19 exposure and distance to the Interest Diversion covenant. The baseline regression specification takes the form $Y_{c,t} = \beta_0 + \beta_1(\text{CLO COVID-19 Exposure})_c + \beta_2(\text{COVID-19 Shock})_t + \beta_3(\text{CLO COVID-19 Exposure}_c \times \text{COVID-19 Shock}_t) + \gamma_0' X_c + \epsilon_{c,t}$ where $Y_{c,t}$ is the distance to the Interest Diversion constraint ($ln(\frac{\text{Current Performance}}{\text{Current Threshold}})$) of CLO c at time t, and X denotes the vector of controls, consisting of current CLO age (Columns 2-4) and CLO size (Columns 3-4), and CCC-share and defaulted-share (Column 4). CLO COVID-19$_c$ is the share of CLO c in industries most vulnerable to COVID-19 – Oil & Gas; Automobiles; Retail; Durable Consumer Goods; Transportation: Cargo; Transportation: Consumer. COVID-19 Shock$_t$ is an indicator variable that takes a value of 1 after the onset of the pandemic, and 0 otherwise. Standard errors are two-way clustered by CLO and month-year.

Appendix D Data Construction of Firm-Level Variables

In this section, I describe the definition of variables.

1. *Debt Growth (long-term)* is defined as the log difference in long-term debt ($\delta ln(\texttt{dlttq})$).
2. *Real Sales Growth* is defined as the log difference in long-term debt ($\delta ln(\frac{\texttt{saleq}}{GDPDEF_{2009}})$), adjusted by a GDP deflator. The GDP deflator is `GDPDEF` series from FRED. All sales values are converted to 2009 dollar terms.
3. *Investment-Capital Ratio* is defined as the ratio of the change in capital stock to the lagged capital stock. For each firm, the initial value of capital stock is equal to the level of gross plant, property and equipment (`ppegt`). This is k_{it+1} for firm i. The evolution of k_{it+1} is computed using changes in net plant, property and equipment (`ppent`). Missing observations of net plant, property, and equipment are estimated, using linear interpolation of values right before and after the observation, only if there are not two or more consecutive missing observations. This definition is used in Ottonello and Winberry (2020).
4. *R&D Growth* is defined as the log difference in R&D expenditures ($\delta ln(\texttt{xrdq})$)
5. *Acquisitions* is the ratio of acquisitions expenditures (`acq`) to lagged total assets (`atq`).
6. *Cash Flow* is the ratio of the operating income before depreciation (`ebitda`) to lagged cash adjusted, total assets (`atq-cheq`).
7. *Employment Growth* is defined as the log difference in employment ($\delta ln(\texttt{emp})$)

Appendix E Alternative Strategies to Contractual Arbitrage

This section compares how the gains from contractual arbitrage compare to two alternate strategies of selling bad, risky assets (Appendix Section E.1) and selling non-distressed, high performing assets (Appendix Section E.2).

E.1 Selling Bad, Risky Assets

Let τ denote the stipulated portfolio share of CCC/Caa1 loans, A denote total CLO assets, and L denote total CLO liabilities. Moreover, for simplicity, assume the portfolio has two types of assets – bad, risky assets, and good, risky assets – the sum of which counts toward the CCC/Caa1 limit, τ. The share of bad, risky assets is denoted by b, whereas the share of good, risky assets is denoted by g. This distinction is important; regardless of whether the risky assets are good or bad, they are marked to the lowest market value of the CCC/Caa1 share of loans – the market value associated with the bad assets, β. The market value of the good assets is γ.

Suppose the CLO breaches its limit on CCC/Caa1 loans, i.e., $b+g>\tau$ and $g>\tau$. Selling the bad, risky assets, b from the portfolio at market price β may loosen the capital covenants, under the binding CCC/Caa1 limit. It can improve the capital covenants by $\frac{(g-\tau)(\gamma-\beta)A}{L}$. The new OC/ID ratio is:

$$OC/ID = \frac{(1-(b+g-\tau))A + b\beta A + (g-\tau)\gamma A}{L}. \tag{E.1}$$

Note that the improvement from selling bad, risky assets is less than the improvement from selling good, risky assets. That is:

$$\frac{(g-\tau)(\gamma-\beta)A}{L} < \frac{g(\gamma-\beta)A}{L} \tag{E.2}$$

Hence, sales of good, risky assets improve the covenant more than sales of bad risky assets.

E.2 Selling Good Assets above Book Value

This section considers how the contractual arbitrage hypothesis compares with an alternative strategy in which CLOs sell non-distressed loans at a higher market price than book price. Selling non-distressed loans will not have any effect on the covenant if non-distressed loans are sold at a market price that is equivalent to the accounted value. Selling non-distressed loans can alleviate the covenant if the market price is above the book value.

In the following, I compare the two strategies of selling CCC/Caa1 loans and non-distressed loans. The main takeaway is that selling loan which were bought cheaply can involve a great volume of transactions relative to buying defaulted loans.

Let τ denote the stipulated portfolio share of CCC/Caa1 loans, A denote total CLO assets, and L denote total CLO liabilities. Moreover, for simplicity, assume the portfolio has two types of assets – bad, risky assets, and good, risky assets – the sum of which counts toward the CCC/Caa1 limit, τ. The share of bad, risky assets is denoted by b, whereas the share of good, risky assets is denoted by g. This distinction is important; regardless of whether the risky assets are good or bad, they are marked to the lowest market value of the CCC/Caa1 share of loans – the market value associated with the bad assets, β. The market value of the good assets is γ.

Suppose the CLO breaches its limit on CCC/Caa1 loans, i.e., $b + g > \tau$. Consequently, the capital covenants will tighten and the OC/ID ratio is computed as follows.

$$OC/ID = \frac{(1 - (b + g - \tau))A + (b + g - \tau)\beta A}{L}. \tag{E.3}$$

Selling the good, risky assets, g from the portfolio at market price γ may loosen the capital covenants. The new OC/ID ratio is:

$$OC/ID_{CCC} = \frac{(1 - (b + g - \tau))A + (b - \tau)\beta A + g\gamma A}{L}. \tag{E.4}$$

Sales of good, risky assets can improve the capital covenants by

$$\frac{g(\gamma - \beta)A}{L} \tag{E.5}$$

In contrast, if the CLO sells a share μ of non-distressed loans at price $\hat{a}$ where $\hat{a}$ is greater than the book value of 1, the OC/ID ratio will be:

$$OC/ID_{Non-Distressed} = \frac{(1 - \mu - (b + g - \tau))A + (b + g - \tau)\beta + \hat{a}A}{L} \tag{E.6}$$

Sales of non-distressed assets can improve the capital covenants by

$$\frac{\mu(\hat{a} - 1)A}{L} \tag{E.7}$$

The manager will compare Equation E.5 to E.7.
Or:

$$g(\gamma - \beta) \text{ vs. } \mu(\hat{a} - 1)$$

If the CLO manager chooses between selling an equal volume of good CCC/Caa1 loans and non-distressed loans, they will compare:

$$(\gamma - \beta) \text{ vs. } (\hat{a} - 1)$$

Based on the evidence of Figure 6 and Appendix Figure C.8 to the summary statistics on the transaction price of all leveraged loans in CLOs reported in Table 1, it is likely that $\gamma - \beta > \hat{a} - 1$. That is, the difference between the accounted value and market value is likely larger for defaulted loans than non-defaulted loans. For there to be an equivalent impact from selling non-defaulted loans, managers may have to sell a larger share of non-defaulted loans relative to defaulted loans.

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