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AN ECONOMIC ANALYSIS OF COLLATERALIZED LOAN OBLIGATIONS

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To my mother, my greatest blessing in life

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My mother often reminds me to keep my feet firmly planted on the ground and my head in the skies. I take this message to heart, while recognizing that I have been incredibly fortunate to pursue this odyssey, standing on the shoulders of giants.

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ABSTRACT

This dissertation, consisting of three chapters, explores fire sale risk and contagion emanating from covenants intrinsic to optimal contracts in the Collateralized Loan Obligation (CLO) market. In the first chapter, I describe the rise of the market and the importance of covenants in the capital structure and design of CLOs. In the second chapter, I demonstrate how covenants may generate price pressure and fire sale risk around adverse credit events. In the third chapter, I explore the unintended consequences of covenants on innocent bystanders – firms with no direct exposure to the source of distress. Unearthing latent risks in the leveraged loan market is important for understanding novel sources of financial fragility and mechanisms of amplification of shocks.

CHAPTER 1
INTRODUCTION

This dissertation, consisting of three chapters, explores fire sale risk and contagion emanating from covenants intrinsic to optimal contracts in the Collateralized Loan Obligation (CLO) market. In the first chapter, I describe the rise of the market and the importance of covenants in the capital structure and design of CLOs. In the second chapter, I demonstrate how covenants may generate price pressure and fire sale risk around adverse credit events. In the third chapter, I explore the unintended consequences of covenants on innocent bystanders – firms with no direct exposure to the source of distress.

In the first essay, "The Anatomy of Collateralized Loan Obligations: On the Origins of Covenants and Contract Design," I provide a dissection of the CLO market and examine the significance of covenants in facilitating the provision of credit. Since the Great Financial Crisis of 2008, the leveraged loan market has witnessed unprecedented growth. CLOs play an increasingly central role in the provision of credit to corporations, holding as much as 75% of all new institutional leveraged loans, as reported in 2019. The rise of the leveraged loan and CLO markets have attracted the attention of central banks which have been concerned with both the growth of the market and the opaque nature of interconnections between intermediaries, leveraged borrowers, and investors. Despite their increasing importance, little is understood about CLO intermediaries. In this essay, I describe the agency frictions inherent in the CLO market, and discuss how optimal contracts are derived with covenants that curtail against such frictions. In addition, I describe the general macroeconomic milieu that has facilitated the rapid growth of the CLO market as well as recent changes that have developed.

In the second essay, "Financial Covenants and Fire Sales: Fractures in the Leveraged Loan Market," I study the externalities of Collateralized Loan Obligation (CLO) contracts on asset prices. The trading behavior of CLO managers generates price pressure for distressed loans around bankruptcy defaults, introducing fire sale risk. This behavior is driven mainly by covenant considerations. CLOs operating closest to their capital constraints experience significantly lower cumulative returns relative to unconstrained CLOs. Hence, this work demonstrates how CLO covenants interact with managerial incentives in the provision of credit.

In the third essay, "The Externalities of Fire Sales: Evidence from Collateralized Loan Obligations," I investigate how covenants, intrinsic to CLO indentures, provide a mechanism through which idiosyncratic shocks may be amplified, imposing negative externalities on other unrelated firms in CLO portfolios. I exploit cross-sectional variation in firm exposure to the Oil & Gas (O&G) industry through CLOs, as well as the timing of the O&G bust in 2014 to study how non-O&G firms in CLO portfolios are affected. When CLOs are subject to idiosyncratic shocks that push them closer to their covenant constraints, they fire-sell unrelated loans in the secondary loan market to alleviate these constraints. The ex-post, secondary market spread becomes the effective cost of capital for these innocent bystanders, as the expected rate of return across debt instruments is equalized in market equilibrium. Hence, the real costs of fire sales may exacerbate credit crunches through the contraction of credit. In response, firms make financial and real adjustments. Contrary to traditional fire sale settings, I find that CLOs fire sell loans issued by riskier firms for *contractual arbitrage* purposes – exploiting loopholes in the design of covenants. The sample period for this study is 2013-2015, a relatively benign macroeconomic period. However, the results suggest that the effects may be larger during times of stress, including the outset of the COVID-19 pandemic.

Collectively, these essays intend to provide an economic analysis and exposition of the structural aspects and dynamics of CLO intermediaries.

CHAPTER 2

THE ANATOMY OF COLLATERALIZED LOAN OBLIGATIONS: ON THE ORIGINS OF COVENANTS AND CONTRACT DESIGN

2.1 Introduction

Collateralized Loan Obligations (CLOs) have gained significance as a prominent source of credit for risky firms. CLOs purchased nearly 75% of all institutional leveraged loans that were syndicated in 2019, and held 25% of all outstanding leveraged loans in 2020 (Leveraged Commentary and Data (2019); International Monetary Fund (2020)). Analogous to how asset-backed securities facilitate financing of residential real estate and automobiles, CLOs facilitate credit to the segment of constrained corporate borrowers. Despite their growing ascendancy in the risky corporate credit market, it is not well understood how these intermediaries operate in financial markets. A distinctive feature of CLOs is that their operations and activities are governed by a legal indenture, mutually agreed upon by the CLO arranger, manager, and trustee, and executed between the CLO manager and trustee, a fiduciary representative of CLO investors. This is the first of three essays (Kundu (2021*a*); Kundu (2021*b*); Kundu (2021*c*)) to explore the importance of covenants in the capital structure and design of CLOs, provision of credit to constrained firms, as well as the inherent risks to financial stability and externalities to firms.

In the aftermath of the Great Financial Crisis of 2008, extensive financial reforms were implemented to reduce vulnerabilities in the financial system and enhance overall stability. Despite the purported objectives of these reforms, the underlying leveraged loan market has experienced burgeoning development as lending standards have degraded, risk retention regulation has eased, and the ultra low-interest rate environment has facilitated demand for riskier, floating-rate investment products. As banks have shifted from an "originate-to-retain" model to "originate-to-distribute," their direct exposures to credit risk have declined. Liquidity and credit risks have been diversified to willing investors – the largest group of which are CLOs. Substitution of direct bank exposures by shadow banking institutions has diversified risk, however, it has also contributed to the complexity of interconnections and opacity of shock transmission channels (International Monetary Fund (2020)).

Study of the CLO market merits further investigation given the increase in global corporate debt and increasing prevalence of the shadow banking sector in intermediating credit. The number of outstanding CLOs increased more than twofold from 2010 (Figure 5.2). Recent reports claim that global corporate debt totalled between $71-75 trillion in 2018. Of this total, the US held 20% or $15 trillion, representing an increase of 41% in total US corporate debt over a ten year time horizon (Chan et al. (2020)). Leveraged loans, a subset of total corporate debt issued by riskier firms, constitute 6-25% of US GDP. CLOs, in particular, have a sizeable exposure to leveraged loans as the largest purchasers of institutional leveraged loans.

CLOs operate as *special purpose vehicles* (SPVs), typically with a manager who makes active trading decisions. An SPV issues tranched asset-backed securities or notes to investors, and uses the proceeds to finance the purchase of the underlying portfolio of leveraged loans. From a balance sheet perspective, the assets of a CLO consist of leveraged loans. The liabilities are notes which are issued to investors. Principal and interest payments received from leveraged loans are used to pay out noteholders, according to a principal and interest waterfall.

In this paper, I focus on the role of covenants in securitization and capital structure of a CLO. In principle, the financial interests of a CLO manager are most aligned with the equity class; compensation consists of a fixed fee and a subordinated fee that is proportional to the residual interest available to the equity class. This presents the canonical agency problem of corporate finance (Jensen and Meckling (1976)). It is in the interest of CLO managers to shift investment decisions in favor of the equity class to maximize revenue at the expense of debtholders. From the perspective of debtholders, a manager's effort provision is inscrutable and verifying incoming cashflows can be costly. For this reason, legal indentures include clauses that place limits to managerial trades. In particular, managers must comply with quality and coverage covenants which are intended to be disciplining devices for managers to appropriately screen and monitor their investments. The presence of these covenants are designed to reduce the possibility of "tranche warfare." The optimal compensation contract is obtained when portfolio managers and investors optimize over a feasible set of contracts. The insights from this inquiry may be extrapolated to other securitization settings. The covenants inherent in CLO contracts are not unique to CLOs; they exist for other structured products with a similar purpose.

In addition to the feature and design of contracts, undergirding the market, I provide a comprehensive review of the CLO market including how CLOs differ from other institutions, participants, description of their lifetime, as well as the machinations and fundamental mechanics of CLOs. Moreover, I describe recent changes and developments in the markets, including emerging vulnerabilities.

The paper is organized as follows. Section 2.2 provides a comprehensive overview of fundamental aspects of the CLO market. Section 2.3 dicusses the role of covenants in CLO contracts. Section 2.4 describes post-crisis changes and development. Lastly, I conclude in Section 2.5.

2.2 A Review of the CLO Market

In this section, I expound on the fundamental aspects of the CLO market including, an exposition of how CLOs are distinct from other funds and a survey of the participants.

2.2.1 What is a CLO?

A (arbitrage) CLO operates as a *special purpose vehicle* which issues tranched asset-backed securities or notes, and uses the proceeds to finance the purchase of the underlying portfolio of leveraged loans[1]. Investors gain exposure to a diversified pool

1. Most CLOs are arbitrage CLOs. The objective of arbitrage CLOs is to maximize the excess spread between assets and liabilities. A small share of CLOs are *balance sheet CLOs*, which are designed for banks and other financial institutions to fund loans on their balance sheet. The purpose of balance sheet CLOs is to diversify credit risk through tranching. Balance sheet CLOs sell the securitized assets to an SPV, while retaining the equity tranche.

of senior secured loans through the purchase of notes. The liabilities of a CLO consist of multiple debt tranches, and an equity tranche. The higher-rated (lower risk) tranches pay out lower returns relative to lower-rated (higher risk) tranches. A manager ("CLO manager") operates a CLO by making active trading decisions, and using principal and interest received from the pool of underlying leveraged loans to pay out debtholders, according to a principal and interest waterfall. Debt tranches are paid a fixed spread above the three-month LIBOR rate based on seniority, while the equity tranche receives the remaining spread between assets and liabilities, after adjusting for fees and costs. This excess spread provides a form of credit enhancement, as it may be used towards the purchase of new collateral within the parameters laid in the indenture (described further below).

Figure 5.1 shows the flow of funds and distribution of loans and securities in the risky corporate credit market. Banks serve as arrangers in both the syndicate loan market, and CLO market. This exposes them to pipeline risk and CLO warehousing financing risks. In the syndicated loan market, risk is shared across the syndicate which consists of banks that structure, arrange, and underwrite the deal, as well as non-bank institutional investors, including mutual funds, hedge funds, and insurance companies. Banks typically retain amortizing Term Loans A and revolving credit facilities on their balance sheet, while selling non-amortizing Term Loans B+ to other banks or non-bank institutional investors. Moreover, banks may also directly extend credit to risky corporations in the form of term loans and revolving credit facilities, without syndication. Outside of a syndicate, non-bank institutions generally cannot extend revolving credit facilities, but may provide additional funding to risky corporations through the purchase of secondary loans or securities through OTC markets, as facilitated by banks.

What constitutes the underlying asset portfolio? The underlying portfolio of assets consists largely of risky syndicated bank loans known as "leveraged loans," while the remaining portfolio may consist of other financial securities, as tabulated in Table 6.4. CLO portfolios typically consist of Term Loans B and lower, as revolver and Term

Loans A are purchased directly by banks. The S&P Leveraged Loan index estimated the size of the global stock of leveraged loans to be $1.3 trillion in 2019 – a figure that has been cited by the Federal Reserve (Board of Governors (2019)). However, after accounting for loans that are not in the index, revolving credit facilities, and amortizing loans, the Bank of England puts the total to be closer to $3.2 trillion (Financial Policy Committee (2019)). The International Monetary Fund has assessed the total to be even larger, estimating the size of the market to be $5.0 trillion in 2020 (International Monetary Fund (2020)). While the taxonomy of leveraged loans is an inexact science as evinced by differing estimates of the size of the market, a loan is typically considered to be "leveraged" if the loan is secured by a first or second lien, and it meets one of the following criteria: *(i)* the issuing firm also issues high-yield bonds, i.e., is highly indebted, *(ii)* the issuing firm has experienced an acquisition or will finance an acquisition, *(iii)* the firm or the loan has a borrower rating below investment grade, *(iv)* the loan has a private equity sponsor, or, *(v)* the loan spread is above a prespecified threshold, typically, LIBOR+125 bps (Federal Stability Board (2019). These numerical figures put the size of the leveraged loan market between 6-25% of the US GDP. CLOs have a sizeable exposure to leveraged loans, assessed to be between $700-$870 billion (Financial Policy Committee (2019); International Monetary Fund (2020)).

Figure 5.2 shows the growth in the leveraged loan and CLO markets. This figure shows the gross leveraged loan issuance (bank loans and institutional loans) in comparison to high-yield bond issuance (top left), global leveraged loans outstanding by geographic area (top right), new issue CLO volume for US and EU (bottom left), and CLOs outstanding in the US and EU (bottom right). The leveraged loan market has experienced greater growth than the high-yield bond market. This is largely driven by the growth of institutional loans. Moreover, the vast majority of both leveraged loans and CLOs outstanding are issued in North America. However, the amount of leveraged loans issued outside of North America and Europe has also been growing. Furthermore, both the US and EU experienced exponential growth in the volume of new issue CLO after 2010. The size of the market is unprecedented.

While new issuance of structured products including collateralized bond obligations (CBOs) and collateralized debt obligations (CDOs) dwindled after the financial crisis, CLOs experienced a revival. Unlike other securitizations which are static, or replaced after investor redemption, CLOs are actively managed funds which issue debt in tranches as bonds or notes with differential risk-return exposures. However, CLOs are distinguished from other funds in four ways. First, CLOs are in operation for a fixed duration – upon maturity, the fund is liquidated and investors may retrieve their investment. Second, investors have limited redemption, as the CLO can be redeemed only if equity investors vote, after the "call date." If investors need liquidity before the call date, their only option is to find a buyer to sell to. Third, CLOs are highly levered, as they take on debt to purchase their investments. This debt is committed for the duration of the CLO. Fourth, debt investors are protected from adverse contingencies. If the CLO experiences default or significant losses, cash is diverted from junior debtholders and equity holders to the senior debtholders (Creditflux (2020)).

As presented in Table 6.1, between 2009-2018, the median size of a CLO is $427 million, with a standard deviation of $218 million. The median Moody's Weighted Average Rating Factor is 2,853, which suggests that the pool of assets is rated in the B2-B3 range. The median annual equity distribution is 16.625%. The loans of a leveraged loan issuer are distributed across a median value of 78 CLOs. Across all CLOs, the median par value of an issuer's loans total to $105 million. The median size of a trade is $\sim$ $250 million. The median transaction is traded at par.

In Figure 5.17, I show the industry distribution of leveraged loans held by CLOs and leveraged loans (top), as well as the annual share of second lien loans for CLOs and leveraged loans (bottom). The top figure shows that CLO managers hold a disproportionately smaller amount of loans in the oil and gas industry, and larger amount in the telecommunications industry, relative to the industry distribution of leveraged loan issuance. This is in part, informed by historical mishaps. Historically, many CLOs held a large share of asset-heavy businesses in the industrial sector. After the oil price plunge in 2015, managers reduced exposure to the oil and gas industry by a significant margin. The bottom figure shows that CLO managers typically hold onto a smaller share of second-lien loans relative to issuance. Kundu (2021*b*) discusses this figure at greater length, and with other supporting evidence, concludes that CLO managers are not passive buy and hold investors, but actively screen their underlying portfolios.

2.2.2 Who Participates in the CLO market?

CLOs are similar to other funds that are established as tax-exempt, bankruptcy-remote companies operating through a manager. The manager is responsible for making investment and trading decisions in accordance with covenants. According to Fitch Ratings data, the largest 30 managers represented 60% of all CLO issuance (Johnson (2018)). The most active managers of CLOs are listed in Figure 5.4. Many of the managers are affiliated with private equity firms or investment banks. The most active CLO managers in terms of the total amount managed are Credit Suisse, GSO Capital Partners, and Carlyle Group. CLO managers are paid a senior fee that is a fixed fee, unconditional on performance, a junior fee, proportional to the amount of money available to the subordinated class (equity), and a performance fee, for returns beyond a hurdle rate. Changes in the junior and senior fees from 2009-2018 are described in Table 6.3; the median junior fee remained 35 bps through 2009-2011 and declined steadily from 2011-2014 to 30 bps where it has remained. The median senior fee has ranged from 15-20 bps. The variance in fees has declined drastically in 10 years from 2009 to 2018.

There are a several other parties involved in a CLO besides the manager. Arrangers or underwriters are tasked with structuring the CLO and selling notes to investors. The top US arrangers of CLOs are listed in Figure 5.4. The top three arranging banks in terms of the number of deals are Citigroup, Morgan Stanley, and Bank of America Merrill Lynch. Often, the arranging bank is also responsible for providing warehouse funding for the deal and may act as the initial legal purchaser of the notes at closing or settlement date. If CLO investors experience unforeseen demand shocks, the arranging bank may end up retaining notes – a potential source of risk. Further, arrangers serve as market makers in the secondary CLO market as they have knowledge regarding the original investors of the notes, or may retain notes themselves, facilitating the match process between interested investors and potential buyers.

The contract that governs the management of a CLO is a legal indenture – a contract executed by the CLO and the trustee. The trustee acts as a fiduciary representative of the CLO investors and is typically, a commercial bank. The trustee administers collateral, maintains custody of the cash accounts, and, settles trades daily and remits funds to investors on payment dates. Additionally, the trustee is responsible for calculating whether the CLO is in compliance with covenants on a monthly basis, and circulating monthly trustee reports to investors. Furthermore, the trustee acts on behalf of investors if there is a disagreement between managers and investors. Moreover, if a CLO defaults, the trustee will seize control of the CLO at the behest of the controlling class of debtholders – typically, a share of the most senior debtholders.

In addition, there are a number of law firms, employed by the arranger, the manager, and the trustee to negotiate terms of the indenture. The majority equity arranger may also employ a law firm to negotiate contractual clauses on their behalf. There are four legal documents through a CLO's lifetime. The most significant of these contracts for the manager is the indenture, which is signed between the manager and the trustee. Additionally, there are collateral management agreements between the manager and issuers, a prospectus designed for investors, and an interest rate hedge agreement between issuers and a swap counterparty for hedging interest rate mismatch. New contracts are typically amended from previous deals (Creditflux (2020)).

Rating agencies affect the structure of CLOs by affecting both assets and liabilities. On the liabilities side, most CLO notes, with the exception of the equity tranche are rated by one or two agencies. Agencies monitor CLO performance over the lifetime of a CLO and, correspondingly, upgrade or downgrade the rating of notes. Before a CLO comes into legal existence, arrangers solicit ratings from rating agencies for assurance of the ratings. Rating agencies have discretion to alter the structure of CLOs through different rating assignments with effects on regulatory capital (more details below).

On the assets side, ratings are particularly important for CLO managers in satisfying quality and concentration limits. The distribution of S&P ratings across CLOs is shown in Figure 5.7. In summary, the figure shows that 29% of issued leveraged loans are rated C and below, while only 6% of leveraged loans in CLOs are rated C and below from 2009-2018. The vast majority of leveraged loans in CLOs are rated B or BB.

During the financial crisis, a seismic shift occurred in the CLO market as investors created a lasting over-the-counter secondary CLO market to offload their exposures. Most crisis buyers were hedge funds, private capital investors, and private equity firms – prospective buyers of leveraged loans as well. The creation of the secondary market changed the composition of the CLO investor base as well as the way CLOs were viewed from being exclusively long-term investments to quasi-short-term trading instruments as well. The existence of the secondary market has further fueled the rise of the CLO market. However, in comparison to the total volume of outstanding CLOs, trading volumes of secondary CLOs are still meager. Many have not been traded since issuance. CLO managers may sell CLOs through first-price sealed bid auctions known as *BWICs* or bids-wanted-in-competition.

CLO investors are attracted to CLOs because they offer exposure to a diversified portfolio of loans, with higher yield offerings relative to other financial products, while being perceived as more resilient, given historically low default rates. CLO investors constitute a wide spectrum of financial institutions. However, the extent to which non-bank financial institutions are involved in the CLO market remains a moot question. According to the Bank of England, 36% of CLO investors are banks, 20% are insurance companies, 10% are hedge funds, 6% are open-ended funds, 4% are CLO managers, 4% are structured credit funds, 3% are separately managed accounts, 1% are pension funds, and 15% are unallocated (international) (Financial Policy Committee (2019)). In contrast, the IMF reports that 37% of CLO investors are banks, 17% are insurers, 10% are pension funds, 9% are mutual funds, 6% are hedge funds, 5% are CLO managers, and 15% are unallocated. This is shown in graphical form in Figure 5.6. The large discrepancy in the amount of investment by pension funds suggests that the estimate of holdings is ambiguous for more opaque institutions. Federal Stability Board (2019) and Liu and Schmidt-Eisenlohr (2019) also provide estimates of the breakdown of investors by tranches. This is shown in Figure 5.8. Moreover, investment by institutions is segmented by tranches; while asset managers and insurers invest across the entire capital structure, more regulated institutions, like banks, almost exclusively purchase AAA notes. The AAA tranche is purchased mostly by banks (over 40%), followed by asset managers and insurers – the remaining 15% of the tranche is held by structured credit funds, pensions, mutual funds and hedge funds. The mezzanine tranche is held mostly by asset managers and insurers – the remaining 30% is held by hedge funds, mutual funds, pensions, structured credit funds, and banks. The equity tranche is the most diverse tranche, held by structured credit funds, hedge funds, pension funds, insurers, CLO managers and private equity firms (International Monetary Fund (2020); Liu and Schmidt-Eisenlohr (2019)).

The dynamic between debtholders and equity holders is distinct from other funds as cash flows are distributed according to a waterfall in CLOs. Similar to a corporation, debtholders or lenders provide leverage to equity investors, allowing CLO managers to take on more risk and increase returns. However, to curtail against risk-shifting, managers must comply with covenants to protect the interest of debtholders. Cash flows and covenants are discussed in Section 2.3.

2.2.3 Timeline of a CLO's life

The average life of a CLO spans seven years. This is shown in Figure 5.5. There are six main events that characterize the life of a CLO, starting from planning until call/redemption. Below, I describe the steps a CLO takes from genesis to demise. First, a manager meets with various arranging banks to solicit information on the size of the CLO, management fees, note prices, and potential debtholders. The manager also contacts potential equity investors who may constitute the "control equity investor." This planning phase is completed roughly six months before a CLO comes into operation.

Next, the manager enters the "warehouse" phase of the portfolio, which necessitates the actual acquisition of assets. In order to fund purchases, CLOs require both equity capital and debt financing. Equity capital may come from the control equity investor, or, the CLO manager may provide the capital through another fund. However, equity capital is usually insufficient to cover the total cost of acquisition, hence, a CLO will need to obtain debt financing from a warehouse facility, typically, the arranger to complete the acquisition. The maturity of warehouse financing is generally limited to two years, as it is expected that CLO managers will pay back the debt using the proceeds of the note issues. Unlike term funding provided to CLOs, warehouse lines of credit are provided against the market value of the portfolio. If the value of investments fall below a threshold, the arranging bank may require equity holders to provide additional capital, analogous to purchasing investments on margin. If equity investors are unable to post additional capital, the CLO may be unwound in the warehouse phase, and arrangers may seize the collateral (Creditflux (2020)).

While the manager is purchasing loans for the portfolio, the arranger will market the CLO notes to investors across the country and ensure that there are buyers for the notes. Not all tranches are in equal demand, therefore, similar to bookbuilding, arrangers will syndicate CLO notes, assess total demand by tranches, and alter features of the tranches or price to secure buyers. In the month before a CLO comes into existence, the terms of the notes, including size and price are confirmed with investors. At this point, investors commit to purchasing notes. One month later, as investors pay for the notes, a CLO will come into existence on the *closing* or *settlement* date. The time from planning to closing is typically six months.

After the closing date, the CLO manager begins receiving management fees, and must ensure that there is sufficient cash from the assets to fund the liabilities on the payment dates. Roughly four months later, a CLO becomes *effective* after it is fully "ramped up," at which point the covenants start applying and rating agencies confirm the rating of the notes. The CLO then enters the *reinvestment period* which allows the manager to conduct trades and reinvest proceeds until the end of the reinvestment period, roughly four years later. At the end of the reinvestment period, the CLO begins paying its most senior debtholders. After at least 50% of debtholders have been paid, equity investors vote to redeem the CLO if the net asset value is large enough to pay out all debtholders. Shortly thereafter, the CLO sells the loans and pays all equity holders and the CLO is redeemed – often before the maturity date. The non-call period, which lasts roughly two years after the closing date of the CLO, prohibits equity holders from calling the CLO during this period.

If a firm experiences default, a CLO is likely to receive equity shares of the defaulted firm through restructuring. In this case, CLO equity holders are unlikely to call the CLO until the defaulted assets rebound in price, to avoid losses. In this case, the CLO will continue to run until legal maturity, around 10-13 years after the closing date (Creditflux (2020)). CLOs are a cash-flow based venture. Actions through which a CLO may end up holding equity, like debt-equity swaps can reduce cash flow and put the CLO in violation of its covenants. If the CLO breaches its covenants and the CLO itself experiences default, the controlling class will decide how to proceed with the CLO. This is discussed next.

2.3 Covenants and Cash flows

There are several covenants CLOs have to regularly comply with. These can be classified into two classes of covenants: maintain-or-improve constraints, and constraints with tripwires for paying back liabilities prematurely. The coverage covenants act as "shock absorbers." In event of violation, coverage covenants can divert proceeds used for junior management fees and equity distributions towards paying down liabilities in event of violation, or towards the purchase of "higher-quality" collateral. Covenant violation can cause investors to lose confidence in the security and hurt the reputation of the associated manager. In addition, under more extreme circumstances, they can lead to downgrades of CLO tranches. Quality covenants are maintain-or-improve constraints, which prevent managers from making trades that can tighten the constraints. These are discussed further in detail.

As outlined in the indenture, cash flows from the underlying loan portfolio are distributed according to two waterfalls: interest waterfall and principal waterfall. The interest waterfall stipulates the conditions for distribution of interest payments to specific classes of debtholders, based on priority. Junior debtholders may only be paid after senior debtholders are paid in full, and there is sufficient cash left.

Figure 5.9 shows the sequence of actions a manager may take, following an interest and principal waterfall. Consider a simplistic setting in which the manager is bound to only two sets of covenants associated with the AAA-A tranches and BBB-B tranches, respectively. Using interest proceeds from the underlying pool of assets, first, the CLO will pay tax and administration fees to the trustee who represents the investors. Then, the CLO will pay its manager a management fee. Then the CLO will pay tranche AAA-A. If the CLO passes all of its coverage covenants, it will progress down the waterfall to make interest payments on BBB-B. If the CLO satisfies all the triggers after paying tranche BBB-B, the manager will progress further down the waterfall and collect her management fee. Then, the equity tranche will receive payments up to a prespecified hurdle rate, at which point the manager will receive a performance fee and the remaining interest will be split between the manager and the equity class. The principal cascade involves fewer steps. When principal is received, the CLO manager first makes any outstanding payments to debtholders. If the CLO has been called, reached maturity, is past the reinvestment period, or has failed a coverage covenant, the manager will pay debtholders in order of seniority. Subordination creates a hierarchy for losses.

Figure 5.10 shows the sequence of events if the CLO *fails* its covenants. Suppose the CLO starts at the leftmost green rectangle, indicating that it has paid interest on the BBB-B tranche. If the CLO fails a interest coverage or overcollateralization covenant (described in the subsequent section), the CLO will be forced to delever. First, the CLO will pay back the principal on the AAA tranche in full. If the CLO is still failing its interest coverage or overcollateralization covenants, the CLO will have to pay back the principal on the AA tranche, and continue paying tranches in full, in order of seniority until the CLO is in compliance. Suppose the CLO has satisfied the interest coverage and overcollateralization covenants after paying the AAA tranche in full. Then, the manager will then be able to continue down the interest waterfall. If the CLO subsequently fails its interest diversion constraint, the manager will use proceeds from the underlying pool of assets to purchase new collateral until the CLO is in compliance. Then, the manager may continue progressing down the waterfall.

For illustration of how losses may distribute to different tranches, Figure 5.11 shows the return of the equity tranche and cumulative losses as a function of portfolio losses. The x-axis plots the distribution of portfolio losses from lowest to highest. The left y-axis plots the equity return in percent. The right y-axis plots the cumulative loss as a percent of principal balance. The equity distribution is defined as follows:

$$\text{Equity Distribution} = \frac{\text{Interest payment} \times \frac{12}{\text{Payment frequency}}}{\text{Par value of equity}} \times 100 \tag{2.1}$$

This figure shows that the equity return decreases monotonically in the amount of portfolio losses from lowest to highest. After returns to equity are "wiped out", subsequent tranches in ascending order of seniority are affected; tranches rated below BBB and below experience losses before the BBB tranche, A tranche, and AA tranche.

In recent years, the aggregate share of risky loans across has been less than 7%. Figure 5.12 shows the annual share of risky loans across all CLOs, as defined by the aggregate sum of the share of CCC assets, defaulted assets, and discount obligations. The figure indicates that the share of assets rated CCC has been $<$6.5% in recent years, while the default rate has been $<$1% – significantly lower than the default of leveraged loans, which has hovered around 2-3%. Kundu (2021*b*) motivates the study of managerial trading behavior by further exploring this difference in default rates. Low CLO default rates have benefitted the equity tranche, which as experienced positive returns, as exhibited in Figure 5.13. This figure shows that the equity distribution increased from 5% in 2009, to nearly 30% in 2012. Since then, the equity distribution has declined to 10%. Equity returns exhibit high volatility, within and across years.

2.3.1 *Why Are There Covenants at All?*

As explained in Section 2.2, a CLO manager purchases a portfolio of loans which serve as collateral for senior and subordinate tranches of debt and equity. For equity investors, debt tranches provide leverage and risk premia benefits to the equity tranche. Debt is issued up until the point at which the default risk from higher leverage increases the debt credit spread by enough to decrease equity returns (Garrison (2005)). In the absence of any covenants or payout policies, upon experiencing defaults, managers are motivated to gamble for resurrection and are motivated to risk-shift given the option-like structure of the payoff to equity investors, discussed below. Following the logic of Jensen and Meckling (1976), if the marginal cost of equity monotonically declines in the leverage ratio and the marginal cost of debt monotonically increases in the leverage ratio, the optimal capital structure is determined when these marginal costs are equal. In the absence of any disciplining devices, the capital structure of CLOs creates perverse incentives for the manager. There is historical evidence of this from the CDO market – a close cousin of CLOs.

From 1998 through 2002, CDOs were inundated with a deluge of corporate defaults. According to Garrison (2005), a paper focused on managerial incentives in CDOs, the five year investment grade cohort experienced the worst financial performance during this period – 32% worse than the second worst cohort from 1982-1986, and 328% worse than average. Furthermore, in 2003, it was reported that 63% of all CDO tranches collateralized by high-yield bonds had experienced downgrades while 41% of CDO tranches collateralized by investment-grade bonds experienced downgrades. The paper provides strong evidence in support of the claim that managers exploited structural weaknesses, as the collateral held by corporate CDOs experienced greater defaults than the overall corporate debt market at every rating level, attributed to both selection ex-ante, and trading ex-post. As cited in the paper, a 2002 Moody's case study found that CDO investors could have avoided 13 out of 27 debt downgrades if the manager of a typical 1998 high-yield bond CDO held market collateral, an additional 8 downgrades could have been avoided if the manager appropriately managed risk after stress befell the market, and, "managers have introduced risk" and "deviate from the spirit of the indenture" (Garrison (2005)).

The CLO manager's financial interests are aligned with the equity tranche. A manager's compensation is based on a fixed senior fee, a junior fee proportional to the proceeds for the equity class, and, a performance fee for returns beyond a hurdle rate. Additionally, CLO managers may have *skin in the game* with a personal interest in the equity tranche. As the financial interests of the CLO manager are most aligned with the equity class, compensation can be thought of as a European call option where the exercise price equals the face value of debt. If the CLO does exceptionally well, the manager will take home the bacon. But, if it does poorly, the manager will not bear any cost because of limited liability and will continue to receive the fixed senior fee while debtholders bear losses. By increasing the risk of investments, as measured by the volatility of potential outcomes, the value of the call option increases. However, greater risk can materialize as losses to debtholders if defaults are realized. Hence, there is a divergence of interests of the manager and investors of different tranches.

Debtholders are naturally averse to riskier projects as they do not benefit from greater returns; compensation for debtholders is fixed above a benchmark rate, based on seniority. For this reason, if debtholders know that it is in the interest of the highly-leveraged CLO manager to take on inordinate levels of risk to fill their coffers, they will not invest in these CLOs, ex-ante. Hence, CLOs are structured to include additional features and indenture restrictions that place limits to managerial behavior. These enhancements are analogous to dividend payout policies and debt covenants in alternate contexts (Garrison (2005)). Coverage and quality covenants inherent in most CLO indentures, as well as concentration limits, curtail risk-shifting behavior.

In DeMarzo (2005), tranching assets allows for the creation of low-risk assets which can increase the amount of capital raised by a manager. In this setting, covenants can be additionally interpreted as a safeguard in ensuring that senior debt-claims are as riskless as possible (Kundu (2021*b*)). In addition to serving as disciplining devices, contracts, more broadly, critically determine the optimal capital structure of a CLO, ex-ante, by allocating control rights between the manager and investors. The ability of managers to financially avail from a proportion of equity proceeds provides an incentive for managers to exert effort in financial management. However, this trades off with the covenants which restrict risk-shifting behavior. Hence, the introduction covenants may undermine benefits from greater effort exertion, while increasing costs to risk-shift.

In light of these tradeoffs, optimal contracts are designed as equity contracts, for they are more efficient than debt contracts, ex-ante; debtholders benefit more when the manager's incentives are aligned with the equity tranche rather than debt, due to greater benefits from higher effort provision (Garrison (2005)). Moreover, neither effort provision, risk-shifting tendencies, nor incoming cash flows are directly contractible, therefore debt financing is used as a tool to allocate control, contingent on the manager's ability to fulfill its obligations with regard to covenants (Aghion and Bolton (1992)).[2] The presence of debt-focused covenants in the contract operate as disciplining devices for managers to appropriately screen and monitor their investments, deterring risk-shifting trades. The covenants allow investors to exert control when incentives conflict and managers make poor choices. These covenants are designed to reduce the possibility of "tranche warfare" and are most efficient in addressing risk-shifting without impinging upon a manager's incentives to exert effort (Garrison (2005)). Additionally, concerns about reputation can also prevent risk-shifting and force managers to exert greater effort (Hirshleifer and Thakor (1992); Diamond (1989)).

There are two broad classes of covenants: coverage covenants and quality covenants. Quality covenants are maintain-or-improve constraints, while coverage covenants can enforce punitive action. Coverage covenants, like the interest coverage and overcollateralization covenants (described below), can force managers to pay down liabilities prematurely or divert proceeds towards the purchase of value-increasing assets until the covenant is satisfied, protecting the interests of debtholders. This is analogous to the literature on dividend policies which force managers to pay excess proceeds

2. Note that covenants are not costless. They limit the choice set of investment opportunities (Smith Jr. and Warner (1979)).

out to debtholders, reducing the discretion for riskier management practices (Stulz (1990); DeAngelo, DeAngelo and Stulz (2006); Zwiebel (1996)). Empirical work has corroborated the theory that covenants reduce the cost of debt or agency cost of debt financing (Brady and Roberts (2015); Wei (2005); Chava, Kumar and Warga (2010); Billett, King and Mauer (2007)). Covenants add significant protection to debtholders, increasing the total amount of capital raised by CLOs, which in turn, may benefit equity investors.

A supplementary channel that can transfer wealth from debtholders to equity investors is the *dilution channel*. Equity investors benefit from diluting the claim of existing debtholders by issuing more debt, i.e., increasing leverage. If a CLO's assets experience default, a senior debtholder's claim on the CLO's assets may be diluted if firm leverage is higher. Hence, coverage covenants which stipulate a diversion of cash flow towards paying down liabilities in event of a breach, can also be thought of as *anti-dilution* covenants, as they force a reduction in the amount of leverage.

Further, reputational concerns can also serve as a mitigating force against asset substitution. CLO managers may invest in assets that are less risky and/or divest themselves of assets that are riskier to signal adeptness in marketing and advertising to potential investors. It is often cited that CLOs experienced very low defaults relative to their CDO counterparts, refering the performance of CLOs during the financial crisis. This suggests that managers may be sensitive to the default rates of their portfolios. Kundu (2021*b*) further explores this, showing that the discrepancy in default rates between CLOs and leveraged is loans is a result of active management of assets. Further, in Section 4.3.4 of Kundu (2021*b*), it is shown that the default rate of a CLO's assets is related to the subsequent initial deal size of new CLOs for a given manager. Hence, it may also be in the manager's interest to diligently manage their portfolios out of career and reputational considerations.

Lastly, the capital structure of securitized products, including CLOs, has been affected by recent banking regulation. This is discussed in detail in Section 2.4.2.

2.3.2 *Coverage and Quality Covenants*

The **Overcollateralization** (OC) covenants ensure that there is a specific level of subordination and coverage at all times, relative to the triggers for each tranche. The purpose of the OC covenant is to create first-loss tranches. The presence of first-loss tranches creates a cushion for principal losses that are borne by more senior tranches. In case of a covenant breach, proceeds are diverted from junior tranches to senior tranches until the covenant is met.

$$OC = \frac{\text{Par value of collateral+Defaulted collateral value+Purchase price of discounted collateral-'CCC' excess adjustment}}{\text{Principal balance of tranche and all senior tranches}} \tag{2.2}$$

The equation above indicates that the covenant relies on both realized and unrealized losses of collateral. Assets in a CLO are marked to par value and are not subject to market volatility unless an asset experiences default, is downgraded to CCC, or is a discount obligation. With defaults, the asset is marked to the lower value of market value or recovery value. Excess CCC assets are marked to the lowest market value of the CCC bucket. Discounted obligations are marked to the purchase price until they trade above a threshold (typically 90 cents/dollar) for more than 30 days. The thresholds are graded so that the Junior OC covenants fail before the Senior OC covenants. If a CLO fails an OC covenant for a particular tranche, all interest payments are diverted from tranches below that tranche to pay the principal of more senior tranches; payments are diverted in rising order of seniority, hence, the most senior tranches are most secure.[3] Specifically, if the Junior OC covenant is violated, the CLO will not be able to make distributions to the equity investors nor collect junior management fees. Unlike many debt contracts, these covenants cannot be renegotiated. Hence, violation is punitive. Kundu (2021*b*) examines how these ratios may be affected under various trading strategies.

The **Interest Diversion** (ID) covenants are similar to the OC covenants insofar as the ratios are computed identically. The threshold for ID covenants is lower, therefore, the Interest Diversion covenant is triggered before any of the OC covenants. Further-

3. The denominator of the OC ratio decreases, increasing the ratio.

more, in case of a breach, interest proceeds are used to purchase more collateral and increase the numerator of IDT/OC covenants rather than paying down debt. Thus, managers are incentivized to purchase value-increasing assets. This covenant is effective in removing opportunities for asset substitution by forcing managers to purchase high-quality, value-increasing assets.

A CLO may violate the tranche-specific OC/ID constraint if the assets-to-liabilities threshold ratio falls below a prespecified threshold, suggesting that the adjusted par value of assets is low relative to the principal balance of that particular tranche and all tranches senior to it.

The **Interest Coverage** (IC) covenants are similar to the OC covenants, as they can also cause the CLO manager to pay down liabilities early. The IC covenants ensure that there is specific coverage for interest due on tranches relative to the IC triggers for each tranche.

$$IC = \frac{\text{Interest from collateral}}{\text{Interest due on tranche and senior tranches}} \tag{2.3}$$

If a IC ratio falls below a threshold, principal and interest are diverted to pay down liabilities until the constraint is in compliance with the covenant in question. A CLO may violate the tranche-specific IC constraint if the interest received from the collateral is too low relative to the interest that is owed on that particular tranche and all tranches senior to it. In event that the IC or OC covenants are triggered, the CLO manager will have to deleverage, reducing the likelihood of additional losses. Hence, the covenants make risk-shifting less profitable, and set limits to a CLO's leverage.

There are a number of maintain-or-improve covenants, known as "quality covenants." These covenants are not directly punitive, as they do not affect management fees nor equity distributions. However, the covenants stipulate that in the event that they are triggered, the manager must maintain portfolio credit quality and cannot make trades that will worsen the constraints. These covenants include the **Weighted Average Spread**, **Weighted Average Life**, **Weighted Average Rating Factor**, **Minimum Weighted Average Recovery Rate**, **CCC-bucket**, as well as **Concentration limits**. The Weighted Average spread covenant stipulates that collateral has sufficient interest proceeds to pay interest on rated notes and equity; Weighted Average Life covenant stipulates that the collateral is amortizing (limiting portfolios with high WAL exposed to downturn and default); the Weighted Average Rating Factor covenant stipulates that the average loan rating of the portfolio is above the specified threshold; the Minimum Weighted Average Recovery Rate covenant stipulates that assets meet a minimum level of recovery expectations in case of default. CCC-bucket places a limit to the amount of loans that are rated Caa1 or lower or are on watch for eminent downgrade (typically, 5-7.5%); Concentration limits are additional CLO-specific covenants that can limit exposures to various industries, second-lien loans, covenant-loans, and specific corporate borrowers.

Summary statistics on eight salient covenants are reported in Table 6.6. The covenants are: Weighted Average Rating Factor (WARF), Weighted Average Spread (WAS), Weighted Average Life (WA Life), Interest Diversion, Senior Overcollateralization (Classes A/B), Junior Overcollateralization (Classes <= D), Senior Interest Coverage (Classes A/B), Junior Interest Coverage (Classes <= D), and Interest Diversion. The median value of the WA Life and WARF constraints are below the threshold. These are maintain-or-improve covenants, thus, violation does not stringently impact managers. The median capital and liquidity constraints are above the threshold. The interquartile range of capital constraints is very narrow; <2% for the Interest Diversion covenant, <3% for the Junior OC covenant, and <15% for the Senior OC covenant. The liquidity constraints exhibit greater variation, and are farther from the liquidity thresholds in comparison to the capital constraints. The average risky share of a CLO is 9%. The average CCC-bucket of a CLO is 6.5%, and the average percent of defaulted loans is 2.5%.

Table 6.2 shows the correlation across different constraints. The Interest Diversion constraint is highly correlated with the Junior OC constraint. The Senior IC and Junior IC constraint are highly correlated. The liquidity constraints exhibit moderate correlation with the Weighted Average Spread. The capital constraints exhibit moderate correlation with the liquidity constraints. The quality constraint exhibit very low correlation between one another.

2.4 Changes and Developments

2.4.1 CLO 1.0 vs. CLO 2.0

CLOs experienced significant changes during the Great Financial Crisis. Pre-crisis deals, *CLO 1.0*, differ from post-crisis deals, *CLO 2.0* in several ways. The reinvestment period and non-call periods of CLOs 2.0 are $\sim$ four years and $\sim$ two years, respectively, as compared with a reinvestment period of $\sim$ seven years and $\sim$ two to four years for CLOs 1.0, respectively. Additionally, with CLOs 1.0, managers are permitted to continue investment even after the reinvestment period. This is not permitted with CLOs 2.0. Moreover, CLOs 1.0 historically had high leverage as debt tranches were 10x larger than equity. The earliest CLOs 2.0 had lower leverage with debt tranches that were 4-6x larger than equity. Leverage of more recent CLO 2.0s has surpassed the leverage of CLOs 1.0. Furthermore, CLOs 2.0 allow for tranche-by-tranche refinancing and repricing, which is not permitted under CLOs 1.0; the entire CLO must be redeemed before an individual tranche is repaid (Creditflux (2020)). In summary, CLO 2.0s have shorter reinvestment and non-call periods, higher levels of subordination, and more rigorous collateral eligibility requirements as the indentures of CLO 2.0 are more restrictive than 1.0. AUM by outstanding vintage is shown in Figure 5.14. At the start of 2019, late vintage CLOs represented almost 50% of total CLO AUM, while CLOs issued between 2014 and 2016 represented 40% of CLO AUM.

2.4.2 Treatment of Securitization under Basel and Dodd-Frank

The capital structure of CLOs has changed with regulation. Under the Basel regulatory frameworks, banks are required to maintain a minimum total capital ratio of 8%. Exposure to securitized assets affects the denominator of this ratio by affecting the total value of credit risk-adjusted assets. Treatment of securitization in the denominator is two-pronged. Banks with the ability to carry out complex analyses may use the *internal* *ratings-based approach* and apply risk-weights based on internal modeling. Other banks can utilize the *standardised approach* and apply risk-weights using broad ratings categories. The risk-weights under the standardised approach are based on the ratings of the tranches and carry larger capital charges than the internal ratings-based approach. However, banks can circumvent paying the full capital charge. With the standardised approach, banks may employ the "look-through" approach, in which they can apply the weighted-average risk weight of the entire pool, adjusted by the concentration of the tranche in question as the capital charge. With the internal ratings-based approach, banks can apply their own model to determine the appropriate risk-weight for an unrated position.

However, the securitization frameworks of the Basel accords are not applicable in the US, as Section 939A of the Dodd-Frank Act prevents a ratings-based approach to securitizations. Instead, securitizations are treated according to a "supervisory formula approach" (SFA). The treatment of securitizations under SFA is analogous to the treatment of unrated tranches under Basel II. Because banks do not actually hold the underlying pool of the CLO, they do not have sufficient data to follow SFA. For this reason, banks often opt for the "simplifed supervisory approach" or "gross-up approach." Regardless of the approach, banks must gauge the total amount of expected credit losses of their exposures. Hence, CLO trading decisions can affect bank regulatory capital, by altering the exposure of liabilities.

Figure 5.15 shows how the structure of liabilities have changed from 2009 through 2018 by the number of tranches. From 2009-2012, 47% of all CLO tranches were rated AA-Aaa, as compared to 41% between 2012-2016 and 33% from 2017-2018. The share of A-rated liabilities has steadily declined over time, while the share of Triple-C liabilities and unrated liabilities has increased. The majority of tranches that are not rated are equity and equity-like tranches. For concreteness, a quick back-of-the-envelope calculation indicates that for CLOs with standard capital structures, the share of the "A" tranche (in terms of size) decreased from 75% in 2009 to 62% in 2018. The share of the "SUB" tranche increased from 8.41% to 22.9%. Larger subordinated tranches offer better protection for senior debtholders, e.g., AAA investors, in case of a downturn. Figure 5.16 exhibits the variability in tranche sizes within a CLO. Most variation in tranche sizes comes from the AAA and equity tranches.

2.4.3 US Risk-Retention Regulation

Theories of financial intermediation suggest that securitization can affect intermediaries' due diligence. Securitization of loans allows banks to shift credit risk to securitizers. The incentives to properly monitor and screen borrowers are contingent upon the amount of risk retained by the agent who does the monitoring. In the absence of any enforcement of risk retention, informational asymmetries between end investors and earlier participants in the securitization chain can cause a "lemons" problem. The aim of risk retention is to bring the incentives of securitizers closer to traditional portfolio lending so that securitizers and originators appropriately evaluate borrowers and underwrite loans judiciously. If securitizers have "skin in the game" or retain a portion of their securitizations, they will internalize the costs and rewards of the risk they bear; informational asymmetries are reduced as compensation is sensitive to risk.

In 2014, pursuant to section 15G of the Securities Exchange Act 1934, added by section 941 of the Dodd-Frank Act, six federal agencies stipulated that the securitizer of a CLO (manager) issued after December 24, 2016 must retain 5% of the economic risk. The intent of this act was to align the interests of the securitizers with the investors, and prevent securitizers from packaging and selling risky loans to end investors who would bear the losses. However, there was wide latitude in how securitizers could satisfy this. Managers employed various risk-retention strategies like establishing capitalised majority-owned affiliate (C-MOA) companies, majority-owned affiliate (MOA) companies, or capitalised manager vehicles (CMV) to nominally meet the requirements and comply with the letter of the law. Moreover, securtizers could satisfy the retention provision by holding vertical interest (interest in equal proportions of each class of notes), horizontal interest (within a tranche), or any combination that constituted at least 5% of the economic risk of the CLO. Furthermore, securitizers could have transferred their retained interest upon approaching the "sunset" period, whereby the balance of the pool was 33% of the closing balance, notes amortized to 33% of their original principal, or two years after the closing date (Creditflux (2020)).

The risk-retention rule was reversed in February 2018. Traditional (Broadly Syndicated Loans) CLO funds no longer have to retain 5% interest in their funds. However, middle-market CLOs are still subject to the 5% risk retention rule.

2.4.4 Volcker Rule

The Volcker Rule, adopted in December 2013 prevents US banks and non-US banks with US branches and affiliates from sponsoring or owning interests in a wide range of covered funds, including CLOs. This is because the controlling class has the right to dismiss a manager. However, caveats apply. Banks may be exempt from the Volcker rule if they hold positions for market-making, or, hold positions to satisfy risk retention stipulations under Dodd-Frank. Moreover, "loan securitizations" are excluded, hence, banks can hold an ownership interest in a CLO if the CLO exclusively invests in loans. After the implementation of the Volcker Rule, there has been a steady decline in the share of non-loan issue types as documented in Table 6.4. Notably, bonds comprised 5% of a CLO's portfolio in 2011 and fell to 0.23% in 2018; letters of credit fell from 1.45% to 0% in the same time period; revolvers fell from 1.08% to 0.12% in the same time period.

2.4.5 Emerging Vulnerabilities

In this section, I discuss emerging vulnerabilities in the leveraged loan and CLO markets. Understanding the potential sources of stress is crucial in developing deeper insights into how shocks can propagate across the financial system, and potential amplification mechanisms. As suppliers of credit in the corporate loan market have become more dispersed in the spirit of greater risk-sharing, greater connections have formed between banks and institutions in the shadow banking sector, providing a more opaque and convoluted avenue for shocks to amplify. Additionally, the chains of intermediation have lengthened. As shown in Figure 5.1, direct and indirect exposures can have broader implications for the functioning of financial markets and systemic risk. Below, I enumerate general risks in the leveraged loan and CLO markets.

These mains risks have been highlighted in the recent Financial Stability Reports of International Monetary Fund (2020) and Federal Stability Board (2019).

1. **Increase in cov-lite loans:** The increase in the incidence of cov-lite loans may be driven by the availability of funding and competition for loan mandates. Additionally, as bank participation has declined in the leveraged loan market, bank incentives to monitor their borrowers has fallen while CLOs' coordination costs of monitoring have increased. Furthermore, non-bank financial institutions, like private equity firms, benefit from greater incidence of cov-lite loans, as firms can increase leverage, while "shifting risk to creditors," increasing their own returns (Federal Stability Board (2019)). Covenant breaches can force firms to the renegotiating table and force restructuring, as a covenant breach may be viewed as a *default* from the perspective of creditors. With cov-lite loans, the risk of breaching a covenant is lower. This weakens creditor protections, eliminates the option of early intervention, and can reduce recovery ex-post. As Ivashina and Vallee (2019) show, erosion of "ring-fencing" around secured assets in the presence of carve-out and deductible clauses can benefit equity shareholders.

2. **Leverage on leverage:** As a greater share of M&A and LBO deals adjust EBITDA for synergy addbacks and operational improvements, the adjusted EBITDA figures are overstated, while the adjusted debt/EBITDA is understated. The adjustments range from 15-30% (Federal Stability Board (2019)). This suggests that firms may be more levered than they report. The risk to the shadow banking sector has increased as deals financed by non-bank financial institutions has increased more sharply than for banks (International Monetary Fund (2020)). Additionally, as ratings have declined (more single-B or lower loans) with weaker covenants (preventing early restructuring), firm leverage has increased. Within

a firm, the relative amount of subordinated debt has declined, reducing the size of the loss-absorption buffer before senior loans are affected. This can have a pronounced effect on the recovery rate of senior loans. Further, the average quality of CLOs has deteriorated. As a result, credit spreads have widened with higher forecasts of downgrades and defaults (International Monetary Fund (2020)). During the financial crisis, leverage amplified shocks (International Monetary Fund (2020)). As leverage can come from a variety of sources, including the firms themselves, banks, shadow banking sector, and the credit system in aggregate, the potential for amplification is large, especially considering that leverage can be hidden. Hence, while the current schema of credit provision may be efficient, it can also introduce new risks with leverage at every juncture.

3. **Greater concentration:** Despite concentration limits, as CLOs hold up to three-quarters of all new institutional loans and one-quarter of all outstanding leveraged loans, in aggregate, they may have significant exposure to the same set of borrowers or industries. 90% of CLOs are exposed to the top 50 US borrowers, and 80% are exposed to the top five borrowers (Federal Stability Board (2019)). Default can impose negative externalities on other firms held in the CLO portfolio or the same industry. This is explored in Kundu (2021*c*). If coverage constraints become more correlated across CLOs, forced sales can cause fire sales, as shown in Kundu (2021*b*). Additionally, expected losses to subordinated tranches can be quite large. The concern of concentration is not limited to the CLO market. Banks and shadow banks have the largest exposures in the syndicated loan market, hence the potential for distress is widespread. Further, as credit suppliers operate both in the high-yield bond and loan markets, and borrowers strategically switch from the loan to high-yield bond market, price correlation between the two markets has been reported to be larger during economic downturns (International Monetary Fund (2020)). Kundu (2021*c*) provides evidence of rates equilibrating in market equilibrium.

4. **Run risk:** If there is broad demand for cash, liquidity risk can further deteriorate

the amount of liquidity in CLO and loan markets. During the COVID-19 crisis, new issuance of risky credit declined sharply while bid-ask spreads soared and ETFs experienced deep price discounts (International Monetary Fund (2020)). Historically, in event of panic or shock, mutual funds experience significant outflows – COVID-19 was no exception. Given global chains of intermediation in the risky credit market, run or redemption risk anywhere can have an impact everywhere.

2.5 Conclusion

Collateralized Loan Obligations (CLOs) are increasingly important providers of credit to risky corporate borrowers. Despite this, little is understood on how CLOs function. This paper, along with Kundu (2021*b*) and Kundu (2021*c*), take the first step in filling the the gap on the role of CLO intermediaries in risky credit markets. With substitution between banks and shadow banking institutions in credit markets, understanding how CLOs function is critical for developing deeper insights into how the shadow banking sector operates, potential risks emanating from the sector, and, for developing policy reforms to mitigate against adverse contingencies.

In particular, this paper describes fundamental aspects of the CLO market, including the role of covenants in the design of contracts and capital structure. I discuss the interests of the two main contracting parties – the manager and investors, and, describe the nature of the contract and consequences in event of covenant breaches. Moreover, I explain how the CLO market functions and expound on salient features including recent changes, developments, and potential sources of risk. In the subsequent essays of this series, I demonstrate how the covenants can impose risks to financial stability (Kundu (2021*b*)) and have externalities to firms (Kundu (2021*c*)).

CHAPTER 3

FINANCIAL COVENANTS AND FIRE SALES: FRACTURES IN THE LEVERAGED LOAN MARKET

3.1 Introduction

This paper explores how the market for Collateralized Loan Obligations (CLOs) affects leveraged loan prices. A CLO operates as a special purpose vehicles (SPV) with a manager who makes active trading decisions. Akin to other intermediaries, CLOs facilitate the pooling of risks by reducing search frictions in the product market, and providing expertise in risk management and asset allocation (Koijen and Yogo (2020)). CLO managers issue tranched asset-backed securities or notes to investors, and use the proceeds to finance the purchase of the underlying portfolios of leveraged loans. CLOs constitute a consequential source of credit for constrained corporate borrowers – they purchased 75% of new institutional leveraged loans issued in 2019 and held 25% of all outstanding leveraged loans (pro rata and institutional) in 2020 (Leveraged Commentary and Data (2019); International Monetary Fund (2020)). Moreover, unlike static securitizations of the past, CLO managers actively manage their portfolios. However, the actions and operations of a CLO are governed by a legal indenture. In this paper, I show that fire sale risk in the leveraged loan market may manifest from contractual features rather than asset fundamentals, thus demonstrating how financial contracts may be a source of financial fragility.

Unearthing latent risks in the leveraged loan market is important for understanding novel mechanisms of transmission and the amplification of shocks. This is a systemically important question. In recent years, central banks have forewarned of turmoil in the leveraged loan market. A recent report from the Financial Stability Board (FSB) of the Bank for International Settlements highlights several vulnerabilities (Federal Stability Board (2019)). First, there is a concern that the degradation in the quality of loan contracts has not been fully priced. The simultaneous weakening of creditors' rights and potential increase in likelihood of default can reduce recovery rates and affect investors beyond measure. Second, there is concentration of leveraged loans and CLOs among a finite number of large banks, exposing them to several types of risk, including pipeline risk, warehousing risk, and credit risk. Unanticipated shocks that transmit to banks can impinge upon their ability to perform other functions of financial services. Third, non-bank investors, including insurance companies, private equity, private capital investors, open-ended funds, and hedge funds constitute large buyers of CLOs and leveraged loans and are a source of long-term capital, hence, any episodes of distress for either these institutions, or, leveraged loan or CLO markets may spillover in the opposite direction. Lastly, in assessing vulnerabilities, the FSB notes that there is a paucity of work that investigates the relation between CLOs and banks, and assesses "systemic implications" of risks manifesting from connections.

In this paper, I focus on CLO managerial behavior, as prescribed by covenants, as a conduit for studying these risks in the leveraged loan market. Evidence from the Great Financial Crisis would suggest that unlike their CDO and CBO counterparts, CLOs are resilient, as they emerged as unscathed survivors and did not require an overhaul in their design. Further, CLO markets are perceived to be impervious to fire sale risk, as long-term capital is locked-in for the duration that the CLO is in operation, providing a stable source of investment (Kundu (2021*a*)). However, I argue that the perceived safety of the CLO market is a result of active management, informed, in part, by quality and coverage covenants that CLO managers must comply with on a regular basis. Despite limited redemption, I show that covenants can force CLO managers to make perverse trading decisions with widespread consequences. I focus my analysis to a relatively benign macroeconomic period between 2009 and 2018, to show that latent sources of risk can have pernicious effects even during favorable conditions.

Quality and coverage covenants serve as checks against managerial risk-shifting behavior and are intended to reduce the possibility of "tranche warfare." There are eight covenants that are considered in this study: Weighted Average Spread, Weighted Average Rating Factor, Weighted Average Life, Interest Diversion, Junior Overcollateralization (Junior OC), Senior Overcollateralization (Senior OC), Junior Interest Coverage (Junior IC), and Senior Interest Coverage (Senior IC). The former three quality covenants ensure that CLOs are sufficiently diversified and have limited exposure to various qualitative dimensions of risk. The latter five coverage covenants ensure that CLOs have adequate liquidity and capital to finance their obligations. As regulatory bodies have limited supervisory authority to directly address the risks originating from CLOs, understanding how the self-governing charter operates is critical.[1]

I begin by providing suggestive evidence that CLO managers engage in both selection and monitoring of leveraged loans; the composition in the issuance of leveraged loans differs from the composition of CLO portfolios, and, the default rate of CLOs is significantly lower than the default rate of leveraged loans. This motivates the study of CLO managerial behavior with regard to distressed loans; a loan is "distressed" if it is issued by a firm that files for Chapter 11 bankruptcy at some point during the sample period. I show that active management may generate price pressure around bankruptcy defaults when constrained managers sell distressed loans that put them near the covenant edges. As CLO managers approach their covenant thresholds, they sell in the secondary loan market to generate more slack in their constraints. This is because the consequences of covenant breaches come with great pecuniary and non-pecuniary costs. When a large share of CLO managers experience simultaneous constraint, price pressure may materialize as fire sale risk.

The main findings in this paper relate to price patterns. There is price pressure in the secondary loan market around bankruptcy default events. Further, price pressure is driven by constrained managers who sell distressed loans that put them near the covenant edges. I exploit variation in the distance to various covenant constraints and find that there is heterogeneity in the CAAR based on capital constraints; price pressure is evident for CLOs that are relatively more constrained. Loans which belong to CLOs that are relatively capital-constrained experience a CAAR of -4.09% as compared to -0.79% for loans belonging to CLOs that are relatively capital-unconstrained

1. In April 2020, the Federal Reserve announced that loans and CLOs are included in Term Asset-Backed Securities Loan Facility (TALF), providing funding to entities that hold AAA notes of new CLOs which invest in newly issued loans.

at the trough. In the measurement of the capital constraints, loans are marked at par value, unless they are defaulted, discount obligations, or in excess of a CCC/Caa1-limit, in which case, the accounting treatment changes. These inflections in accounting rules can induce CLO managers to aggressively sell distressed loans preemptively. The result is that trading based on capital constraints can result in trades at fire sale prices, followed by subsequent positive abnormal returns that compensate liquidity providers. The quadratic price patterns hold for other events as well, including missed interest and principal payments, which are common precursors of downgrades and other adverse credit events like bankruptcy defaults. In addition to the heterogeneous effects based on the degree of intermediary constraint, I also find that loans of longer maturities or loans of higher ratings experience deeper troughs as compared to loans of shorter maturities or lower ratings – reflecting variation in liquidity premia. Lastly, I study whether CLO managers create price pressure or respond to it. As second lien loans constitute a small share of CLOs' portfolios – CLOs are not active purchasers of second lien loans, the impact of sales is expected to be muted, assuming that prospective buyers are relatively unconstrained. I do not find evidence of price-pressure for second lien loans. Therefore, I attribute the price impact to CLO managerial behavior.

To further investigate the origins of price pressure, I study how the *selling* patterns may be explained by the distances to the covenant thresholds. I find that a one standard deviation increase in the distance to the capital covenant measures is associated with a 3.0-3.8% decline in the probability that a firm sells risky loans – loans that are rated CCC/Caa1 or worse in excess of the CCC/Caa1 limit, discount obligations or defaulted loans. A one standard deviation increase in the distance to the most stringent liquidity covenant is associated with a 1.71% decline in the share of risky loans. These findings provide the basis for the price patterns observed around bankruptcy defaults. Moreover, I study whether covenants may also explain other aspects of CLOs. I find that CLOs' size increases in the *threshold* of the covenant constraints. Equity distributions increase in the distance to the liquidity triggers.

3.2 Related Literature

This paper contributes to two main strands of the literature: (1) contracts and covenants, and (2) fire sales.

First, this paper contributes to the literature base at the intersection of asset prices and optimal compensation contracts. With the exception of Buffa, Vayanos and Woolley (2019) and Cvitanić and Xing (2017), most of the theoretical literature has fixed optimal contracts and found equilibrium asset prices, or fixed asset prices and found optimal contracts. This paper empirically demonstrates the interaction between contracts and asset prices, providing direct evidence of how different degrees of constraint can produce heterogeneous effects on equilibrium asset prices. Several papers have explored various aspects of loan contracts and covenants including, (e.g., Ivashina and Sun (2011*a*); Shivdasani and Wang (2011); Nadauld and Weisbach (2012); Becker and Ivashina (2016); Bozanic, Loumioti and Vasvari (2018); Ivashina and Vallee (2019))). More recently, there have been several papers which document the trading behavior and performance of CLOs, including Liebscher and Mählmann (2017), Loumioti and Vasvari (2019), Peristiani and Santos (2019), Fabozzi et al. (2020), and Cordell, Roberts and Schwert (2020). However, in contrast to these papers, I connect the market prices of leveraged loans to the trading behavior of CLOs, as governed by covenants in managerial contracts. This demonstrates how optimal contracts may produce externalities on asset prices. Further, it suggests that while covenants are effective in addressing agency frictions between debt and equity holders, they can create new risks. Thus, this paper sheds light on how covenants act as latent sources of amplification in the transmission of shocks, informing the discussion on the design of contingent financial contracts – in particular, how the inability to renegotiate affects incentives – in addition to the systemic implications.

Second, this paper contributes to the literature base on fire sales and intermediary asset pricing, showing how fire sale risk can transpire even in closed-end funds as a precautionary externality due to covenant constraints. Forced asset sales can stem from a variety of reasons, often related to liquidity (e.g., Shleifer and Vishny (1992);

Kiyotaki and Moore (1997); Duffie, Gârleanu and Heje (2005); He and Xiong (2012); He and Milbradt (2014)). In this work, I demonstrate that fire sale risk may transpire even in the absence of investor withdrawals or regulatory constraints due to the design of covenants.[2] The two key differences from the extant literature are covenants and the setting – leveraged loans in the relatively illiquid secondary loan market. While fire sales and price pressure have been studied in several different contexts, both real and financial, (e.g., Pulvino (1998), Coval and Stafford (2007); Mitchell, Pedersen and Pulvino (2007); Ellul, Jotikasthira and Lundblad (2011); Campbell, Giglio and Pathak (2011); Greenwood and Thesmar (2011); Jotikasthira, Lundblad and Ramadorai (2012*a*); Dick-Nielsen and Rossi (2019)), demonstrating how *realizations* of different forms of constraint can produce dislocations in prices, there is a paucity of empirical work, investigating how fire sales can arise out of *precaution*. CLO managers are subject to tranche-specific coverage covenants. These covenants exist as course-correcting devices to mitigate the risk of future realizations of constraint. If a covenant is violated, a CLO may be forced delever to preemptively pay down liabilities which occurs through the liquidation of loans. Hence, the finding that covenants may themselves induce fire sales shows how fire sales can become self-fulfilling by expectations of future constraint via covenants.

The closest work to this paper is independent and contemporaneous work produced by Elkamhi and Nozawa (2020*a*). Both papers study how fire sale risk can materialize in the leveraged loan market. They show that increasing efforts towards CLO portfolio diversification has produced similarities across CLOs in loan holdings. However, it remains unclear *(1)* what explains CLO portfolio composition and *(2)* how do other salient dimensions of CLO management influence price pressure and fire sale risk. I provide direct evidence of how *both* quality and coverage covenants determine different aspects of CLO trading behavior, as well as the associated composition of the

2. Related papers which show that intermediaries face constraints that affect their risk-bearing capacity include He and Krishnamurthy (2012) and He, Kelly and Manela (2017). This paper contributes to the empirical literature, joining Froot and O'Connell (1999); Adrian, Etula and Muir (2014); Ivashina, Scharfstein and Stein (2015); Koijen and Yogo (2015); Du, Tepper and Verdelhan (2018); Du, Hébert and Huber (2019); Boyarchenko, Fuster and Lucca (2019) among others.

underlying CLO portfolios. In addition to trading behavior, covenants may also explain other characteristics of CLOs, including CLO size and equity distributions. Understanding how covenants function is important for deepening our understanding of the origins of financial fragility and assessing counterfactual scenarios, i.e., how do the effects vary with different covenant thresholds and different contractual designs? Apart from covenants, I evaluate other potential explanations of managerial trades and show that concerns specific to managerial reputation and bankruptcy can magnify the observed effects. Hence, our findings are complementary in demonstrating how a multitude of factors can influence price pressure and fire sale risk.

The roadmap for the paper is as follows. I provide a brief overview of the institutional setting in Section 3.3. Data sources used in this study are described in Section 4.3. The main results on price pressure and fire sale risk are in Section 3.5. I explore the underlying motives behind these price patterns in Section 3.6. Lastly, I conclude in Section 4.8.

3.3 Collateral and Covenants

In this section, I provide a condensed summary of covenants. For a comprehensive discussion of contracts, and the CLO market more broadly, I refer readers to Kundu (2021*a*).

CLOs are tranched financial instruments with two main classes of tranches: debt and equity. Debt tranches are senior to equity tranches. Debt tranches are paid a fixed spread above LIBOR based on seniority; higher-rated debt tranches have lower risk and pay out lower returns relative to lower-rated tranches which have higher risk and higher returns. The remaining *excess spread* – remaining proceeds after proceeds from the underlying pool of loans are distributed towards debt tranches – is allocated between the CLO manager and the equity class. Naturally, this generates an agency friction as the manager's compensation consists of a fixed fee and subordinated fees that are proportional to the residual interest available to the equity class.[3] This payoff

3. Hence, compensation is like a European call option where the strike price is the face value of debt.

structure can introduce gratuitous risk to CLO investors, as CLO managers are incentivized to maximize the excess spread – where the management fees are created. A 2002 Moody's case study found that CDO managers introduced risk and could have avoided 13 out of 27 debt downgrades if the manager of a typical 1998 high-yield bond CDO held market collateral, and, avoided an additional eight downgrades if the manager appropriately managed risk after the credit downturn of 1998 (Garrison (2005)). This agency problem provides the impetus for the implementation of covenants – to check against the deterioration in quality of asset pools and risk-shifting behavior.

There are two types of covenants: quality covenants and coverage covenants. Quality covenants are maintain-or-improve constraints which do not directly prescribe any action on the manager in event that they are triggered. The Weighted Average Spread, Weighted Average Life, and Weighted Average Rating Factor, are examples of quality covenants which stipulate that the underlying collateral must have sufficient interest proceeds to pay interest on rated notes and equity, is amortizing (limiting portfolios with high Weighted Average Life exposed to downturn and default), and the average loan rating of the portfolio is above the specified threshold, respectively. Coverage covenants ensure that there is a specific level of coverage and subordination relative to the covenant triggers for each tranche. Coverage covenants serve are disciplining devices to ensure that CLO managers adequately screen and monitor their portfolios. If triggered, they may divert proceeds from junior tranches towards paying down liabilities in order of seniority, or towards the purchase of value-increasing collateral. Diversion is punitive for the manager who may suffer pecuniary losses, as well as social capital losses, with regard to career prospects and reputation.

There are three types of coverage covenants: Overcollateralization (OC) covenants, Interest Diversion (ID) covenants, and Interest Coverage (IC) covenants.

$$OC/ID = \frac{\text{Par value of collateral+Defaulted collateral value}}{\text{Principal balance of tranche and all senior tranches}} + \\ + \frac{\text{Purchase price of discounted collateral-'CCC/Caa1' excess adjustment}}{\text{Principal balance of tranche and all senior tranches}} \tag{3.1}$$

$$IC = \frac{\text{Interest from collateral}}{\text{Interest due on tranche and senior tranches}} \tag{3.2}$$

The OC and ID covenants are *capital constraints* which are measured similarly. The ID covenant has a lower threshold than any of the OC covenants. If it is breached, proceeds are diverted towards the purchase of high-quality, value-increasing loans rather than paying down liabilities in order of seniority. The IC covenants are *liquidity constraints* which ensure that there is a specific level of coverage for interest due on tranches relative to the triggers. In the event that the IC covenant is breached, similar to the OC covenant, principal and interest is diverted towards paying down liabilities until the CLO is in compliance with the covenant restrictions.

The kinks in the accounting of the capital constraints may trigger forced sales. For the most part, CLOs are immune from market volatility as loans are typically marked at par value. However, if an asset experiences default, puts the CLO in excess of its CCC/Caa1 concentration limit, or, is a discount obligation, the asset will be marked to the lower of market value or recovery value, the lowest market value among the CCC/Caa1 loans, or the purchase price until the loan trades above a threshold (typically 90) for more than 30 days, respectively. The nonlinear nature of the accounting rules may induce CLO fire sales upon experiencing constraint.

3.4 Data and Motivation

3.4.1 Data

The primary data source for this project is the *CreditFlux CLO-i Database*. The database utilizes data from over 35,000 trustee reports, prospectuses, and covers over 1,200

CLOs in the US. It contains information on transactions, holdings, test results, tranches and equity distributions. In terms of coverage, in 2019, the CLO-i database covered 67-76% of the entire CLO market (Kundu (2021*a*)). Past research that has used the CLO-i database has cited coverage to be between 46-65% of the market (Benmelech, Dlugosz and Ivashina (2012)). In this paper, the sample period of interest starts in 2009 and ends in 2018.

As shown in Table 1 of Kundu (2021*a*), over this period, the median size of a CLO is $427 million, with a standard deviation of $218 million. The median Moody's Weighted Average Rating Factor is 2,853, which suggests that the pool of loans is rated in the B2-B3 range. The median annual equity distribution is 16.625%. The loans of a leveraged loan issuer are distributed across a median value of 78 CLOs. Across all CLOs, the median par value of an issuer's loans total to $105 million. The median size of a trade is $\sim$ $250 million. The median transaction trades at par.

I gather data on defaults from the UCLA-LoPucki Bankruptcy Database and Moody's Default & Recovery Database. The UCLA-LoPucki Bankruptcy Database provides detailed data on all large, public companies that have filed for bankruptcy since October 1, 1979. A company is considered to be "public" if it filed an Annual Report with the SEC within the last three years of filing for bankruptcy. A company is considered "large" if the Annual Report listed total assets to be at least $100 million (in 1980 dollars). In contrast, the Moody's Default & Recovery Database does not have any stipulations on the size and status of a company. It provides comprehensive data on defaults, ratings, recoveries, and detailed information on debt, as far back as the 1920s. Moody's Default & Recovery Database segments defaults by the type of default. My primary focus is on Chapter 11 bankruptcies. I also record "intermediate" default events including missed interest and principal payments, sourced from the Moody's database to study whether the baseline findings are robust to other credit events. In total, there are 400 borrowers who file for Chapter 11 bankruptcy in the CLO portfolios at some point in the sample period. There are 72 borrowers who missed an interest or principal payment at some point in the sample period. Additionally, in the absence of information on bankruptcy outcomes, or dates of filing, I consult additional resources on bankruptcy data, including S&P's Leveraged Commentary and Data's List of Leveraged Loan Defaults.

To study price pressure in the CLO market, I model the change in fundamental value using the following data series: (1) 5-Year Treasury Constant Maturity Rate, (2) Barclay's Corporate IG Index Return, (3) Barclay's Corporate HY Index Return, (4) S&P 500 Index Return, (5) S&P/LSTA Leveraged Loan Index Return, (6) Analyst forecasted earnings. Data series 1-5 are available through the Bloomberg Terminal. Data series 6 is obtained from the Thomson Reuters Institutional Brokers' Estimate System Analyst Forecasted Earnings via Wharton Research Data Services.

To rule out competing hypotheses, I make use of additional datasets and merge them with the primary CLO-i datasets. To dispel the hypothesis that new information is responsible for price changes, I examine whether there are informational spillovers in the stock market from trades in the loan market through an event study framework. For this, CRSP daily data is used in the Event Study by WRDS service. I also use S&P's Capital IQ Capital Structure data to study dynamics in debt structure, to better understand how bankruptcy affects firm organization. To investigate whether the divestment of loans issued by distressed firms is unique to "sophisticated" CLO managers who are affiliated with private equity firms, I use data on private equity firms from *Private Equity International*'s List of 300 Private Equity International Firms, and the frequently updated, crowd-sourced encyclopedia page titled *List of private equity firms* from Wikipedia.

The lack of issuer identification in the CLO-i database necessitates hand-matching of the data. Punctuation, case sensitivity, abbreviations, and inconsistent syntax, and conflation of subsidiaries/holding companies in reporting are some of the issues which hinder merging mechanically. Hence, I generate crosswalks between the CLO-i datasets and other datasets.

3.4.2 *Motivation: Evidence of Screening and Monitoring*

CLO managers are not passive buyers. They actively screen their investments. Figure 5.17 shows two dimensions through which CLO managers screen their portfolios: industry and lien. Discrepancies between the CLO distribution of loans at inception ("closing date"), and the underlying leveraged loan market, suggest that managers do not make indiscriminate purchases of leveraged loans. The top figure shows that CLO managers hold a disproportionately smaller amount of loans in the oil and gas industry, and larger amount in the telecommunications industry relative to the industry distribution of leveraged loan issuance.[4] The bottom figure shows that CLO managers typically hold onto a smaller share of second-lien loans relative to issuance.

CLO managers also monitor the quality of their investments. Figure 5.18 indicates that the trailing twelve month default rate among leveraged loans was 1.75% at the end of 2018, as compared to 2.4% at the end of 2017, based on Thomson Reuters' estimates. S&P places a higher estimate of the default rate for leveraged loans, ranging from 2.77% to 3.26% from 2015 through 2018. Regardless of the exact percentage, CLOs have reported a significantly lower default rate as compared to leveraged loans. The bottom figure in Figure 5.18 shows that among post-crisis vintage CLOs, 86% reported no defaulted assets in their portfolio, and 10% had 1-2% of principal in default at the end of 2018. This suggests that CLO managers take actions to reduce the risk of their portfolios.

To further explore the difference in default rates, I calculate the median projected default rate of CLO. The projected default rate is calculated under the assumption that CLOs are unable to make any trades from the closing date until maturity. The findings of this exercise are reported in Table 6.5. The projected default rate often exceeds the realized default rate on leveraged loans, and *far* exceeds the realized default rate of CLOs in every year (see Figure 10 of Kundu (2021*a*)). This suggests that managers

4. Historically, CLOs held a large share of asset-heavy businesses in the industrial sector. In particular, managers had sizeable exposures to the oil and gas industry. However, after the oil price plunge in 2015, managers reduced their exposure to the oil and gas industry by a significant margin, forming expectations on future performance.

may make riskier bets, ex-ante, and sell out of risky positions before the positions bear losses. This behavior may be explained by managerial incentives. When managers create CLOs, they focus on making the equity tranche attractive, because that is where the management fee is created. However, when the CLO is in operation, managers adjust their portfolio in response to covenant constraints. The discrepancy in the projected and realized default rates suggest that covenants play a critical role in mitigating agency frictions.

3.4.3 *Formulation of Hypotheses*

I formulate several empirical hypotheses based on a framework that captures the problem of CLO managers. The model integrates elements from DeMarzo (2005), Vayanos and Vila (2019), and Bolton, Chen and Wang (2011). The model has three main objectives: *(1)* to explain the origin of covenants, *(2)* to show that covenants can generate price pressure and trigger fire sales in the leveraged loan market, and *(3)* to connect price pressure of loans to the affected issuers' default policy. First, I explain that covenants arise to ensure that senior debt claims are virtually risk-free in securitization. Second, I show that covenants make CLO managers *preferred-habitat* investors, subject to unique shocks that may alter their demand. These shocks can transmit to asset prices via a market clearing condition, generating price pressure. Third, I show that the endogenous spread can affect a firm's optimal default policy. The model provides a framework for assessing tradeoffs in considering structural modifications of covenants, and, helps explain the empirical findings. The full model is described in Appendix A.6. There are six empirical predictions, derived from the model.

These predictions are centered on how covenants influence different characteristics of CLO and managerial trading behavior. Covenants are jointly determined between the stakeholders of the CLO. The main objective is to show that these covenants may have unintended consequences on loan prices. The ancillary objectives are to show that covenants can determine other features, intrinsic to the structure of CLOs.

3.4.4 Predictions

1. **Prediction #1:** CLO size increases in the stringency of covenant constraints
2. **Prediction #2:** Equity distributions increase in the performance of covenant constraints
3. **Prediction #3:** Share of risky assets decreases in the performance of covenant constraints
4. **Prediction #4:** Price impact decreases in the performance of covenant constraints
5. **Prediction #5:** Price impact increases in the scarcity of potential buyers' capital, i.e., lower arbitrageur demand
6. **Prediction #6:** Firms which experience downward price pressure are more likely to experience distress

In this paper, I provide empirical tests of Predictions 1, 2, 3 and 4. Empirical tests of Prediction 6 are provided in Kundu (2021*c*). Kundu (2021*c*) studies how diffuse idiosyncratic shocks can snowball into systemic rick as distress propagates to other portfolio firms through CLO intermediaries.

There are methodological challenges in implementing an empirical test of Prediction 5. Using data from Lipper Hedge Fund Database (TASS) and Thomson Reuters Lipper U.S. Mutual Funds, I find that the aggregated amount of potential buyers' capital increases over the sample period.[5] Hence, a regression of the price impact on buyers' potential capital cannot disentangle the effect of the time trend from the effect of the change in the supply of capital. Cross-sectional tests relating potential buyers' capital to price pressure through comparisons of different types of funds, e.g., industry-specific funds, may inform the estimated relation between the two variables. However, the limited number of distinct funds that constitute potential buyers, as well as the lack of variation in the composition of CLO assets, namely, by maturity and rating, suggest that the statistical power of the test is limited. With supplementary data on lapsed payments from CLOs, structural estimation techniques à la Koijen and Yogo

5. Potential buyers include bankruptcy-focused hedge funds, distressed markets hedge funds, private equity hedge funds, alternative event driven mutual funds, corporate debt funds BBB-rated, and loan participation Funds

(2019) may be used to study more broadly, how the degree of price pressure varies with the elasticity of arbitrageurs demand upon experiencing an exogenous shock. This provides an avenue of future work.

3.5 Price Patterns

The baseline empirical methodology is based on Ellul, Jotikasthira and Lundblad (2011).

$$P_{i,t} = (1 + A_{i,t}Q_{i,t}) \times E_t(V_i) \tag{3.3}$$

$$ln(\frac{P_{i,t}}{P_{i,t-1}}) \approx (A_{i,t}Q_{i,t} - A_{i,t-1}Q_{i,t-1}) + ln(\frac{E_t(V_i)}{E_{t-1}(V_i)}) \tag{3.4}$$

$$A_{i,t} = \gamma_0 + \gamma_1 ln(S_{i,t}) + \eta_{i,t} \tag{3.5}$$

The observed trade price, $P_{i,t}$ of loan i on date t is a function of the $E_t(V_i)$, $Q_{i,t}$, and $A_{i,t}$ which denote the fundamental value, purchase indicator (-1 for sale), and half spread (spread around the fundamental loan value), respectively. $A_{i,t}$, the half-spread is a function of the trade size, $S_{i,t}$ where $E(\eta_{i,t}) = 0$.

The regression specification is the following.

$$ln(\frac{E_t(V_i)}{E_{t-1}(V_i)}) = \alpha + \beta Z_{i,t-1,t} + \nu_{i,t-1,t} \tag{3.6}$$

By substitution, this yields:

$$ln(\frac{P_{i,t}}{P_{i,t-1}}) \approx \alpha + \beta Z_{i,t-1,t} + \gamma_0(Q_{i,t} - Q_{i,t-1}) + \gamma_1(Q_{i,t} ln(S_{i,t}) - Q_{i,t-1} ln(S_{i,t-1})) + \epsilon_{i,t-1,t} \tag{3.7}$$

where $E(\nu_{i,t-1,t}) = 0$ and $\epsilon_{i,t-1,t} = \nu_{i,t-1,t} + Q_{i,t}\eta_{i,t} - Q_{i,t-1}\eta_{i,t-1}$

Abnormal returns are measured using a simple market model. Given the similarities between loans and bonds, à la Merton (1974) and Ellul, Jotikasthira and Lundblad (2011), I specify the change in fundamental value as Z, a function of the following: (1) 5-Year Treasury Constant Maturity Rate (match duration of average leveraged loan),

(2) Barclay's Corporate IG Index Return, (3) Barclay's Corporate HY Index Return, (4) S&P 500 Index Return, (5) S&P/LSTA Leveraged Loan Index Return, (6) Thomson Reuters Analyst forecasted earnings per share. $Z_{i,t-1,t}$ denotes the vector of these components from $t-1$ to t. The change in the expected fundamental value is assumed to be a linear function of the realized change. The results are robust to alternative specifications including the use of realized earnings or firm's stock returns in lieu of forecasted earnings, and, loan-level control variables. However, the addition of these variables reduces the sample size substantially.

I use this regression specification to study the cumulative average abnormal return (CAAR), similar to Coval and Stafford (2007). After controlling for both market and issuer-specific changes in fundamental value, the abnormal return, $AR_{i,t-1,t}$, reflects the liquidity component associated with price changes. For each issuer-quarter, I compute the quarterly average abnormal return (AAR). The calculation of standard errors associated with the CAAR estimates is described in Appendix A.1. I normalize the AAR five quarters before bankruptcy default to zero. The AARs are accumulated to CAARs by quarters from default in the baseline specification. I compute the AARs based on quarters to ensure that the number of events remains sufficiently large. Quarterly CAARs are likely to be smaller than monthly or weekly CAARs, as taking the average across a large time horizon is likely to reduce the influence of egregiously abnormal trades during specific periods (see figure A.2.4 for quarterly aggregation). Hence, the quarterly CAAR estimates may be interpreted as a lower bound for the CAAR in any given period.

I segment the analysis based on the distance to the capital covenant thresholds, as CLOs operate closest to these constraints (see table 6.6). The aggregate price pressure effects are reported in Appendix A.2. There are typically three types of coverage covenants that CLOs are subject to: Overcollateralization (OC), Interest Diversion, and

Interest Coverage (IC).

$$OC/ID = \frac{\text{Par value of collateral+Defaulted collateral value}}{\text{Principal balance of tranche and all senior tranches}} + \\ + \frac{\text{Purchase price of discounted collateral-'CCC/Caa1' excess adjustment}}{\text{Principal balance of tranche and all senior tranches}} \tag{3.8}$$

$$IC = \frac{\text{Interest from collateral}}{\text{Interest due on tranche and senior tranches}} \tag{3.9}$$

The OC and ID covenants are *capital constraints* which are measured similarly; the ID covenant has a lower threshold than any of the OC covenants, and, if it is breached, proceeds are diverted towards the purchase of high-quality, value-increasing loans rather than paying down liabilities in order of seniority. The IC covenants are *liquidity constraints* which ensure that there is a specific level of coverage for interest due on tranches relative to the triggers. In the event that the IC covenant is breached, similar to the OC covenant, principal and interest is diverted towards paying down liabilities until the CLO is in compliance with the covenant restrictions.

I compare the CAAR of loans that are held by relatively capital-constrained CLOs with loans that are held by relatively capital-unconstrained CLOs in figure 5.19. A CLO is designated as "constrained" if its distance to the Interest Diversion covenant is below the median, and "unconstrained" otherwise. Hereafter, I use the term *covenant performance* to refer to the distance to the covenant threshold.[6] I find that loans which belong to constrained CLOs experience higher cumulative abnormal losses than loans belonging to unconstrained CLOs. In the quarter after default, the CAAR of loans held by CLOs that are capital-constrained is -4.09% as compared to -0.79% for loans held by CLOs that are capital-unconstrained. The CAAR of loans held by relatively unconstrained CLOs do not experience virtually any losses. In contrast, the loans held by constrained CLOs experience a sharp drop in the CAAR around default and a gradual recovery. There is persistence in the differences between the constrained and

6. Specifically, covenant performance is the ratio between its reported result on the constraint and the constraint threshold.

unconstrained groups, as shown in Appendix A.1. Figure A.1.1 presents the CAAR for a longer time horizon of [-9. 8] quarters around default, indicating that even several quarters after default, there are signs of growing divergence – CLOs that are relatively unconstrained experience higher CAAR relative to CLOs that are relatively constrained.

This begs the question, why do not potential buyers absorb the excess supply of loans, given arbitrage opportunities? It is profitable for potential buyers to exploit the discrepancy in cumulative returns, based on how constrained a CLO is. Buyers could increase profits by purchasing distressed loans from constrained CLOs at deeply discounted prices in the days around default and selling in the quarters thereafter.[7] Despite this, the total amount of purchase may be insufficient to completely eliminate arbitrage opportunities, as CLOs are marginal investors in the institutional loan market who are likely to experience similar constraints à la Shleifer and Vishny (1992). This makes the pool of potential buyers limited. Moreover, arbitrageurs may not be able to absorb shocks to demand because of limits to arbitrage. Akin to a Shleifer and Vishny (1997) setting, prospective buyers, including hedge funds and mutual funds, that specialize in distressed loans, use other people's capital in investment, which can impede their ability to correct for mispricing when it is most profitable to do so; outside investors of these funds cannot disentangle mispricing from errors in strategy, thus, when prices deteriorate and concomitantly, performance, outside investors may withdraw capital causing arbitrageurs to liquidate positions when the gains are greatest. Limits to arbitrage, in conjunction with the insufficiency of prospective buyers may explain why reversal takes several quarters.

3.5.1 What Explains the Price Pattern?

The observation that managers choose to divest of loans preemptively suggests that the cost of holding onto distressed loans and breaching a covenant, is greater than the

7. Alternatively, they may deploy a long-short strategy, buying loans from constrained CLOs and shorting loans, which did not end up getting securitized, issued by the same firms, or, from CLOs that are relatively unconstrained.

cost of premature selling. In this section, I investigate the relation between market price, decision to sell, and capital covenant ratio – specifically, the Interest Diversion ratio.

Before experiencing any distress, the manager's Interest Diversion covenant result is:

$$ID^{orig} = \frac{A}{L} = \frac{(1-\mu)A + \mu A}{L} = \frac{A}{L}, \tag{3.10}$$

where μ is the share of distressed loans that will experience default, A denotes the total value of loans (leveraged loans), and L denotes the total value of liabilities (notes).

Case #1: Loans Marked to Par Experience Default

If loans that are marked at par in a CLO portfolio experience default, the CLO manager has two options: sell the loan preemptively or hold onto the loan.

If the manager holds on to the distressed share through bankruptcy, the CLO's Interest Diversion ratio will become:

$$ID_1^{Keep} = \frac{(1-\mu)A + \mu\theta A}{L}, \tag{3.11}$$

where θ represents the lower of market value, or recovery value after default. This is lower than the initial ratio, ID^{orig}.

If the manager sells the distressed share preemptively at price γ, the CLO's Interest Diversion ratio will become:

$$ID_1^{\text{Sell}} = \frac{(1-\mu)A + \mu\gamma A}{L}, \tag{3.12}$$

where γ represents the prevailing market value.

Thus, the manager will sell the distressed share preemptively to loosen the constraint, as long as $\gamma \geq \theta$. This is plausible, as the prevailing market value, prior to default, is likely to be higher than the lower of the market price or recovery rate after default. This condition remains the same, even if the defaulted assets are accounted as CCC/Caa1 loans before default. I consider this case next.

Case #2: Loans in CCC/Caa1 Bin Experience Default

Let τ denote a CLO's limit of CCC/Caa1 loans. ρ denotes the share of CCC/Caa1 loans, and μ denotes the distressed share of the CCC/Caa1 and below that is soon to default ($\rho + \mu$ is the realized share of CCC/Caa1). Suppose $\rho + \mu > \tau$

Initially a CLO's Interest Diversion ratio is:

$$ID^{\text{CCC}} = \frac{(1 - (\mu + \rho - \tau))A + (\mu + \rho - \tau)\delta A}{L}, \tag{3.13}$$

where δ denotes the lowest market value of all loans in the CCC/Caa1 bin.

If the manager keeps the distressed loans through bankruptcy, the CLO's Interest Diversion ratio will become:

$$ID_2^{\text{Keep}} = \frac{(1 - (\mu + \rho - \tau))A + (\rho - \tau)\delta A + \mu\theta A}{L}. \tag{3.14}$$

If the manager sells the distressed loans preemptively at price γ, the CLO's Interest Diversion ratio will become:

$$ID_2^{\text{Sell}} = \frac{(1 - (\mu + \rho - \tau))A + (\rho - \tau)\delta A + \mu\gamma A}{L}. \tag{3.15}$$

The manager will sell distressed loans if $\gamma \geq \theta$.

This simple exercise demonstrates how accounting rules inherent in covenants can create price pressure around bankruptcy default events. Sharp changes in the accounting rules are a source of fragility in the market and can determine trading behavior around adverse credit events. CLO managers can mechanically improve performance on the capital constraints by selling loans with the largest difference between the market value and accounted value, to build par.

3.5.2 *Plausibility of Recovery Post-Default*

The recovery trajectory for defaulted loans is plausible. Managers can maximize their distance to the Interest Diversion covenant by selling loans in descending order of the difference between market value and accounted value. The loans that exhibit the greatest discrepancy are unlikely to be the worst performing loans. Hence, consistent with the model of Appendix A.6, bankruptcy may be an endogenous outcome of secondary market spreads – not necessarily tethered to firms' fundamental value. This provides an explanation for price recovery. Moreover, concerns of selection bias are relatively minute. There is no difference in the trajectory if I impose the same group of issuers pre- and post default. Attrition of issuers is $< 5\%$, indicating that the vast majority of firms that entered Chapter 11 bankruptcy from 2009-2018 emerged successfully.

Further, the nature of the claim may make impairment limited. CLOs hold senior secured debt, secured by collateral with a first lien. Senior secured debtholders experience the strongest creditor control and protection. They are ensured the collateral security as recourse in event of default and are entitled to the collateral until they are paid in full. In the event that the value of the collateral is below the value of the loan, the residual claim will rank with other unsecured claims and receive payment on a pro rata basis.

Moreover, recovery is enabled through restructuring of new and existing contracts and improvements to the capital structure. As observed, it takes between one to two years for the price to fully recover to par. According to the UCLA-LoPucki Bankruptcy Research Database, the annual average case duration ranges from 216-613 days in the sample period. Hence, the time to recovery is within reasonable range of the case duration. I compare the capital structure 6-18 months before bankruptcy, to the capital structure 6-18 months after bankruptcy for the firms in the sample in figure A.5.5. The total amount of debt falls by 56% after restructuring. There is approximately a 22% decline in the amount of secured debt, and 75% in the amount of unsecured debt. The reduction in old secured debt is likely understated, as it encompasses new issuance from restructuring, including DIP loans. Figure A.5.6 shows the relative changes in capital structure pre and post bankruptcy. The figure shows that the relative share of unsecured debt decreases after bankruptcy, while the relative share of secured debt increases. The decrease in debt may be attributed to debt-equity swaps or writeoffs. Strengthening of the capital structure can facilitate firm operations, providing a path for recovery. This provides another possible explanation for the price pattern.

Furthermore, anecdotal evidence indicates that the median discounted ultimate recovery of bank loans is 100% while the average is 82% (Emery, Cantor and Ou (2007)). As the percent of debt junior to bank debt increases, the bank loan recovery rate increases. The most likely ultimate recovery rate was reported to be 100% (average is 84.6%), occurring in almost two-thirds of cases for global project finance loans from 1983-2015 (Davison et al. (2017)). Further, the recovery rate has increased over time. In the COVID-19 era, it has been reported that bank loans with more than a 75% cushion reported a 94% average discounted recovery with very low variation among loans with similar cushions (Lukatsky (2020)). Larger cushions are characteristic of leveraged loans.

Lastly, the reversion in prices may also reflect two distinct types of premia aside from structural changes: *(1)* skills premium, and *(2)* liquidity premium. It may reflect compensation to more sophisticated investors who are effective navigators and negotiators of the bankruptcy process and can bear the costs of restructuring. That is, CLOs may sell distressed debt to loan-to-own players who may avail of the control rights associated with senior secured loans to increase returns. Alternatively, it may also reflect changes in the liquidity premia. Post-default, bank loans are less liquid and therefore earn a larger liquidity premium. This is likely larger for loans issued by firms, resembling fallen angels. The liquidity premium can explain larger declines in prices for higher rated loans. I explore the liquidity premium in the next section, comparing the CAAR across loan characteristics.

3.5.3 CAAR by Loan Characteristics

In this section, I investigate which loan characteristics may act as mitigating or amplifying factors. I compare the price pressure for distressed loans that are higher rated to those which are lower-rated, and, distressed loans that are of longer maturities to those of shorter maturities.

Figure 5.20 presents the CAAR for higher-rated issuers as compared with lower-rated issuers. "Higher-rated" loans are loans rated Baa3 and above. "Lower-rated" loans are all other loans. I find that lower-rated loans exhibit a lower CAAR than higher-rated loans. This is expected – deviations from fundamental values, which are informed by the ratings, are expected to be larger for firms with higher ratings as compared to firms with lower ratings around bankruptcy defaults, consistent with the explanation that CLOs sell their best risky loans – loans whose market values deviate from the accounted values by the greatest margin – in descending order to alleviate the capital constraints. One to two quarters before default, the CAAR of the higher-rated loans ranges from negative 4.12-5.41%, while the CAAR of the lower-rated loans ranges from negative 1.19-2.22%. The difference in the CAAR between the two categories ranges from 2.93-3.19%, and is statistically meaningful. Additionally, higher-rated loans reach their trough during the quarter of default, while lower-rated loans reach their trough in the quarter after default.

In figure 5.21, I analyze loans based on remaining maturity, and segment them into "longer" maturity loans, and "shorter" maturity loans, based on whether the remaining maturity is above or below the median remaining maturity. I find that while shorter maturity loans recover back to par relatively quickly, longer-maturity loans show a slower trajectory of rebounding. Three to four quarters after default, the difference in CAAR ranges from 4.71-8.10% and is statistically significant.

Bank loans that are less liquid earn a larger liquidity premium. After bankruptcy, longer-maturity loans and higher-rated loans are less liquid, hence, the associated liquidity premia may be higher. This is a potential explanation, underlying the observed relationships which show that higher-rated or longer-maturity loans experience a deeper trough, as compared to lower-rated loans or shorter-maturity loans.

3.5.4 *Do CLO Managers Cause Price Pressure or Respond to it?*

Thus far, the results establish that there is price pressure in the leveraged loan market around bankruptcies. However, it is unclear whether CLO managers cause price pressure or respond to it.[8] To study this, I look at second lien loan prices. second lien loans constitute a small sliver of a CLO manager's portfolio, as described in table 5.17 and table 5 of Kundu (2021*a*); CLO managers are not marginal investors of second lien loans. Therefore, if CLO managers *cause* price pressure, the impact is expected to be muted for second lien loans. Conversely, if the price effects of second lien loans are consistent with the patterns illustrated above, it may suggest that the source of price pressure is elsewhere. I plot the CAAR for second lien loans in figure 5.22. The CAAR of second lien loans does not exhibit any large reaction, until default. In the quarter of default, the CAAR is almost -40%. Moreover, the CAAR does not exhibit signs of recovery or reversal.[9] This suggests that the permanent adjustment in returns may be attributable to new information that is revealed upon default – not unanticipated demand shocks. Thus, this test substantiates the hypothesis that CLO managers create price pressure.

3.6 CLO Covenants

Thus far, I have documented selling patterns of defaulted loans around bankruptcy events. To ensure that the selling patterns are robust and not confounded by structural features of CLOs, I conduct a number of tests. The objective of these tests is to explore whether the trading behavior of CLO managers is attributable to structural aspects of the CLO, namely, age, affiliation, identity of the manager/CLO, time of trade, or quality of underlying issuers. I do not find distinguishable differences in these di-

8. The findings reported in section A.3 suggest that CLO managers contribute to price pressure, as the CLO trading patterns mirror the price patterns.

9. Even after extending the time horizon, CAAR remains stabilized around a new low

mensions. These findings are reported in Appendix A.3. Next, I investigate how CLO covenants may produce the trading and price effects with regard to distressed loans.

Quality and coverage covenants inherent in CLO managerial contracts check against risk-shifting behavior to ensure that the CLO managers appropriately screen and monitor their CLOs. In this section, I implement empirical tests for several of the predictions described in Section 3.4.3. I begin by studying which covenants, if any, serve as potential determinants of the share of risky loans. This can explain the preemptive selling decisions of CLOs.

There are a total of 780 covenant observations covered in the dataset. I restrict my sample to covenants which have more than 100 observations, and filter them into eight categories: Weighted Average Rating Factor (WARF), Weighted Average Spread (WAS), Weighted Average Life (WA Life), Interest Diversion, Senior Overcollateralization (Classes A/B), Junior Overcollateralization (Classes $<=$ D), Senior Interest Coverage (Classes A/B), Junior Interest Coverage (Classes $<=$ D), and Interest Diversion.[10] For a given covenant, I compute the covenant performance as the ratio between its current result and the current threshold.[11]

Table 6.6 shows the summary statistics for CLO characteristics, including constraints, CLO size, and equity distributions. Two of the maintain-or-improve covenants, WA Life and WARF, exhibit median values below the threshold of 1. The median capital constraint is slightly above one, while the median liquidity constraint exhibits a larger buffer from the threshold. In addition, the interquartile range of the capital constraints is $<$2% for the Interest Diversion constraint, $<$3% for the Junior OC constraint, and $<$15% for the Senior OC constraint. The liquidity constraints exhibit greater variation. The median annualized equity distribution and median CLO size are 17.63% and

10. Details on the covenants are described in Section 3.3 of this paper, and Section 3 of Kundu (2021*a*).

11. Table 2 of Kundu (2021*a*) shows the correlation across different covenants. Predictably, the Interest Diversion constraint is highly correlated with the Junior OC constraint – the two most restrictive capital constraints. The liquidity constraints exhibit high correlation amongst each other. The capital constraints are moderately correlated with the liquidity constraints. Liquidity constraints are moderately correlated with the Weighted Average Spread constraint. The quality constraints do not exhibit much correlation among each other, suggesting that the covenants capture different quality dimensions of the CLO portfolio.

$397 million, respectively, with significant variation across CLOs. Furthermore, the average share of risky loans is 9%; the average CCC/Caa1-bucket of a CLO is 6.5%, and the average percent of defaulted loans is 2.5% (Kundu (2021*a*)).

3.6.0.1 How do Covenants Affect Portfolio Management?

In this section, I study how covenants affect portfolio management by examining how managers' trading decisions are influenced by covenant restrictions. First, using a linear probability model, I study how the choice to sell risky loans is related to a CLO's quality and coverage covenant performances. Second, I study the sensitivity of risky loans to the covenant constraints by relating the levels and changes of the share of risky loans to the quality and coverage covenant performances. Across the regression specifications, I include manager-year, arranger, and trustee fixed effects, to ensure that the results are not driven by structural differences across CLOs. In addition, I control for performance, size, and CLO age, when appropriate. The standard errors are two-way clustered at the manager and year levels. I report the main findings below.

In table 6.7, I examine the relation between a manager's choice to sell risky loans and covenant performance – the extensive margin. Risky loans are defined as the sum of the share of CCC/Caa1-rated loans, defaulted loans and discount obligations. I winsorize 1% of the covenant performances and standardize them (mean = 0, standard deviation = 1) for ease of comparison and interpretation. A one standard deviation change in the Junior OC covenant performance (column 5), relative to the mean, is associated with a 3.8 percentage points decline in the probability that a manager sells risky loans. The estimated decline is 3 percentage points and 3.18 percentage points for a one standard deviation change in the Interest Diversion and Senior OC covenant performances (columns 3, 7), respectively, relative to their respective means. All three of these measures are capital constraints, reflecting a CLO's specific level of subordination and coverage, relative to the triggers associated with the tranches. Furthermore, the R^2 of the ID covenant is the largest among all the covenants, corroborating the price pressure analysis of section 3.5.

Next, I study how outcomes of risky loans, on the intensive margin, vary with the covenant performances. The results from this cross-sectional analysis are shown in table 6.8.

In Panel A, I examine the relation in levels between the covenant performance and the share of risky loans. Panel A of table 6.8 indicates that the share of risky loans is most strongly explained by the liquidity constraints. A one standard deviation increase in the Junior IC covenant performance (column 4), relative to the mean, is associated with a 1.71 percentage points decline in the share of risky loans. A one standard deviation increase in the Senior IC covenant performance (column 6), relative to the mean, is associated with a 0.77 percentage points decline in the share of risky loans.

In Panel B, I examine how the covenant performance in a given period is related to the subsequent trading of risky loans. The liquidity constraints are most strongly related to a change in the share of risky loans. A one standard deviation increase in the Junior IC covenant performance (column 4), relative to the mean, is associated with a 1.06 percentage points decline in the subsequent amount transacted. A one standard deviation increase in the Senior IC covenant performance (column 6), relative to the mean, is associated with a 0.41 percentage points decline in the subsequent amount transacted. The WAS covenant performance (column 1), which is moderately correlated with the liquidity covenant performance, also exhibits a strong relation, consistent with the maintain-or-improve conjecture; a higher WAS is associated with lower subsequent purchase of risky loans – a one standard deviation increase in the WAS covenant performance, relative to the mean, is associated with 0.58 percentage points decline.

In Panel C, I examine the reverse relation – how the change in the share of risky loans is related to changes in the covenant performances. I find that a 1 percentage point increase in the share of risky loans transacted is associated with a reduction in the Junior and Senior IC covenant performances (columns 4, 6) by 0.009 and 0.006 standard deviations, relative to their respective means. Moreover, a 1 percentage point increase in the share of risky loans transacted is associated with an increase in the WAS covenant performance by 0.01 standard deviations, relative to the mean.

Hence, these findings corroborate Prediction 3 – the share of risky loans decreases in the performance of covenant constraints. This can explain the trading decisions of CLO managers. Moreover, several additional tests of robustness, supporting the mechanism that covenants generate trading and price effects are reported in Appendix A.4, in which I consider different measures of the constraint and alternate empirical methodologies. I consider alternative mechanisms that may produce the established trading and price effects including private information, bankruptcy, and reputational concerns in Appendix A.5. Next, I examine how covenants affect other characteristics of CLO deals, namely, size and financial performance.

3.6.1 Covenants as Determinants of CLO Size and Equity Distributions

3.6.1.1 Covenants as Determinants of CLO Size

The presence of covenants ensure that senior claims are virtually risk-free, and provide opportunities for recourse in the event of breaches (Appendix A.6). In theory, the certainty associated with senior riskless claims should allow the CLO intermediary to raise more capital than in their absence. This is tested in the data. The results are presented in table 6.9. For ease of interpretation, the outcome variable, size, defined as log of total loans is standardized. The independent variable denotes the standardized *threshold* of the constraints. CLOs exhibit wide variation in the reported threshold values. Therefore, I scale all reported thresholds to lie between 0 and 10 pre-standardization.[12] The results are reported in table 6.9. As the threshold may vary across managers, I use a within manager-year estimator, and include arranger and trustee fixed effects to control for unobserved heterogeneity across agents involved with CLOs. Additionally, I control for the age of the CLO and financial performance.

There is a positive relation between coverage covenant thresholds and the size of

12. If the reported threshold is less than 10, there is no adjustment. If the reported threshold is between 10 and 100, I scale by a factor of 10. If the reported threshold is between 100 and 1000, I scale by a factor of 100.

the CLO. For coverage tests (columns 4-7), a higher threshold signifies greater stringency. I find that a one standard deviation increase in the Junior IC and Senior IC thresholds (columns 4, 6), relative to the means, is associated with an increase in the CLO size by 0.15 and 0.19 standard deviations, respectively. A one standard deviation increase in the Interest Diversion and Junior OC thresholds (column 5), relative to the means, is associated with an increase of 0.12 standard deviations in the size of the CLO. The effect of a one standard deviation increase in the Senior OC threshold (column 7) is economically meaningful, albeit statistically insignificant. Among the quality tests, the effect of the WAS threshold (column 1) is statistically significant – a one standard deviation increase in the Weighted Average Spread, relative to the mean, is associated with a 0.03 standard deviations reduction in the size. Thus, the evidence corroborates Prediction 1 that CLO size increases in the stringency of covenant constraints.

3.6.1.2 Covenants as Determinants of Equity Distributions

In this section, I study the relation between a CLO's equity distribution and covenant performance. In event of coverage covenant breaches, managers may be forced to divert equity proceeds towards the purchase of new collateral until the covenant is no longer breached. This can reduce equity distributions. Hence, I hypothesize that equity distributions increase in the performance of covenant constraints (Prediction 2). Table 6.10 presents the findings. I include CLO-year, arranger, and trustee fixed effects to control for unobserved heterogeneity in these dimensions. In addition, I control for the performance and age of the CLO. The outcome variable is a standardized measure of the equity distribution, and, the independent variable is the covenant performance.[13] I find that the equity distribution exhibits greatest sensitivity to the liquidity constraints. A one standard deviation increase in the Junior and Senior IC covenant performances (columns 6, 8), relative to their means, is associated with a 0.67 and 0.33 standard deviations increase in the equity distribution, respectively, relative to the mean. Using the leave-one-out methodology in column 9, the effect of a

13. Equity Distribution $= \frac{\text{Interest payment} \times \frac{12}{\text{Payment frequency}}}{\text{Par value of equity}} \times 100$

one standard deviation increase in the Junior IC covenant performance, relative to the mean, is larger than the estimate produced using the realized measure – a one standard deviation increase in the Junior IC covenant performance is associated with 0.76 standard deviations increase in the equity distribution, relative to the mean. For the quality tests, a one standard deviation increase in the performance of the WAS (column 1) and WARF (column 2) covenants, relative to their means, is associated with 0.32 and 0.47 standard deviations increase in the equity distribution, respectively. These results are consistent with Prediction 2.

In summary, I find compelling evidence that the choice to sell risky loans is most strongly associated with the capital constraints, while the amount of risky loans varies most with the liquidity constraints. In addition, I find that covenants can determine other features in the structure of CLOs. I find that there is a strong positive relation between the size of a CLO and the stringency of covenants, as well as the CLO's equity distribution and covenant performance.

3.7 Conclusion

This paper shows that CLO contracts have externalities on asset prices. I introduce several stylized facts about the role of CLOs in the intermediation of credit in the leveraged loan market. First, managers are not passive buy and hold investors, unlike their CDO counterparts. There is selection, monitoring and churn. Second, I provide evidence of price pressure around bankruptcy defaults. There are stark differences in returns for capital-constrained and unconstrained managers; the CAAR of loans held by CLOs that are relatively capital-constrained is -4.09% in the quarter after default, as compared to -0.79% for CLOs that are relatively capital-unconstrained. Lastly, differences are also apparent for loans of higher ratings as compared to loans of lower ratings, as well as loans of longer maturities as compared to loans of shorter maturities. These differences may be explained by liquidity premia.

What is the mechanism underlying these findings? CLOs sell loans issued by distressed firms before they file for bankruptcy. Managerial trading behavior is mainly driven by covenant considerations, as the propensity to sell risky loans is explained by distance from the capital constraints, while the amount of risky loans – in levels and changes – is explained by distance from the liquidity constraints. The design of covenants incentivize preemptive sales of distressed loans. In the measurement of the capital constraints (OC and Interest Diversion constraints), loans are marked at par value, unless they are defaulted, discount obligations, or in excess of a CCC/Caa1-limit. In this case, the "affected" loans are marked at the lowest market value of the loans belonging to the CCC/Caa1 bin. The kink in the accounting rules is a source of financial fragility. In addition to determining trading behavior, covenants may also determine the size of a CLO, as well as the equity distribution; a CLO's size increases in the stringency of the liquidity constraints while a CLO's equity distribution increases in the distance from the liquidity constraint. In addition to covenants, reputation and bankruptcy are two additional considerations that may influence managers' trading decisions.

Price pressure may culminate in fire sales if distressed loans are held disproportionately by relatively constrained CLOs, or if other institutional participants are also experiencing stress. In this case, financial frictions can extend the price recovery period, and amplify the magnitude of deviation. Encumbrances to liquidity provision à la Shleifer and Vishny (1992) may arise from search costs or slow-moving capital (e.g., Duffie, Gârleanu and Heje (2005); He and Krishnamurthy (2012); Duffie and Strulovici (2012); Acharya, Shin and Yorulmazer (2009); Brunnermeier and Pedersen (2009)), or other regulatory constraints. Given the low liquidity, macroeconomic risks emanating from the secondary loan market may magnify to a larger extent relative to risks from more liquid markets. This is a cause for concern if covenant constraints can trigger serial defaults. The externalities of covenants are studied in Kundu (2021*c*), spelling out how intermediary distress can propagate to other firms, making risk systemic. Aside from the systemic implications, price pressure may lead to further distress and potentially push issuers of leveraged loans *into* bankruptcy by increasing the cost of financing.

These unintended consequences of covenants intimate that while managerial contracts may be optimal in safeguarding the interests of the CLO manager and investors, concerns about price impact likely do not factor in the decisionmaking process or are of material consideration to either party. This begs the question, can structural modifications to covenants reduce price pressure in the market? Covenant modifications intended to alleviate fire sale risk may inadequately address agency frictions, namely, risk-shifting tendencies, and significantly affect the aggregate supply of credit to risky firms in the economy with broad effects on equilibrium asset prices. This produces tradeoffs between fire sale risk and risk-shifting tendencies with unclear ramifications regarding efficiency. Hence, the welfare implications of covenants remain ambiguous. Future theoretical work in this area can enrich the discussion on market efficiency at the intersection of optimal contracts and equilibrium asset prices.

CHAPTER 4

THE EXTERNALITIES OF FIRE SALES: EVIDENCE FROM COLLATERALIZED LOAN OBLIGATIONS

4.1 Introduction

Financial contracts include provisions intended to align incentives and mitigate capital market imperfections. However, some provisions in contracts may also catalyze fire sales and trigger amplification, fomenting instability. In this paper, I demonstrate how covenants that are intrinsic to collateralized loan obligation (CLO) managerial contracts may kindle fire sales after adverse shocks, affecting firms whose creditworthiness is orthogonal to the shocks themselves. Covenants fulfill critical objectives of mitigating agency frictions and allocating control rights, ex-ante, facilitating the expansion of credit in the economy. However, covenants may also introduce and amplify fire sale risk in some states of the world, ex-post, reducing the amount of credit in those states.

CLOs are the largest purchasers of leveraged loans and constitute an increasingly prominent source of credit to risky firms. To devolve risk in the post-financial crisis era of 2008, banks have shifted from an "originate-to-retain" model to "originate-to-distribute," diversifying credit and liquidity risks to a gamut of investors, chiefly, CLOs.[1] CLOs purchased nearly 75% of all syndicated institutional leveraged loans in 2019 and held 25% of all outstanding leveraged loans (pro rata and institutional) in 2020 (Leveraged Commentary and Data (2019); International Monetary Fund (2020)). However, greater diversification has also contributed to the opacity and complexity of interconnections between the traditional banking and rising shadow banking sectors. The Federal Reserve recently warned that the secondary market for leveraged loans is not liquid and during times of stress, price declines from CLO loan sales may be exces-

1. I refer readers to Kundu (2021*a*) for a comprehensive overview of the leveraged loan and CLO markets.

sive (Board of Governors (2019)).[2] The Bank of England outlined the risk to financial institutions, emphasizing the high concentration of leveraged loans among bank and non-bank institutions with uncertain implications on firm financing (Financial Policy Committee (2019)).[3] The Financial Stability Board has raised questions about the risk to borrowers, stating: "Shocks arising from outside of the leveraged loan and CLO markets that place intermediaries under financial strain, could impair the supply of capital to leveraged borrowers or cause other intermediaries in the market to become unable to offload exposures to leveraged borrowers" (Federal Stability Board (2019)). Understanding the externalities of covenants is critical from a policy perspective for informing regulatory intervention and developing targeted and well-grounded guidelines (Stein (2013)).

Underlying the CLO market is a set of legal indentures, mutually agreed upon by the core trinity of CLO participants: arranger, manager, and trustee. A CLO indenture governs the operations and activities a CLO manager may undertake. Broadly, CLO liabilities are of two forms: debt tranches and equity tranches. Without any contractual embellishments, the inherent structure of a CLO produces agency frictions. The manager's interests are most aligned with the equity class; their compensation consists of a fixed fee and subordinated fees that are proportional to the residual interest available to the equity class. The manager may maximize cash flow by shifting investment decisions in favor of the equity class at the expense of debtholders. Thus, covenants intrinsic to managerial contracts serve as disciplining devices to curtail against risk-shifting behavior and protect debtholders, mitigating conflicts of interest. Specifically, violation of coverage covenants – which ensure that there is a specific level of coverage

2. "Investors in CLOs ... face the risk that strains within the underlying loan pool will result in unexpected losses ... The secondary market is not very liquid even in normal times, and liquidity is likely to deteriorate in times of stress, which could amplify any price declines. It is hard to know with certainty how today's CLO structures and investors would fare in a prolonged period of stress" (Board of Governors (2019)).

3. "Globally, banks account for more than half of the financial system's exposure to leveraged loans...Non-bank investors also have significant holdings of leveraged loans. Leveraged loan holdings by open-ended investment funds are significantly higher than pre-crisis, and large-scale redemptions during stress could amplify price falls. In a stress, the leveraged loan and high-yield corporate bond markets may not be sufficiently liquid to meet demand from borrowers, potentially restricting corporates from accessing funds" (Financial Policy Committee (2019)).

and subordination relative to the covenant triggers for each tranche – may be punitive, as proceeds intended for junior tranches, management fees, and equity distributions may be diverted towards prematurely paying down liabilities in order of seniority or towards the purchase of higher-quality collateral, until the CLO is in compliance with its constraints. Therefore, covenants also provide a mechanism for allocating control rights between debt and equity investors. Unlike in other settings, covenants in CLO indentures are not renegotiable, reducing the potential for the ex-ante hold-up of investment decisions, ex-ante (Gârleanu and Zwiebel (2009)).

The objective of this paper is twofold: *(1)* to understand whether contracts have externalities on asset prices, and if so, *(2)* to explore the mechanism through which firm distress can propagate to other firms. I postulate that shocks can propagate through capital markets via CLO fire sales. Although covenants are largely effective tools in addressing agency frictions, in some states of the world, they can generate forced sales. The markets for loans and corporate debt are relatively illiquid; hence, CLO forced sales can have material effects on the prices of debt securities, even if the creditworthiness of the debt's issuer is unchanged.

For illustration of the mechanism through which idiosyncratic risk may amplify to systemic risk, consider the following microcosm of the empirical setting, as presented in Figure 5.23. Firms and CLO intermediaries can be conceived as a web. In the network, CLOs purchase loans issued by firms, which are represented by the outer circles, and firms are connected to other firms through the CLO. The spokes are bidirectional because firm performance affects cash flows to CLOs, and intermediary distress may also transmit to firms (left figure). If a firm experiences extreme distress, as represented by the red outer circle, a CLO may be pushed against its constraints, as represented by the pink color (center figure). In this event, the CLO manager will sell loans issued by the distressed firm preemptively to eliminate the risk of becoming further constrained, thereby disconnecting the red firm in the diagram (Kundu (2021*b*)). Furthermore, the CLO manager may sell other unrelated risky loans – loans issued by innocent bystanders with no direct exposure to the source of distress – to generate more slack in the constraints, represented by the pink firms with dashed connections to the CLO (right figure). Thus, financial constraints may potentially create a cycle. If a firm becomes distressed and a CLO is pushed against its constraints, the manager may sell the distressed loan as well as sell loans issued by innocent bystanders. This action may alleviate CLO constraints. However, it may also ultimately sow the seeds of future distress (bottom figure). In this paper, I focus on how actions the CLO manager takes affect innocent bystanders.

I begin by first describing the institutional background and the covenants intrinsic to CLO managerial contracts. I demonstrate how the accounting of covenant constraints gives rise to opportunities for *contractual arbitrage*. Specifically, the piecewise nature of accounting of covenant constraints incentivize constrained CLO managers to sell loans issued by the riskier segment of firms. The loans in this segment may be accounted below market value, unlike the remaining portfolio, which is marked at book value. CLO managers may maximize improvements to the capital constraints by selling the best of the riskier loans which recover the highest market values but is accounted for at lower valuations. This framework proffers conjectures regarding the distributional effects of fire sales.

To study the externalities of fire sales, I use a Bartik-style difference-in-differences identification strategy, exploiting the timing of the oil price plunge in 2014, as well as cross-sectional variation in the oil and gas (O&G) exposure before the shock. After the oil price plunge, CLOs with higher O&G exposure experienced a tightening in their capital constraints, relative to CLOs with lower O&G exposure. The level of constraint directly affects selling pressure experienced by CLOs, which in turn, affects the prices of debt securities issued by innocent bystanders. In the ideal thought experiment, the objective is to compare the differences in outcomes between two virtually identical innocent bystanders, held in different CLO portfolios with varying O&G exposures, after the O&G price plunge. This empirical design largely circumvents concerns about non-random matching between CLOs and portfolio firms. I find the O&G share is related to the distance to the capital constraints. A 1 pp increase in the O&G share before the shock is associated with a 0.05 to 0.08 standard deviations decline in the distance to the most stringent capital constraint covenant, after the shock. I argue the O&G price plunge was exogenous, and conduct a battery of tests to study selection.

I proceed in several steps. First, I find evidence of increased selling after the shock. A 1 pp in a firm's exposure to O&G through CLOs, before the shock, is associated with 0.106 to 0.182 standard deviations decline in the transaction amount. Second, I study the effects on asset prices. I find a 1 pp increase in a firm's exposure to O&G through CLOs, before the shock, is associated with a decline of $0.67-$1.82 in the secondary loan price, an increase of 18-23 bps in the primary loan spread, an increase of 28-35 bps in the bond credit spread, a 0.03 standard deviations decline in the quarterly change in the unused line of credit, and a 0.03 standard deviations increase in the quarterly change in the drawn line of credit. The increase in the spreads across different forms of debt instruments is explained through a variation of a no-arbitrage argument that connects fire sales to credit crunch effects. In market equilibrium, the expected rate of return for any form of debt issued by a firm is equalized; therefore, for affected innocent bystanders, their effective cost of capital may increase.

Next, I study the real effects to firms. I examine how non-O&G portfolio firms respond. I find that before the shock, a 1 pp increase in a firm's exposure to O&G through CLOs is associated with a 0.04 standard deviations decline in long-term debt growth, a 0.03 standard deviations decline in cash flow, a 0.04 standard deviations decline in investment, a 0.09 standard deviations decline in R&D growth, and a 0.04 standard deviations decline in employment growth, after the shock. Correspondingly, before the shock, a 1 pp increase in a firm's exposure to O&G through CLOs is associated with a 0.3 pp decline in monthly equity returns, after the shock. Further, I study how investment responds across different characteristics of firms. I find that firms that do not have access to the bond market, smaller firms, younger firms, firms in the tradable sector, and firms that had last refinanced before the shock drive the aggregate decline in investment. This finding corroborates the hypothesis that firms that are more bank-dependent are most vulnerable to intermediary constraints. The link between financial market dislocations and real effects is plausible. The dislocation in asset prices endures up to seven quarters – long enough for real effects to materialize. This finding suggests that a temporary episode of distress can damage firms for a longer-term – an externality of "short-termist" damage control.

An opposing hypothesis to contractual arbitrage is that CLOs sell loans that trade above par while purchasing those below par. I find direct evidence that the likelihood of selling a loan above (below) par decreases (increases) in the degree of constraint, after the shock. Further, the interest rates and incidence of default associated with portfolio loans also decline in the degree of constraint, after the shock. I show that CLOs that had higher O&G exposure before the shock decrease their share of risky loans afterwards by more than CLOs that had lower O&G exposure before the shock. Lastly, as confirmatory evidence, consistent with contractual arbitrage, I find that a 1 pp increase in a firm's exposure to O&G through CLOs, before the shock, is associated with a decline of $2.32 in the secondary loan price (per $100 par), a 56 bps increase in the primary loan spread, and a 0.12 standard deviations decline in investment, among risky firms – firms that defaulted on a loan at some point in the sample – after the shock. These point estimates are economically meaningful, statistically significant, and stable, standing in contrast to the estimates produced for non-risky firms.

For external validity, I study whether the proposed mechanism is consistent with the findings from a more recent crisis: the COVID-19 pandemic. As I conduct my analysis for a relatively benign macroeconomic period – from 2013-2015, it raises concerns for what may occur when markets become more 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, simultaneous default may have disastrous implications (Federal Stability Board (2019)). I replicate the baseline result using the COVID-19 shock for external validity and to study how the magnitude changes under a larger, adverse shocks. The identifying assumption of 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 the analysis is from January 1, 2020 to May 6, 2020. I restrict the time horizon to prevent "contamination" from federal interventions. I use various measures of exposure to different vulnerable industries and show that the estimate across all specifications is larger in magnitude than that of the baseline analysis. Hence, the effect is expected to be larger during crisis periods with limited intervention.

This work provides two novel contributions. First, I show that intermediaries that operate in a market setting may serve as a linchpin between financial markets and real economic activity – distinct from the standard credit supply shock channel of banks. Second, I show that when intermediaries become constrained, they sell the riskier segment of loans rather than the safest loans. This fire sale is an unintended consequence of the design of optimal contracts.

This paper contributes to the existing literature by providing evidence of how a source of market financing can affect firm financial decisions through covenants, standing in contrast to a rich literature base on credit supply shocks that has focused on bank lending relationships. Bank intermediaries are known to be more efficient at resolving informational asymmetries than the market, by developing unique relationships with firms, allowing for close monitoring. If a bank collapses, naturally, dependent borrowers may also be in distress. Theoretical work emphasizes how shocks to bank capital can affect real economic outcomes through the credit channel (e.g., Bernanke and Blinder (1988); Bernanke and Gertler (1989); Holmstrom and Tirole (1997)). Empirical work, exploiting variation through the use of instruments and natural experiments, investigates how changes in bank credit supply affect real economic outcomes with varying deductions (e.g., Kashyap, Lamont and Stein (1994); Gerlter and Gilchrist (1994); Kashyap and Stein (2000); Peek and Rosengren (2000); Khwaja and Mian (2008); Paravisini (2008); Ivashina and Scharfstein (2010); Chava and Purnanandam (2011); Benmelech, Bergman and Seru (2011); Schnabl (2012); Chodorow-Reich (2014); Huber (2018); Amiti and Weinstein (2018); Kundu and Vats (2021)). CLOs, in contrast, are at arm's length. They are institutions that hold bank loans. CLOs are not directly involved with firms, nor do they possess any firm-specific private information about fundamentals (Kundu (2021*b*)). Thus, the finding that frictions in capital markets can transmit to firms is a novel contribution.

This paper is also related to the literature on fire sales. I show fire sale risk can transpire in closed-end funds due to contractual frictions – not triggered by withdrawals or demandable deposits, building off of results in Kundu (2021*b*). When CLOs experience constraint, they sell the riskier segment of loans to alleviate the capital constraints associated with the covenants. This result is in contrast to prior work that posits that intermediaries sell their most liquid loans to minimize selling costs and fire sale discounts. The main distinction is the underlying mechanism of fire sales. The extant literature examines various mechanisms through which fire sale risk can materialize (e.g., Shleifer and Vishny (1992); Shleifer and Vishny (1997); Pulvino (1998); Coval and Stafford (2007); Mitchell, Pedersen and Pulvino (2007); Caballero and Simsek (2013); Jotikasthira, Lundblad and Ramadorai (2012*b*); Campbell, Giglio and Pathak (2011)). I contribute to this literature by showing that covenants intrinsic to optimal contracts may foment financial instability. Specifically, I demonstrate that the accounting of covenant constraints may influence the incentives of CLO managers and their trading decisions, by extension. The piecewise treatment of covenant constraints may explain why CLO managers sell riskier loans. Further, I show that forced sales in the relatively illiquid secondary loan market may spill over to other financial markets with real effects at the firm level.

The roadmap for the paper is as follows. I explain the institutional setting and contractual arbitrage in section 4.2. The data sources used in this study are described in section 4.3. The empirical strategy used in this analysis is discussed in section 4.4. I present the main results in section 4.5. I explore the underlying mechanism in section 4.6. The checks for external validity are described in section 4.7. Lastly, I conclude in section 4.8.

4.2 Institutional Background

In this section, I provide a pithy summary of how CLOs function. For a more detailed discussion, I refer the readers to Kundu (2021*a*).

A CLO operates as a *special purpose vehicle* that issues tranched asset-backed securities or notes, and uses the proceeds to finance the purchase of the underlying portfolio of leveraged loans. From a balance sheet perspective, the loans of a CLO consist of leveraged loans, and, the liabilities consist of notes that are issued to investors. Higher-rated tranches have lower risk and pay out lower returns relative to lower-rated tranches which have higher risk and higher returns. There are two categories of tranches: debt tranches and equity tranches. Debt tranches are paid a fixed spread above LIBOR based on seniority. The equity tranche receives the remaining spread after proceeds from the underlying loans have been distributed towards senior liabilities. The objective of the CLO is to maximize the excess spread.

As the financial interests of a CLO manager are most aligned with the equity class – a manager's compensation consists of a fixed fee and subordinated fees that are proportional to the residual interest available to the equity class – managers have incentives to risk-shift in favor of the equity class to maximize revenue.[4] Debt investors do not benefit from excess risk or returns because they are paid a fixed spread above LIBOR based on seniority. As monitoring a manager's investment decisions and verifying cash flows may be costly from the perspective of debt investors, covenants are in place to address the risk-shifting motives of CLO managers.

Covenants serve as disciplining devices for managers to adequately screen and monitor their investments. Covenants allow investors to exert control when incentives conflicts. There are two classes of covenants: quality covenants and coverage covenants. Quality covenants are maintain-or-improve constraints. These constraints do not directly prescribe any action to the managers in the event of a breach. In event that a quality covenant is triggered, the manager must maintain the credit quality of the portfolio and may not make trades that may worsen the credit quality. In contrast to quality covenants, if coverage covenants are triggered, proceeds from the underlying loans may be diverted from junior tranches, junior management fees and equity distributions towards paying down liabilities in order of seniority, prematurely or to-

4. If managers are residual claimants, i.e., have skin-in-the-game, managers may have even greater incentives to risk-shift.

wards the purchase of "higher-quality" collateral. Coverage covenants may be financially costly to the manager in several ways. First, fees and payments may be siphoned off from the manager and other junior stakeholders. These constraints may impair the manager in optimizing the portfolio. 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.

Given the "course-correcting" nature of coverage covenants, I center my focus on these covenants. There are three types of coverage covenants that CLOs are typically subject to: Overcollateralization (OC) covenants, Interest Diversion (ID) covenants, and Interest Coverage (IC) covenants. The OC and ID covenants are *capital constraints*, 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 OC and ID covenants are measured similarly, with two caveats. First, the ID covenant has a lower threshold, hence, it is triggered before any of the OC covenants. Second, if the ID covenant is breached, proceeds are diverted towards the purchase of high-quality, value-increasing loans to eliminate the opportunity for asset substitution. This contrasts with the consequences of violating OC covenants, which force 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 constraints*. 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, cushions for principal losses for more senior tranches.

CLOs operate closest to the ID constraint. From 2009-2018, CLOs operated within a 3% margin of the ID threshold, 5% margin of the Junior OC threshold, and 109% margin of the Junior IC threshold (Kundu (2021*b*)). Given the variation in the degree of constraint across covenants, I narrow my attention to the capital constraints.

$$\frac{\text{Par value of collateral+Defaulted collateral value+Purchase price of discounted collateral-'CCC' excess adjustment}}{\text{Principal balance of tranche and all senior tranches}} \tag{4.1}$$

In the calculation of the capital constraints, 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, a loan is marked to the lower of market value and recovery value, lowest market values of the CCC/Caa1 bucket, or purchase price until the loan trades above a threshold (typically 90 cents/$) for more than 30 days, respectively. I discuss the implications of these accounting rules next.

4.2.1 Contractual Arbitrage

The piecewise nature of the accounting of covenant constraints can influence the incentives of CLO managers in their selling behavior. Consider the following illustration of how CLO managers can engage 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, as discussed in Section 4.6.3.

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 subject to mark-to-market accounting at the lowest market value of 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. Moreover, for simplicity, assume that there are two types of assets in the portfolio – bad, risky assets, and good, risky assets – the sum of which count towards the CCC/Caa1 limit, τ. The share of bad, risky assets is denoted by ρ while the share of good, risky assets is denoted by μ. 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.

Suppose the CLO breaches its limit on CCC/Caa1 loans, i.e., $\rho + \mu > \tau$. Consequently, the capital constraints will tighten and the OC/ID ratio will be:

$$OC/ID = \frac{(1 - (\rho + \mu - \tau))A + (\rho + \mu - \tau)\delta A}{L}. \tag{4.2}$$

Selling the good, risky assets, μ from the portfolio at market price γ may loosen the capital constraints. It can improve the capital constraints by $\frac{\mu(\gamma-\delta)A}{L}$. The new OC/ID ratio is:

$$OC/ID = \frac{(1 - (\rho + \mu - \tau))A + (\rho - \tau)\delta A + \mu\gamma A}{L}. \tag{4.3}$$

However, the CLO suffers a financial loss – the total book value of the assets declines by $\mu(1 - \gamma)A$. Hence, there is a tradeoff between loosening the constraint and CLO profits. This illustrative example demonstrates how a CLO can maximize improvements to its capital constraints 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.

This provides an explanation behind one of the main findings of this paper, namely, CLO managers sell their best risky loans while keeping the worst ones. This type of value-destructive trading – giving up the upside in good times for mitigating risk in bad times – may be a source of contagion across markets and pose risks to financial stability. I discuss this further in Section 4.6.3.

4.3 Data

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 of this study is 2013-2015.

The primary data source is the *CreditFlux CLO-i Database*, which provides information on over 35,000 trustee reports, prospectuses, and covers over 1,200 CLOs in the US. CreditFlux provides granular data on CLO transactions and their associated prices, holdings, covenants, tranches, and equity distributions. In 2019, the CLO-i database covered 67% to 76% of the market, whereas in earlier years, the coverage seems to have been 46% to 65% of the market (Kundu (2021*a*); Benmelech, Dlugosz and Ivashina (2012)). Additional information on coverage and characteristics of the data are described in the Data section of Kundu (2021*b*). I restrict my analysis to firms that received a syndicated loan, as reflected by 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. This database contains extensive and comprehensive data on the terms of loan pricing contracts that is sourced from both SEC filings and directly from lenders and borrowers. The processed data covers a total of 1,429 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 WRDS Bond Database provides comprehensive coverage of all traded corporate bond issues, sourced from TRACE Standard and TRACE Enhanced. The dataset includes information on bond types, monthly prices, returns, coupons, and yields. The processed dataset covers a total of 136 distinct issuers. I retrieve monthly equity returns from CRSP. CRSP provides information on individual securities, including identity information, price histories and trading volumes, delisting information, distribution history, and share outstanding values. 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. Compustat provides data on firm fundamentals from balance sheets, statements of cash flows, income statements, and supplemental data items. I describe the construction of firm-level variables in section B.2.

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 457 distinct issuers. I use Capital Structure data to understand the dynamics of firm liquidity, specifically, data on lines of credit. This data is sourced from press releases, company websites, and stock exchanges as well as through direct feeds from SEC, SEDAR, ASX, and RNS. The processed dataset covers a total of 315 distinct issuers. Both datasets are collapsed to the quarterly frequency.

Lastly, I use two time-series data series 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. I also use the GDP Implicit Price Deflator for adjusting nominal firm fundamentals.

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 and databases. 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, Capital IQ's Identifier Converter, and the Roberts Dealscan-Compustat Linking Database (Chava and Roberts (2008)).

4.4 Motivation and Empirical Strategy

In this section, I describe the motivation and empirical strategy underlying my findings.

4.4.1 Motivation

CLO covenant constraints can influence managerial trading behavior. In this section, I present two pieces of evidence that demonstrate how covenant performance may determine trading decisions with unintended price effects.

First, I examine heterogeneity in price pressure around Chapter 11 bankruptcy defaults. In Figure 5.24, I plot the price pattern around bankruptcy defaults for three categories of loans: the cumulative abnormal average returns (CAAR) for loans that are issued by distressed firms and held by constrained CLOs ("Dist. Constrained," shown in red), loans issued by distressed firms and held by unconstrained CLOs ("Dist. Unconstrained," shown in blue), and, non-distressed firms held by constrained CLOs ("Non-dist., Constrained," shown in red) around firm bankruptcy.[5] A CLO is constrained if its performance on the Interest Diversion constraint is below the median.[6] *Non-dist., Constrained* loans are loans that are issued by non-distressed firms and held by constrained CLOs. I match this set of non-distressed firms to distressed firms that *do* file for Chapter 11 bankruptcy, based on similar industry and size characteristics. The *Non-dist., Constrained* set of firms present a counterfactual for how non-O&G non-risky firms held by constrained CLOs perform relative to non-O&G risky firms held by constrained CLOs. The average abnormal returns are normalized to zero, five quarters before bankruptcy default.

I find distressed firms held by unconstrained CLOs. as well as non-distressed firms

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5. The specification is

$$ln(\frac{P_{i,t}}{P_{i,t-1}}) \approx \alpha + \beta Z_{i,t-1,t} + \gamma_0(Q_{i,t} - Q_{i,t-1}) + \gamma_1(Q_{i,t}ln(S_{i,t}) - Q_{i,t-1}ln(S_{i,t-1})) + \epsilon_{i,t-1,t}$$

where $P_{i,t}$ of loan i on date t is a function of the $E_t(V_i)$, $Q_{i,t}$, and $A_{i,t}$, which denote the fundamental value, purchase indicator (-1 for sale), and half spread (spread around the fundamental loan value), change in fundamental value is Z is a function of the following: (1) 5-Year Treasury Constant Maturity Rate (match duration of average leveraged loan); (2) Barclay's Corporate IG Index Return; (3) Barclay's Corporate HY Index Return; (4) S&P 500 Index Return; (5) S&P/LSTA Leveraged Loan Index Return. $Z_{i,t-1,t}$ denotes the vector of these components from $t-1$ to t. Identifying assumptions are: $E(\nu_{i,t-1,t}) = 0$ and $\epsilon_{i,t-1,t} = \nu_{i,t-1,t} + Q_{i,t}\eta_{i,t} - Q_{i,t-1}\eta_{i,t-1}$. Origins of this specification are described in section 4.1 of Kundu (2021*b*).

6. Loans that fall in the constrained category are analogous to loans issued by WidgetCo B held by CLO B. Loans that fall in the unconstrained category are analogous to loans issued by WidgetCo A held by CLO A using the empirical framework of section 4.4.2.

held by constrained CLOs, exhibit virtually no impairment around firm bankruptcies. However, distressed firms that are held by constrained CLOs exhibit price pressure with a significant decline and reversal around default. At the trough, loans held by constrained CLOs experience a 5% cumulative abnormal average return, relative to the return five quarters before default.[7] CLOs trade at fire sale prices upon experiencing capital constraints. The reversal is explained by subsequent positive abnormal returns that compensate liquidity providers.[8]

Further, I examine the relation between the propensity to sell mark-to-market or risky loans and covenant performance in Table B.1.1. Risky loans are defined as loans rated CCC/Caa1 or worse in excess of the CCC/Caa1 limit, discount obligations, or defaulted loans. I use a linear probability model, exploiting variation within manager-year to examine how distance to the covenant threshold affects the likelihood of a risky sale.[9] The outcome variable takes a value of 1 if the CLO sells risky loans, and 0 otherwise. I find that a one standard deviation loosening in the capital constraints – shown in columns 3, 5, and 7 for the ID, junior OC, and senior OC covenants, respectively – relative to the mean, is associated with a 3% decline in the likelihood of selling risky loans, after accounting for structural aspects of CLOs through additional arranger and trustee fixed effects. In addition, the R^2 of the ID covenant is the largest among all the covenants.[10] The results from this exercise inform the choice to restrict the analysis to the capital constraints, and in particular, the ID covenant – the most stringent capital constraint.

7. Quarterly CAARs are likely to be smaller than monthly CAARs. Taking the average across a larger time horizon attenuates the influence of anomalous and egregiously abnormal trades.

8. A common hypothesis is that information revelation explains these findings. If information revelation informed selling behavior, the price would fall to a new level and stabilize there. The lack of "flattening" in prices suggests trades are not driven by new information. Other hypotheses as well as implications are discussion in Kundu (2021*b*).

9. 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 (Loumioti and Vasvari (2019)).

10. The *propensity* of selling risky loans is most strongly associated with performance on the capital constraints (OC and ID covenants), whereas the *amount* exhibits greatest sensitivity to the liquidity constraints (IC covenants), as shown in Kundu (2021*b*). For a comprehensive examination of competing hypotheses and detailed discussion of the relation between covenants and trading patterns, see Kundu (2021*b*).

These two pieces of motivating evidence demonstrate *(1)* covenants produce price effects around bankruptcy default events, and, *(2)* covenants produce trading effects. These stylized facts motivate the study of how trading decisions and price patterns may be mechanical responses of innocent bystanders to CLO forced sales.

4.4.2 *Empirical Methodology*

The ultimate objective of this paper is to identify how CLO covenants determine the transmission of shocks. However, reliance on explicit measures of CLO health through performance measures, including distance to covenant thresholds, may raise concerns about non-random matching between CLOs and firms. To circumvent these selection concerns, I exploit cross-sectional variation in exposure to the O&G industry before the shock as a measure of risk that directly affects the capital constraint. In addition, I exploit the timing of the O&G price plunge to analyze the impact of the shock.

Consider the following thought experiment, as depicted in Figure 5.25. There are two CLOs: CLO A and CLO B. CLO A does not hold any firms operating in the O&G industry. CLO B has a sizeable exposure to firms in the O&G industry. With the exception of O&G exposure, suppose that both CLOs both hold a similar portfolio of loans issued by comparable firms in their respective portfolios. When the O&G price plunge occurs, CLO A is unaffected because it is not exposed to O&G. However, CLO B may operate closer to its covenant thresholds, as many O&G firms may be in distress and fall back on interest/principal payments. If CLO A contains a loan issued by WidgetCo A and CLO B contains a loan issued by WidgetCo B – both of which are vulnerable to fire sales – the main objective of this paper is to study if any differential effects occur for WidgetCo A as compared with WidgetCo B, simply based on differences in the distance to covenant triggers. Broadly, how do idiosyncratic shocks propagate to other portfolio firms through CLO intermediaries?

4.4.3 *Specification*

The baseline specification is a Bartik-style exposure difference-in-differences design. The sample period of study is 2013-2015:

$$
\begin{aligned}
Y_{f,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t \\
+ \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \alpha_f + \alpha_{m,y} + \epsilon_{f,t},
\end{aligned}
\quad (4.4)
$$

where f denotes the portfolio non-O&G firm ($f \in$ CLO c), t indexes the time, and m, y denote the month and year, respectively. Firm O&G Exposure$_f$ measures the issuer amount-weighted average O&G share of non-O&G firm f across all CLOs before the shock occurs, in the pre-period. Oil Shock$_t$ is an indicator variable that takes a value of 1 if the O&G price plunge has occurred, and 0 otherwise. For simplicity, I refer to the *Oil Shock* variable as *Post*, hereafter.[11] 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 the CLOs.

Several assumptions underlie this empirical specification. In the remaining section, I will establish credibility of this design.

4.4.3.1 Concern #1: Exogeneity

A common concern with difference-in-differences specifications for causal inference is the exogeneity of shocks. If the shock is not exogenous, the policy may be correlated with the errors, causing inconsistency of the estimators. I argue the O&G price plunge is exogenous. Figure 5.26 exhibits the average crude oil price ($ per barrel) from 1960 through 2020.[12] The price precipitously dropped starting from June 2014 to 2016 – one of the three largest declines since World War II, and the longest-lasting since the

11. Goldsmith-Pinkham, Sorkin and Swift (2020) recommends measuring controls in the same time period as the shares. As I directly include firm fixed effects, I do not add firm-specific controls to the regressions.

12. See Figure B.1.1 for the monthly crude oil price trend.

supply-driven price plunge of 1986 (Stocker, Baffes and Vorisek (2018)).[13]

Several major factors contributed to the oil price plunge. First, booming shale production in the US and improvements in fracking technology reduced break-even prices of shale production; post-crisis financing conditions facilitated improvements in oil extraction through hydraulic fracking and horizontal drilling.[14] Given the shorter life cycle of these projects and lower capital costs relative to conventional extracting methods, shale oil is more elastic to oil price changes than crude oil (e.g., 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 contemporaneous demand shocks also occurred contemporaneously, for example, stock market turbulence experienced in China, 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.

4.4.3.2 Concern #2 with Strategy: Selection

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 or purchase different loans. This may manifest as

13. A plot of monthly crude oil prices from 2012-2018 is available in Figure B.1.1.

14. Further, increased biofuel production and extraction from Canadian oil sands also coincided with the price plunge.

differences in observable characteristics of portfolio firms, as well as differences in the concentration of investment across industries and geographies. I refer to a CLO with *high O&G* exposure if its portfolio share in the O&G industry is above the median. It has *low O&G* exposure otherwise.

First, portfolios are largely overlapping across CLOs. While the total value of outstanding CLOs increased from 2007 through 2019 – from $308 billion to $606 billion – the number of issuers across CLOs experienced a rather meager increase from 4,229 to 4,659 over the same time horizon (International Monetary Fund (2020)). Kundu (2021*a*) reports that the median issuer's loans were held in 78 CLOs in the aftermath of the Great Financial Crisis. The similarity in portfolio holdings is in part driven by the standardization of covenants across CLO portfolios (Bozanic, Loumioti and Vasvari (2018); Elkamhi and Nozawa (2020*b*)). Thus, 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 (Federal Stability Board (2019)).

Second, I do not find that the capital constraint threshold varies with O&G exposure before the shock, as shown in Table B.1.2. In this cross-sectional regression, I study whether the ID threshold and O&G exposure are statistically related, fixing the time period to the last report date before the shock. I include issuer controls, and various fixed effects intended to control for rating, industry, issuer, and year. I do not find stable or statistically significant point estimates. This suggests that there is no relation between the covenant threshold and O&G exposure. Moreover, the O&G price plunge was not a foreseeable event; hence, the O&G shares may be viewed as randomly assigned. Furthermore, because the test threshold cannot be renegotiated, it is unlikely to be endogenous to CLO investment decisions and trading behavior.

Third, Figure B.1.2 demonstrates that differences in the investment of non-O&G industries is negligible in comparing CLOs with high O&G exposure – CLOs with O&G exposure above the 75^{th} percentile – with CLOs with low O&G exposure – CLOs with O&G exposure below the 25^{th} percentile, before the shock. I do not find material differences in the allocation of non-O&G industries; the second largest difference in industry allocation between CLOs with high O&G exposure and CLOs with low O&G exposure is more than twice as small as the difference in O&G exposure – on average, it is more than 34 times smaller across all non-O&G industries. The industry Herfindahl-Hischman Index (HHI) is 0.0552 for CLOs with low O&G exposure and 0.05409 for CLOs with high O&G exposure for non-O&G industries, before the shock. Hence, a CLO portfolio may be considered a combination of two distinct portfolios: a portfolio of O&G exposures, and, the "market" portfolio – a portfolio of non-O&G loans. Therefore, I rule out concerns of selection based on industry allocation.

Fourth, in Figure B.1.3, I compare the geographic concentration of investment for CLOs with high O&G exposure – CLOs with above-median O&G exposure – with CLOs with low O&G exposure – CLOs with below-median O&G exposure, before the shock. The location of the firm is identified using the *State* identifier in DealScan. Geographic concentration is very similar; the HHI is 0.0501 for CLOs with low O&G exposure and is 0.0493 for CLOs with high O&G exposure. Therefore, I rule out concerns of selection based on geography.

Fifth, I draw comparisons between CLOs with high O&G exposure and CLOs with low O&G exposure, based on observable characteristics. In Table B.1.3, I compare characteristics of firms that are held by CLOs with high O&G exposure – CLOs with above-median O&G exposure – with CLOs with low O&G exposure – CLOs with below-median O&G exposure, before the shock. 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 several dimensions, including, size, Tobin's Q, leverage, market-to-book equity ratio, investment growth, investment, cash flow, and tangibility.

Sixth, I conduct two additional tests to directly test the sensitivity to oil. First, I study whether non-O&G firms held by CLOs with high O&G exposure have the same dependency on the price of oil relative to firms held by CLOs with low O&G exposure before and after the shock. Second, I study whether which CLO a non-O&G firm will be held by can be forecasted, based on the covariance between the firm's profitability and oil price in a cross-sectional specification, fixing the time period to the last report date before the shock. These results are presented in Tables B.1.4 and B.1.5. I do not find any statistically significant relation between a firm's profitability and the oil price deviation, nor does this relation differ for firms held by CLOs with high exposure to O&G – CLOs with above-median O&G exposure. Using a linear probability model, I also do not find evidence of forecasting CLO selection based on the covariance between oil price and firm profitability. Thus, I rule out concerns about portfolio hedging with respect to O&G exposure.

4.4.3.3 O&G as a Measure of Risk

In this section, I study whether a CLO's exposure to O&G is a relevant proxy for performance on the capital constraints.

Summary statistics for the main outcome variables used in this empirical analysis are provided in Table 6.11 for the sample period of study. Before the shock, the median (mean) firm has a median O&G exposure of 1.74% (2.06%). The 25^{th} and 75^{th} percentile values are 0.0085% and 2.96%, respectively. The standard deviation associated with the firm O&G share is 1.97%. Before the shock, the median (mean) CLO has 1.05% (2.00%) of the portfolio invested in O&G. The 25^{th} and 75^{th} percentile values are 0% and 2.84%, respectively. The standard deviation associated with the CLO O&G share is 4.25%. Variation in O&G exposure may seem limited. However, as CLOs operate closely to their ID constraints, the price plunge may produce material effects as examined in this section.

In Table 6.12, I study the relation between a CLO's exposure to the O&G industry, and its distance from the ID threshold. Note, this is a CLO's exposure to O&G – not the firm's exposure to O&G.

$$ln(\frac{\text{Covenant Result}}{\text{Covenant Threshold}})_{c,t} = \beta_0 + \beta_1(\text{CLO O\&G Exposure})_c + \beta_2(\text{Oil Shock})_t$$
$$+ \beta_3(\text{CLO O\&G Exposure}_c \times \text{Oil Shock}_t) + \gamma_0' X_{c,t} + \epsilon_{c,t} \tag{4.5}$$

where c denotes the CLO, t denotes the time, and X denotes the vector of controls, consisting of age and size. 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 before the shock occurs, and 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, I include manager fixed effects to absorb differences across managerial style and preferences. From columns 2-3, I add CLO controls and time fixed effects. In column 4, I include CLO and year fixed effects. In column 5, I include CLO, manager, arranger, trustee, and month-year fixed effects. The results suggest that a 1 pp increase in the O&G share before the shock is associated with a 0.0486 to 0.0847 standard deviations decline in the distance to the ID threshold, after the shock. This estimate is nontrivial, given that, on average, CLOs operate within 5% of their thresholds (Table 6.11). The estimate is economically meaningful, statistically significant, and stable across all specifications.

Hence, O&G is a relevant proxy for risk, and by extension, a CLO's performance on its capital constraints.

4.4.3.4 Parallel Trends

In this section, I assess pre-trends to study if the baseline result is driven by pre-trends before the oil and gas plunge. For identification, the parallel trends assumption states that the relationships between the secondary loan price of a loan issued by a non-O&G issuer and firm exposure to the O&G industry, as well as the distance to the ID threshold and CLO exposure to the O&G industry, would have followed common trends across CLOs both before and after the price plunge in the absence of the price plunge. However, I cannot assess the counterfactual scenario of what would have occurred in the absence of the price plunge. Therefore, I assess whether divergence occurs between CLOs with greater O&G exposure relative to CLOs with lesser O&G exposure before to the shock: Do they trend in parallel?

In Figure 5.27, I study two features of the data. First, I study if pre-trends are parallel prior to the shock. Second, I study if the aforementioned relations differ *after* the shock.

Specifically, in Figure 5.27, for a given firm, I chart the relation (point estimate) between the secondary loan price of a loan issued by firm f and firm f's O&G exposure, in six-month increments surrounding the shock. In Figure 5.27, for a given CLO, I chart the relation (point estimate) between the distance to the ID threshold for CLO c and the CLO c's O&G exposure, in six-month increments surrounding the shock.

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

In Figure 5.27, the regression specification is:

$$P_{i,f,t} = \sum_{\substack{k=-24 \\ k=k+6 \\ k\neq 0}}^{30} \beta_k \mathbb{1}_{k\leq t<k+6} \times (\text{Firm O\&G Exposure})_f + \sum_{\substack{k=-24 \\ k=k+6 \\ k\neq 0}}^{30} \delta_k \mathbb{1}_{k\leq t<k+6}$$
$$+ \theta_1 \text{Firm O\&G Exposure}_f + \alpha_f + \alpha_y + \epsilon_{i,f,t}. \quad (4.6)$$

In Figure 5.27, the regression specification is:

$$ID_{c,t} = \sum_{\substack{k=-24 \\ k=k+6 \\ k\neq 0}}^{30} \beta_k \mathbb{1}_{k\leq t<k+6} \times (\text{CLO O\&G Exposure})_c + \sum_{\substack{k=-24 \\ k=k+6 \\ k\neq 0}}^{30} \delta_k \mathbb{1}_{k\leq t<k+6}$$
$$+ \theta_1 \text{CLO O\&G Exposure}_c + \alpha_c + \alpha_y + \epsilon_{c,t}. \quad (4.7)$$

$P_{f,t}$ 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, f denotes the (non-O&G) portfolio firm or issuer ($f \in c$), 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 O&G exposure measures. I exclude the last pre-treatment month to avoid perfect multicollinearity.

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 are consistent with the assumption that prior to the shock, the relationships between the secondary loan price of loans issued by non-O&G issuers and firm O&G exposure, and, distance to the ID threshold and and CLO O&G exposure is statistically indistinguishable from the last pre-treatment period – the 95% confidence intervals include the null.

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

4.5 Results

In this section, I describe the main findings of the paper. First, I provide evidence of CLO fire sales. Second, I demonstrate that the fire sales have extensive implications for asset prices across several financial instruments. Third, I show real effects occur at the firm-level.

4.5.1 CLOs Fire-Sell Non-O&G Loans

I begin by examining the trading decisions of CLO managers at the transaction, CLO-issuer, and issuer level. In Table 6.13, I present the relation between firm O&G exposure and the transaction amount. The transaction amount is coded as negative if the transaction is a sale, and positive if the transaction 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. I find a 1 pp increase in a firm's exposure to O&G before the shock is associated with a 0.1062 to 0.1819 standard deviations decline in the transaction amount, after the shock.

Further, I investigate whether these patterns hold in net at the CLO-issuer pair level. I aggregate across all transactions of a given issuer for each CLO. These results are presented in Table B.1.6. 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 a 1 pp increase in a firm's exposure to O&G before the shock is associated with a 0.1057 to 0.2377 standard deviations decline in the net transaction amount at the CLO-issuer level after the shock. Similarly, after aggregating all transactions to the issuer level in Table B.1.7, I find a 1 pp increase in a firm's exposure to O&G before the shock is associated with a 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 or net transaction amount is not tantamount to an increase in the amount of sales; a decline in purchases may yield these findings. To directly test whether the amount of sales increases or purchases decline, I restrict the analysis to purchases and sales, separately, and aggregate to the issuer level. These results are presented in Table B.1.8. There is an increase in the total amount of selling, as reflected in columns 4-6. Concretely, a 1 pp increase in a firm's exposure to O&G is associated with a 0.0815 to 0.1095 standard deviations increase in the net sales at the issuer-level, after the shock. There is a positive change in the amount of net purchases after the O&G shock; however, the estimate is not statistically distinguishable from zero, as reflected in columns 1-3.

Hence, selling increases in the degree of constraint.

4.5.2 *Implications for Asset Prices*

In this section, I discuss how firm exposure to O&G through CLOs is related to asset prices of instruments issued by non-O&G firms after the O&G price plunge.

First, I study how the secondary loan price per $100 of notional par, varies with a firm's exposure to O&G in Table 6.14. In column 1, I do not include any fixed effects. I find that a 1 pp increase in a firm's exposure to O&G before the shock is associated with a decline in the secondary loan price by $1.83, after the shock. Before the shock, a 1 pp increase in a firm's exposure to O&G before the shock is associated with an *increase* in the secondary loan price by $2.03 (per $100 par). The nearly equal and opposite signs reflect the boom and bust of O&G – consistent with the trading patterns before and after the shock in Table 6.13. This finding suggests that the prices of debt securities issued by innocent bystanders are expected to exhibit higher volatility when CLOs have larger exposure to more volatile sectors, such as O&G.

In columns 2-6, I add additional fixed effects including manager, rating-industry, issuer-loan-type, year, and month-year. The inclusion of issuer-loan type fixed effects reduces the point estimate in columns 5 and 6. Based on these columns, I find a 1 pp increase in a firm's exposure to O&G before the shock is associated with a decline in the secondary loan price by $0.67 to $1.82 (per $100 par), after the shock. Thus, secondary loans issued by non-O&G firms trade at a lower price after the shock, if the firm had higher exposure to O&G before the shock. The point estimates are economically meaningful and statistically significant across all specifications.

The identifying assumption for the subsequent analyses is that issuer fixed effects fully control for 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. I include instrument-specific and sectoral controls, when applicable, as additional local demand controls. These controls account for other dimensions of heterogeneity in the data. Time fixed effects are included to control for common shocks. Further, I conduct a falsification exercise in section 4.5.4, confirming the findings are not driven by changes in demand.

Next, in Table 6.15, I study how the spread associated with refinancing primary institutional loans varies with O&G exposure, after the shock. The outcome variable is the all-in-drawn spread, defined as the total annual spread above LIBOR for each dollar drawn from a loan. I classify a loan as *institutional* if it is a term loan that is not term loan A. I include issuer fixed effects across all specifications. The least conservative specification is presented in column 1, and the most conservative is presented in column 5, controlling for various dimensions of loan heterogeneity and common shocks. Across columns 1-5, I find a 1 pp increase in a firm's exposure to O&G before the shock is associated with an increase in the primary loan spread by 13 to 23 bps, after the shock. In spite of the relatively small sample, I find strong significance across all specifications. This suggests firms that refinance after the shock experience higher spreads if they were more exposed to the O&G industry through CLOs before the shock.

Further, in Tables B.1.9 and B.1.10, I study how the loan maturity and loan quantity, respectively, associated with refinancing primary institutional loans varies with O&G exposure, after the shock. In Table B.1.9, I find a 1 pp increase in a firm's exposure to O&G before the shock is associated with a decrease in loan maturity by 2.97 to 4.60 months, after the shock. The point estimate is statistically significant, economically meaningful, and stable across all specifications. Furthermore, in Table B.1.10, I find a 1 pp increase in a firm's exposure to O&G before the shock is associated with a decrease in the loan amount by 0.009 to 0.0677 standard deviations, after the shock. Although the point estimates associated with the loan amount are economically meaningful and stable across all specifications, they are not statistically significant.

Next, I examine the sensitivity of bond credit spreads to firm O&G exposure after the shock. Past work shows that banks are the main source of funding for riskier and more opaque firms, as banks have the ability to monitor borrowers (e.g., Diamond (1984); Diamond (1991); Petersen and Rajan (1994); Petersen and Rajan (1995); Bolton and Freixas (2000)). It is also well established that upon experiencing an aggregate shock, firms substitute from bank debt to public debt (e.g., Kashyap, Stein and Wilcox (1993); Adrian, Colla and Shin (2013); Becker and Ivashina (2014)). In Table 6.16, I investigate whether there is substitution by other market participants. I include issuer and bond-type fixed effects across all specifications. I control for various dimensions of bond heterogeneity in columns 2-6, including time to maturity, security-level, rating, investment-grade status, defaulted status, and fixed effects to control for common shocks. I find a 1 pp increase in a firm's exposure to O&G before the shock is associated with an increase in the bond credit spread by 28-35 bps, after the shock. Furthermore, bond liquidity, as measured by the trade-weighted average bid-ask spread also widens, as shown in Table B.1.11; a 1 pp increase in a firm's exposure to O&G before the shock is associated with an increase in the bid-ask spread by 0.0260 to 0.0269 standard deviations, after the shock. These estimates are statistically significant, economically meaningful, and stable. These findings suggest that if outside investors are unable to discern a deterioration in firm fundamentals from a deterioration in CLO constraints, substitution by other market participants may be imperfect.

Next, given the difficulties of obtaining external financing, I study how firm liquidity is affected, as measured by the amount of credit available through revolving credit facilities. The results of this exercise are presented in Table 6.17. In columns 1-3, the outcome variable is the quarterly change in the unused line of credit. In column 4-6, the outcome variable is the quarterly change in the drawn line of credit. I include issuer fixed effects across all specifications. I add year fixed effects in columns 2-4, and industry and month-year fixed effects in columns 3-6. I find a 1 pp increase in a firm's exposure to O&G before the shock is associated with a 0.0275 to 0.0280 standard deviations decline in quarterly change in the unused line of credit and a 0.0342 to 0.0347 standard deviations increase in quarterly change in the drawn line of credit.[15] These

15. The low frequency (quarterly) of reporting suggests that the standard errors may be understated. To generate an upper-bound, I present the results from wild two-way cluster bootstrapping by issuer and quarter-year from 1,000 simulations in Table B.1.12. The differences are negligible in the t-statistics and p-values. I do not manually compute standard errors, per Roodman et al. (2019), as using the imputed standard errors for inference rely on the asymptotic normality of $\hat{\beta}$, which is not applicable when large-sample theory does not apply.

point estimates are statistically significant, economically meaningful, and stable across all specifications.

In summary, a 1 pp increase in a firm's exposure to O&G before the shock is associated with a 0.1062 to 0.1819 standard deviations decline in the transaction amount, a \$0.67 to \$1.82 decline in the secondary loan price, an increase of 18 to 23 bps in the primary loan spread, increase of 28 to 35 bps in the bond credit spread, a 0.0275 to 0.0280 standard deviations decline in the quarterly change in the unused line of credit, and a 0.0342 to 0.0347 standard deviations increase in the quarterly change in the drawn line of credit.

4.5.3 Implications for Corporate Outcomes

Thus far, it has been established the firm exposure to O&G through CLOs may have significant effects on the prices of various debt securities. In this section, I examine how the innocent bystanders respond.

I study whether firms make financial and real adjustments in Table 6.18 in response to experiencing intermediary constraint and a tightening of credit. I examine how a firm's exposure to O&G through CLOs can affect long-term debt growth in column 1, cash flow in column 2, real sales growth in column 3, acquisitions in column 4, investment in column 5, R&D growth in column 6, and employment growth in column 7. I provide a description on the construction of these variables is in section B.2. I include issuer, industry, and quarter-year fixed effects across all columns. A 1 pp increase in a firm's exposure to O&G before the shock is associated with a 0.0430 standard deviations decline in long-term debt growth, a 0.0304 standard deviations decline in cash flow, a 0.0378 standard deviations decline in investment, a 0.0866 standard deviations decline in R&D growth, and a 0.0447 standard deviations decline in employment growth, after the shock. These estimates are economically meaningful and statistically significant. Furthermore, I find a 1 pp increase in a firm's exposure to O&G before the shock is associated with statistically significant, yet economically minute declines in real sales growth and acquisitions. These results suggest that when intermediaries face constraints and credit supply is constrained, firms reduce their cash flow and scale back operations, as measured by these various dimensions of firm fundamentals. Hence, these findings demonstrate how intermediary distress may propagate to the firm level.

The financial and real adjustment of firm outcomes suggests that there may be a tangible effect on equity returns. In Table 6.19, I study how a firm's exposure to O&G through CLOs may affect its monthly equity return. Across all columns, I include issuer fixed effects. I include year fixed effects in columns 2-4. I add the market model factors in column 3 – the risk-free rate and market risk premium. In column 4, I include the Fama-French three factors, adding SMB and HML to the specification of column 3. In column 5, I include the Fama-French five factors, adding RMW and CMA to the specification of column 5. Specifically, I find that a 1 pp increase in a firm's exposure to O&G before the shock is associated with a decline of 0.2918 to 0.2976 pp in monthly equity returns, after the shock. This point estimate is economically variable, statistically significant and stable. Thus, after the price plunge, equity returns experience a decline in the O&G exposure of a firm. Moreover, according to column 1, a firm's exposure to O&G as well as the level of the price, as reflected by the *Post* variable, can explain 0.0616% of equity returns. Thus, O&G exposure can also predict and explain equity returns to some extent.

4.5.3.1 Cross-Sectional Effects

What types of firms are hit particularly hardest? To answer this question, I run a number of cross-sectional tests, studying the relation between firm O&G exposure and investment for several subsamples for firms. As firm financial and fundamental data is only available for publicly held companies, the estimates are expected to be larger for private or smaller firms, which may be more dependent on bank credit. Although I cannot overcome the data limitation, I can study how the effects differ based on the bifurcation of firms by access to the bond market, size, age, sector, and timing of loan refinancing, shown in Table 6.20. I include issuer, industry, and quarter-year fixed effects throughout all specifications.

It is hypothesized that firms that are dependent on banks as a source of external financing are most susceptible to shocks faced by CLO intermediaries. To test this hypothesis, I segment firms based on access to the bond market. Firms which issue bonds are considered to be firms with access to the bond market. These firms are in column 1. Firms which do not issue any bonds are included column 2. The decline in investment is driven by firms that do not have access to the bond market; a 1 pp increase in a firm's exposure to O&G before the shock is associated with a decrease (increase) in investment by 0.1017 (0.0061) standard deviations for firms without (with) access to the bond market, after the shock.

Similarly, I segment firms based on size. I find the decline in investment is larger for smaller firms. A firm is small if its size is below the median firm size across all firms. Based on columns 3 and 4, a 1 pp increase in a firm's exposure to O&G before the shock is associated with a decrease in investment by 0.0839 (0.0109) standard deviations for small (large) firms, after the shock. Further, segmenting based on median age in columns 5 and 6, I find a 1 pp increase in a firm's exposure to O&G before the shock is associated with a decrease in investment by 0.0669 (0.0341) standard deviations for young (old) firms, after the shock. Hence, smaller firms and younger firms – firms that are more bank dependent – experience larger reductions than larger and older firms. In Table B.1.13, I study how the combination of age and size generate a pecking order in the magnitude of the effect; large and old firms experience the smallest reduction in investment, followed by large and young firms, small and old firms, and small and young firms.

Further, I study whether differences exist in investment based on firm sector. In columns 7 and 8, I segment firms based on sector-type. A firm is tradable if the firm is in the manufacturing, agriculture, forestry, fishing and hunting, mining, or management of companies and enterprises industries. It is nontradable otherwise. I find a 1 pp increase in a firm's exposure to O&G before the shock is associated with a decrease in investment by 0.0418 (0.0358) standard deviations for tradable (non-tradable) firms after the shock. I assess the statistical significance of these differences below.

Lastly, in columns 9 and 10, I study how the timing of loan refinancing affects firm investment, among firms that do not have access to the bond market. In column 9, the set of firms consists of those that had last refinanced *after* the shock within the sample period. The set of firms in column 10 are those that had last refinanced *before* the shock within the sample period. I find that among the firms that are dependent on bank financing, those that had last refinanced before the shock fare worse than those that had refinanced even after the shock; a 1 pp increase in a firm's exposure to O&G before the shock is associated with a decrease in investment by 0.1083 (0.0684) standard deviations after the price plunge, and firms that had last refinanced before (after) the shock, after the price plunge.

Further, I study how the combination of access to the bond market and timing of refinancing generate a pecking order in the magnitude of the effect in Table B.1.14; firms with access to the bond market that had last refinanced after the shock experience the smallest reduction in investment, followed by firms with access to the bond market that had last refinanced before the shock, firms without access to the bond market that had last refinanced after the shock, and firms without access to the bond market that had last refinanced before the shock.

Although the point estimates associated with *no access*, *small*, *young*, *tradable*, and *before shock* refinancing are all economically meaningful, whether the differences between the subsamples are statistically significant is unclear. To assess the statistical significance of the differences of the subsamples, I run difference-in-difference-in-differences empirical specifications and report the significant findings in Table B.1.15. I find the point estimates by size and access to the bond market are statistically distinct. Hence, the findings of this analysis corroborate the hypothesis that firms that are more bank-dependent drive the aggregate decline in investment, shown in Table 6.18.

4.5.4 Robustness

I conduct a battery of robustness tests to check if the results are robust to alternative specifications, measures, and definitions in addition to the supplemental results referenced in the previous sections.

First, to identify whether the findings are truly driven by changes in supply, I conduct a falsification test. Banks typically retain term loans A and revolving lines of credit on their balance sheet. If the findings are driven by changes in demand, the all-in-drawn spreads associated with these facilities should exhibit a similar increase in response to changes in demand. If the findings are driven by intermediary constraint, namely, O&G exposure – not changes in demand – the all-in-drawn spread should not exhibit any sensitivity to firm O&G exposure, after the shock, as firm fundamental quality has not deteriorated. The results of this exercise are presented in Table B.1.16 for revolving lines of credit and Term Loans A. I do not find evidence of any increase in the all-in-drawn Spread for these facilities. Thus, I rule out that the findings are driven by changes in demand.

Second, there may be a concern that omitted variable bias (OVB) is driving the results. To ensure that the results are not driven by OVB, I conduct two placebo tests. I randomize the O&G share from a uniform distribution and run 1,000 Monte-Carlo simulations of two conservative regression specifications: column 5 of Table 6.14 and column 4 of Table 6.15, respectively. The results of this exercise ensure the baseline results are not driven by OVB, as long as the structure of omitted variables is identical across CLOs. The point estimates of the interaction term from 1,000 Monte-Carlo simulations are presented in Figure B.1.6. The outcome variable is the secondary loan price in Figure B.1.7 and the all-in-drawn spread in Figure B.1.8. The "true" estimated point estimates lie outside of the graph. The t-statistics for tests of the null hypothesis – the mean estimate is equal to zero – are -0.7503 and 0.7690 in Figures B.1.7 and B.1.8, respectively. Hence, the null hypothesis that the mean is equal to zero cannot be rejected in either case. This confirms OVB does not drive the results; firm exposure to O&G is crucial for the findings.

Third, I rule out the results are driven by anomalous characteristics of O&G exposure. In Table B.1.17, I verify the results are robust to alternative measures of issuer exposure to CLOs by replicating two conservative regression specifications: column 5 of Table 6.14 and column 4 of Table 6.15, respectively, for various measures of issuer exposure. In columns 1 and 2, the measure of issuer exposure for firm f is constructed by taking an issuer-amount-weighted average of the distance to the ID threshold ($ln(\frac{\text{Covenant Result)}}{\text{Current Threshold}})$) across all CLOs, before the shock occurs. Based on columns 1 and 2, I find a one standard deviation decrease in a firm's exposure to the constraint before the shock is associated with a decrease of $0.42 in the secondary loan price, and an increase of 12 bps for the all-in-drawn spread. In columns 3 and 4, the measure of issuer exposure for firm f is the equal-weighted average O&G share of firm f across all CLOs before the shock occurs. These columns indicate a 1 pp increase in a firm's exposure to O&G before the shock is associated with a decline in the secondary loan price by $0.45 and an increase in all-in-drawn spread by 20 bps. In columns 5 and 6, the measure of issuer exposure for firm f is the loan-frequency equal-weighted average O&G share of firm f across all CLOs before the shock occurs. Note, this differs from the definition used in column 3 and 4 in which there is one entry for each issuer held in a CLO (collapsing across loans). columns 5 and 6 indicate a 1 pp increase in a firm's exposure to O&G before the shock is associated with a decline in the secondary loan price by $0.83 and increase in all-in-drawn spread by 21 bps. In columns 7 and 8, the measure of issuer exposure for firm f is the loan-frequency value-weighted average O&G share of firm f across all CLOs before the shock occurs. These columns indicate that a 1 pp increase in a firm's exposure to O&G before the shock is associated with a decline in the secondary loan price by $0.80 and increase in the all-in-drawn spread by 20 bps. Lastly, in columns 9 and 10, the measure of issuer exposure for firm f is the loan-amount value-weighted average O&G share of firm f across all CLOs before the shock occurs. These columns indicate that a 1 pp increase in a firm's exposure to O&G before the shock is associated with a decline in the secondary loan price by $0.83 and an increase in the all-in-drawn spread by 21 bps. This check confirms that the results are robust to other measures of issuer exposure.[16]

Lastly, I consider how the results differ under an alternative empirical specification in which I directly use the log-transformed oil price instead of the indicator variable 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 Figure B.1.9. As the crude price is higher, firms with greater O&G exposure are expected to experience higher secondary loan prices and lower all-in-drawn spreads. Conversely, when the crude price is lower, firms with greater O&G exposure will experience lower secondary loan prices and higher all-in-drawn spreads. The plots of Figure B.1.9 are consistent with these hypotheses. This result also reinforces the result that the prices of debt securities have higher volatility when their exposure to volatile sectors is higher.

4.6 Mechanism

In this section, I first describe how price effects in the secondary loan market can propagate across debt instruments and why other investors do not step in. Then, I explore the persistence of the O&G shock. Lastly, I connect the incentives of CLO managers to actions they take in managing their portfolios to elucidate the underlying mechanism that sets off the effects described in section 4.5.

4.6.1 What Causes Contagion?

CLO fire sales in the secondary loan market can spur contagion across debt instruments. This effect can be explained by a variation of a no-arbitrage argument. A prospective buyer who seeks exposure to a specific firm may purchase any form of debt secondary issuance, primary issuance, bonds, etc. CLOs constitute marginal investors in the secondary loan market, which is illiquid relative to other capital markets. When they become constrained, CLOs sell loans issued by innocent bystanders to generate slack in their constraints (discussed in more detail in section 4.6.3). As the

16. I have replicated the entire analysis taking CLO structure into consideration by running the regressions at the $Issuer - CLO - Time$ level. The main findings are robust and available upon request.

spread associated with secondary loans widens, other forms of debt also experience a widening of spreads. The reason is that in market equilibrium, the expected rate of return for any form of debt issued by a firm is equalized. For the affected innocent bystanders, the secondary market spread becomes the effective cost of capital. Thus, the real costs of fire sales may exacerbate credit crunches by contracting credit as described in Diamond and Rajan (2011).

This finding begs the following question: why do other investors not step in to eliminate excess returns? More than half of the total volume of leveraged loans is held by banks, which typically retain amortizing Term Loans A and revolving credit facilities while selling the non-amortizing Term Loans B and below to non-bank participants including CLOs, mutual funds, pension funds, and insurers (Kundu (2021*a*)). During periods of crisis, such as the O&G price plunge, the most natural buyers of leveraged loans – other CLOs – may be unable to absorb excess supply, due to similar constraints. "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, coupled with the relatively illiquid secondary loan market, suggests large-scale redemptions may have a tremendous impact and produce persistent dislocations in prices as the total purchase by prospective buyers may be insufficient to offset the price decline. In light of the regulatory and risk-based capital constraints that banks, insurance, and pension funds are subject to, such investors may not be able to absorb excess supply despite the prospects of profitability. Furthermore, less regulated financial institutions, including hedge funds and mutual funds that specialize in distressed loans, may face limits to arbitrage (Shleifer and Vishny (1997)). Performance-based arbitrage may be ineffective when arbitrageurs, including less regulated entities, fear further mispricing and are fully invested. This can explain why the effects persist, as discussed next.

4.6.2 *Persistence and Dynamic Effects*

Forced sales in the relatively illiquid secondary loan market may increase the effective cost of capital across debt markets in market equilibrium. In this section, I discuss the persistence and dynamic effects of the shock. This discussion is important for establishing the plausibility in the link between financial market dislocations and real effects.

For assessing the persistence of the initial shock, I conduct several Jordà style linear projections, as shown in Figure 5.28. The coefficients in these figures are estimated from the following regression:

$$Y + f, t + h - Y_{f,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure}_f \times \text{Post}_t) + \beta_2\text{Firm O\&G Exposure}_f + \beta_3\text{Post}_t + \alpha_f + \alpha_y + \epsilon_{f,t}. \quad (4.8)$$

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 5.28. Figures 5.28 and 5.28 show the responses of the secondary loan price and bond credit spread. Figures 5.28 and 5.28 show the responses of leverage and investment. Figures 5.28 and 5.28 indicate asset prices fall and spreads increase for four quarters. An inflection occurs after four quarters. Prices begin increasing and spreads start declining. Prices and spreads to revert back towards zero after seven quarters. The dynamic effects of firm O&G exposure on bond credit spreads and equity returns shown in Figure B.1.12 are consistent with financial variables exhibiting an instantaneous response. However, firm characteristics respond after a lag. Leverage does not respond until four quarters after the initial shock, as shown in Figure 5.28. It shows signs of reversal after seven quarters. Investment declines two months after the initial shock, and falls until the seventh quarter, after which it reverts back towards zero, as shown in Figure 5.28. These findings suggest that asset prices start falling from the inception of the shock, whereas firm fundamental characteristics begin their descent with a lag. All outcomes exhibit a consistent reversal after seven quarters.

Hence, the dislocation in asset prices endures long enough for real effects to materialize. Persistence arises from financial frictions that may magnify the time for the price to recover and the magnitude of deviation.[17] This finding suggests a temporary episode of distress can damage firms for a longer-term – an externality of "short-termist" damage control, discussed further in section 4.6.3.

4.6.3 Contractual Arbitrage and CLO Portfolio Effects

As described in section 4.2.1, the piecewise nature of the accounting of covenant constraints can distort the incentives of CLO managers. If CLO managers face a sizeable number of downgrades and defaults in their portfolio, their capital constraints may tighten. This result follows from the accounting rules associated with the measurement of capital constraints.

The capital constraints are effectively measures of leverage, defined as the ratio of the total value of assets to total value of liabilities. Assets are marked at book value, unless a loan has experienced default, is rated CCC/Caa1 or below, putting the CLO in excess of its limit, or is a discount obligation. Under these circumstances, a 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. Therefore, adverse credit events may tighten a CLO's capital constraints by increasing the share of defaulted, CCC/Caa1, or discount obligations – inputs to the capital constraints.

Among the loans in the aforementioned categories of distress, CLOs are incen-

17. Encumbrances to liquidity provision can arise from search costs or slow-moving capital (e.g., Duffie, Gârleanu and Heje (2005); He and Krishnamurthy (2012); Duffie and Strulovici (2012); Acharya, Shin and Yorulmazer (2009); Brunnermeier and Pedersen (2009)).

tivized to sell the best of their riskiest loans while keeping the worst ones. If the share of loans rated CCC/Caa1 or below in a portfolio is above its limit, the excess loans are marked at the *lowest* market value of all loans in this segment. The CLO can then maximize improvements to the capital constraint by selling loans in the CCC/Caa1 category in descending order of market value.[18] This mechanism is illustrated in section 4.2.1. Similarly, with regard to defaulted loans, if the projected recovery value of a loan is lower than its market value, a CLO can maximize improvements to the total value of assets as accounted for in the capital constraints, by selling loans in descending order of the difference between market value and recovery value. This may be likely with rating agencies which 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. Lastly, with discount obligations, CLOs can similarly exploit differences between the purchase price and market value to improve their capital constraints. In all three instances, managers can exploit loopholes as the accounting of covenants does not follow a continuous function.

The design of CLO managerial contracts suggests when managers experience constraints, they may sell riskier loans. Although the purported aims of the covenants are to ensure CLOs that operate close to their covenant thresholds appropriately derisk, whether constrained CLOs actually do derisk is ambiguous. An alternative story 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) among CLOs with high O&G exposure, before and after the shock. This change is shown in Figure B.1.2. 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.

Further, although exploiting the differential accounting rules may generate large improvements to the OC constraints, CLOs may alternatively generate improvements by selling loans that trade above par, while purchasing those below par. To study this

18. The assumption is that there is heterogeneity in loan prices within the CCC/Caa1 bin.

hypothesis, I study the propensity to sell risky loans as reflected by the loan price. Using a linear probability model, in Panel A of Table 6.21, I study how the likelihood of selling a loan that trades above par changes in response to firm O&G exposure after the O&G price plunge. The outcome variable takes a value 1 if the loan that is sold trades above \$100 per \$100 of notional par, and 0 otherwise. In Panel B of Table 6.21, I study how the likelihood of selling a loan that trades below par changes in response to firm O&G exposure after the O&G price plunge. The outcome variable takes a value 1 if the loan that is sold trades below \$90 per \$100 of notional par (typical threshold for discount obligations), and 0 otherwise. I include combinations of rating-industry, issuer-loan type, year, and month-year fixed effects in columns 1-5. I find a 1 pp increase in a firm's exposure to O&G before the shock is associated with a decrease in the probability of selling loans above par by 4% to 11%, after the shock. A 1 pp increase in a firm's exposure to O&G before the shock is associated with an increase in the probability of selling loans below par by 2% to 4%, after the shock. This simple exercise suggests that upon experiencing constraints, CLOs are more likely to sell loans that trade below par than above par. This portfolio management technique is plausible, as replicating the par gains generated by the spread between the accounted value of a loan and the market value of a loan through above-par sales and below-par buying may require a greater volume of transactions. I ensure these findings are robust, by studying whether these relationships hold under consideration of CLO O&G exposure (rather than firm O&G exposure). These results are shown in Table B.1.18.

If CLO managers sell riskier loans upon experiencing constraint, the composition of the CLO portfolios may also change. First, I study whether the interest rate associated with individual loans changes with firm O&G exposure, after the shock. This result is presented in Table 6.22. I include index and time (year in columns 1-4, month-year in column 5) fixed effects across all columns. In column 1, I include issuer fixed effects. Manager or CLO fixed effects are included to control for differences across managers and CLOs in columns 2-4. In columns 5-6, I include CLO-issuer fixed effects and CLO-issuer-loan-type fixed effects in column 6. In column 7, I additionally control for loan tenor and rating. In the most conservative specifications, variations in the CLO-issuer fixed effects absorb heterogeneity across CLO-issuer pairs and may be interpreted as a within-CLO-issuer estimator. I find a 1 pp increase in a firm's exposure to O&G before the shock is associated with a decline in the interest rate by 9-13 bps, after the shock. This relationship holds under consideration of CLO O&G exposure (rather than firm O&G exposure), as shown in Table B.1.19. Hence, this finding suggests that the riskiness of a loan, as reflected by the interest rate, declines in the degree of constraint.

I directly test whether the incidence and amount of risky loans changes with the degree to constraint. First, I study whether the incidence of defaulted loans declines in the degree of constraint in Table 6.23. The outcome variable takes a value of 1 if the loan has defaulted, and 0 otherwise. Eighty-two percent 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. The fixed effects structure in this analysis is identical to that discussed for Table 6.22 for columns 1-6, without any index fixed effects. The results indicate a 1 pp increase in a firm's share of O&G before the shock is associated with a 0.1632% to 0.3316% decline in the probability that a loan is defaulted, after the shock. Thus, the probability that a defaulted loan is held by CLOs decreases in the degree of constraint. For robustness, I apply an alternative definition of *risky* loans, using an indicator for whether a loan is rated CCC or below. This robustness test is presented in Table B.1.20. The magnitude is larger; a 1 pp increase in a firm's share of O&G before the shock is associated with a decline in the probability that a loan is defaulted by 0.8172% to 0.9971%. Second, I study whether these findings are consistent with aggregate changes that occur at the CLO-level, exploiting cross-sectional variation in CLO exposure to O&G before the shock. In Table 6.24, I study how a CLO's exposure to O&G affects the share of defaulted and risky (sum of defaulted and CCC share) loans held in a given CLO portfolio in columns 1-3 and columns 4-6, respectively. The results indicate that a 1 pp increase in a CLO's share of O&G before the shock is associated with a decline in the share of defaulted loans by 0.0552 to 0.0566 standard deviations, after the shock. Further, a 1 pp increase in a CLO's share of O&G before the shock is associated with a decline in the share of risky loans by 0.0325 to 0.0337 standard deviations, after the shock. The point estimates are economically meaningful, statistically significant, and stable.

Consistent with the motives established by contractual arbitrage, CLO managers do derisk and sell riskier loans upon experiencing constraint. This finding suggests the financial and real effects ought to be more pronounced for the risky segment of firms held in CLO portfolios. I define a firm as *risky* if it has experienced a loan default in the sample period. A firm is otherwise *non-risky*. In Table 6.25, I compare how the secondary loan price, all-in-drawn spread, and investment outcomes differ for risky and non-risky firms, after including a battery of fixed effects and control variables. I find the aggregate declines in secondary loan price, the all-in-drawn spread, and investment are driven primarily by risky firms. A 1 pp increase in a firm's exposure to O&G before the shock is associated with a decline of $2.32 in the secondary loan price (per $100 par), a 56 bps increase in the all-in-drawn spread, and a 0.12 standard deviations decline in investment, after the shock. These point estimates are economically meaningful, statistically significant, and stable. These findings contrast with the statistically insignificant estimates produced for non-risky firms; a 1 pp increase in a firm's exposure to O&G before the shock is associated with an increase of $0.34 in the secondary loan price (per $100 par), an 11 bps increase in the all-in-drawn spread, and a 0.02 standard deviations decline in investment, after the shock. I test whether these differences are statistically significant in Table B.1.21.

Thus, the findings are consistent withe contractual arbitrage.

4.7 External Validity

In this section, I use the COVID-19 shock to study whether the proposed mechanism may be externally validated. I conduct my analysis for a relatively benign macroeconomic period – from 2013-2015. During this period, financial markets were calm and relatively liquid. Although the effects emanating from a financially tranquil period may be temperate, it raises concerns about what may occur when markets become more illiquid during times of stress. Ninety percent of CLOs are exposed to the top 50 US borrowers, and 80% are exposed to the top five borrowers (Federal Stability Board (2019)). Default can impose negative externalities on other firms held in the CLO portfolio or the same industry. The effects may be especially deleterious effects if issuers simultaneously default. I replicate the baseline result using the COVID-19 shock for external validity and 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 based on the analysis of Foley-Fisher, Gorton and Verani (2020), showing a structural break in the standard deviation of AAA-rated CLO prices occurred then, coinciding with the 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. Moreover, the *Post* variable takes a value of 0 before March 1, 2020, and 1 afterwards. The methodology for the construction of the shock is the same as the baseline analysis. I study how the point estimate changes under different proxies for the capital constraint. This result is shown in Table 6.26, in which I replicate the most conservative specification of Table 6.14 with issuer-loan-type and month-year fixed effects, under different proxies. The capital constraint is proxied by O&G exposure in column 1 as in the baseline analysis, automobile and automotive exposure in column 2, retail exposure in column 3, consumer goods exposure in column 4, transportation (consumer) exposure in column 5, transportation (cargo) in column 6, O&G and auto exposures in column 7, retail and consumer goods exposures in column 8, and all exposures (O&G, automobiles, retail, consumer goods, transportation, and cargo) in column 9. These industries were the most vulnerable during the COVID-19 pandemic. In Table B.1.22, I verify that CLO exposure to these industries affects distance to the ID constraint.

As in the baseline analysis, I study how the outcome varies for firms that are not in the industry designated in the column header. In column 1, I find a 1 pp increase in a firm's exposure to O&G before the shock is associated with a $0.91 decline in the secondary loan price, after the shock – 35% higher than during the O&G shock. In column 2, I find a 1 pp increase in a firm's exposure to automobiles before the shock is associated with a $0.75 decline in the secondary loan price, after the shock. The magnitude is higher when using consumer goods and retail as individual proxies for the capital constraint. According to columns 3 and 4, a 1 pp increase in a firm's exposure to retail and consumer goods before the shock is associated with declines of $1.42 and $2.04 in the secondary loan price, for the respective exposures, after the shock. In column 5 and 6, I study how the estimate differs using different measures of transportation: consumer and cargo respectively. I find a 1 pp increase in a firm's exposure to consumer transportation and cargo transportation before the shock is associated with declines of $0.84 and $3.15 for the respective proxies for the capital constraints. In column 7, 8, and 9, I combine the O&G and auto exposures, retail and goods exposures, and all exposures, respectively, and study how outcomes are affected for firms that are not in the industries that comprise the exposures. These columns indicate that a 1 pp increase in the exposure before the shock is associated with a $0.6923-$1.6799 decline in the secondary loan price, after the shock. The estimate across all columns is larger in magnitude than that of the baseline table. Hence, the effect is expected to be larger during crisis periods with limited intervention.

4.8 Conclusion

This paper demonstrates how covenants provide a mechanism for diffuse, idiosyncratic or sectoral shocks to snowball into larger shocks through CLO intermediaries. When CLOs experience shocks, they may operate closer to their capital constraints. The piecewise nature of accounting associated with the covenant constraints induces CLOs to sell unrelated, riskier loans in their portfolio to alleviate covenant constraints. This type of contractual arbitrage poses systemic concerns. Given the illiquidity of corporate debt markets, including the secondary loan market, forced sales may have substantial financial and real effects. Thus, fire sales originating from the CLO market may exacerbate credit crunches, by propagating shocks through capital markets.

CLOs may be characterized as shadow banking institutions, as they are not subject to direct oversight and operate as unregulated financial intermediaries. Given that regulatory bodies have limited supervisory authority to directly address the risks originating from CLOs and leveraged loans, future theoretical work on the design of optimal contracts with the consideration of welfare effects can inform the tradeoffs associated with different contractual and policy proposals. The impact of reform remains ambiguous with regard to covenants. Some proposals to reduce balance sheet shrinkage in the CLO context may entail making modifications to the frequency and accounting of covenants. On the one hand, greater stringency of covenants via current accounting and reporting methods generates more credit in the economy ex-ante by ensuring that debt claims have minimal risk in most states of the world (DeMarzo (2005)). However, as I show in this work, in some states, they can increase social costs through fire sales, price pressure, and amplification. Conversely, increasing the laxity of covenants by altering the frequency at which they bind or the measurement of constraints may reduce the effective cost of fire sales in some states of the world, but it may also increase the risk of debt claims and limit control rights by inadequately addressing agency frictions. This can reduce the amount of credit ex-ante. Hence, it is unclear what the efficient contract design is, ex-ante, from a policy standpoint. Furthermore, there are additional considerations in informing intervention, ex-post. In and of itself, a forced sale of assets below their long-run fundamental valuations is not considered to be sufficient for regulatory intervention (Stein (2013)). However, when a fire sale creates externalities or welfare effects, it may merit regulatory intervention. In these instances, macroprudential tools may be most useful to minimize the social costs associated with reductions in balance sheet capacity, originating from the shadow banking sector.[19]

19. Hanson, Kashyap and Stein (2011) propose a macroprudential approach to "control the social costs associated with excessive balance sheet shrinkage on the part of multiple financial institutions hit

The joint consideration of contractual design and welfare remains an avenue for future research for deepening our understanding of how covenants act as latent sources of amplification.

with a common shock."

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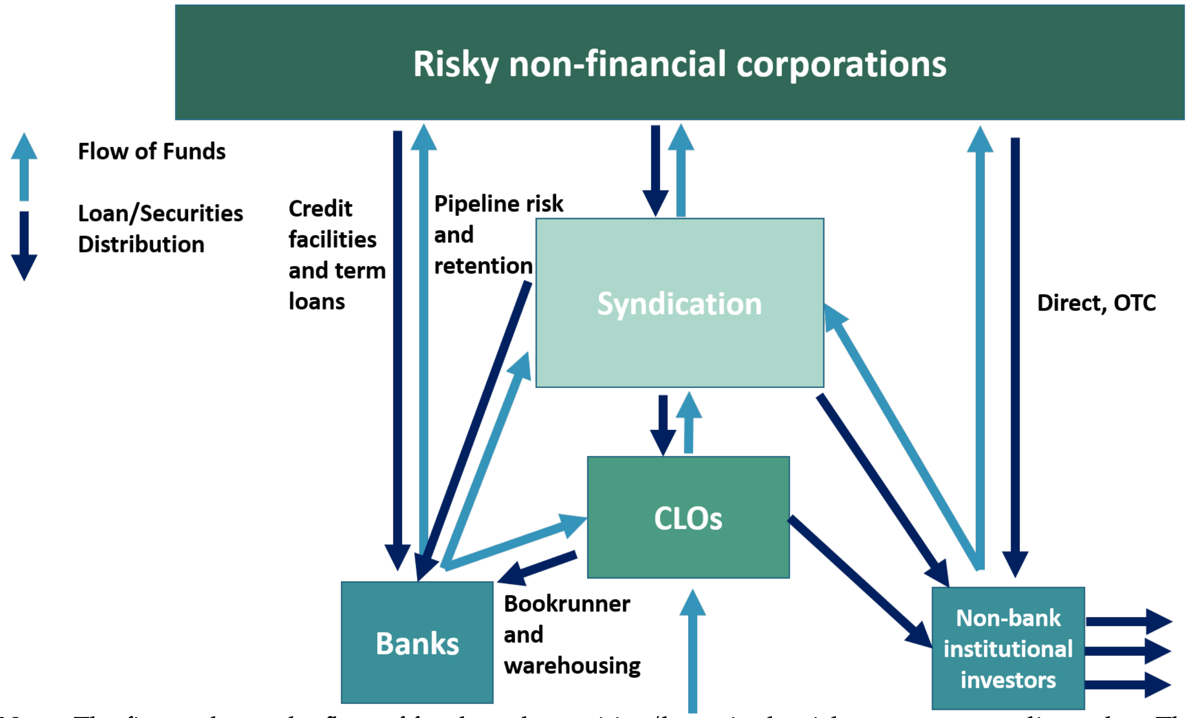
5

APPENDIX: FIGURES

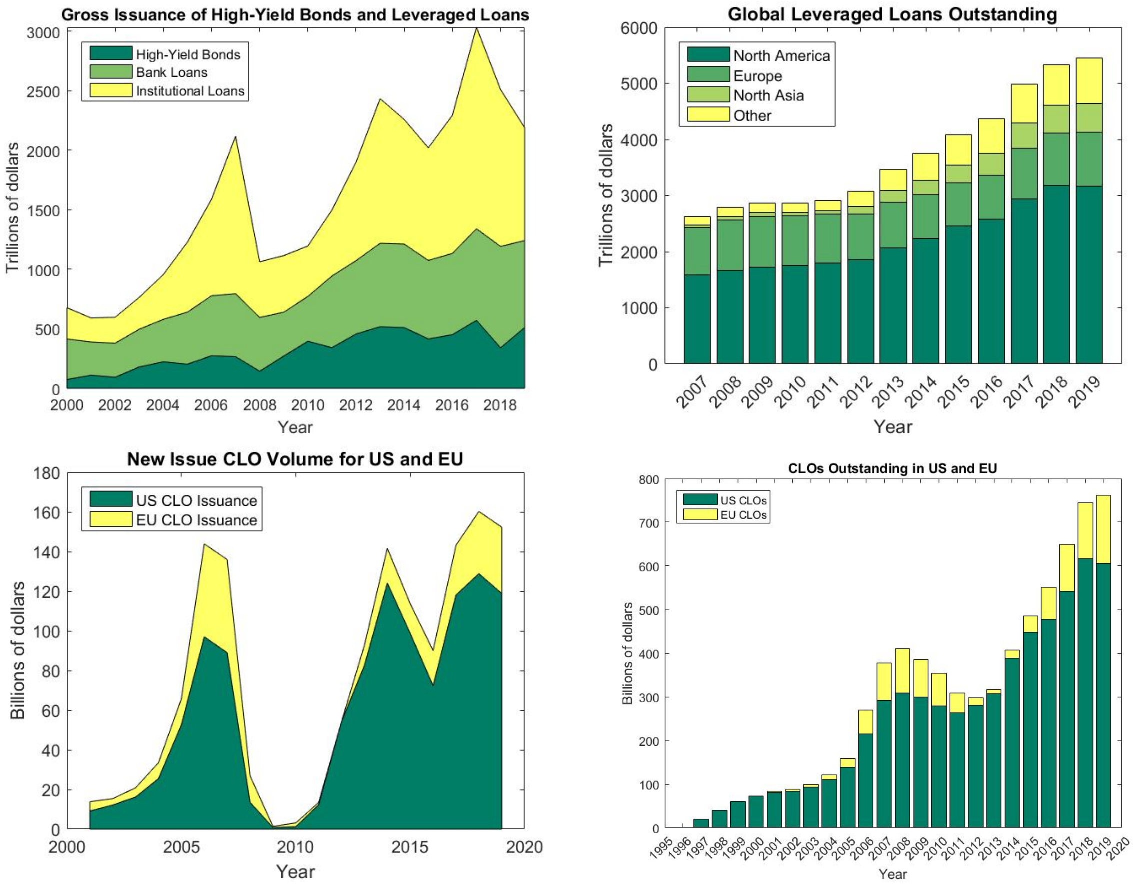
5.1 Chapter 2: The Anatomy of Collateralized Loan Obligations: On the Origins of Covenants and Contract Design

Figure 5.1: Financial plumbing of risky credit provision



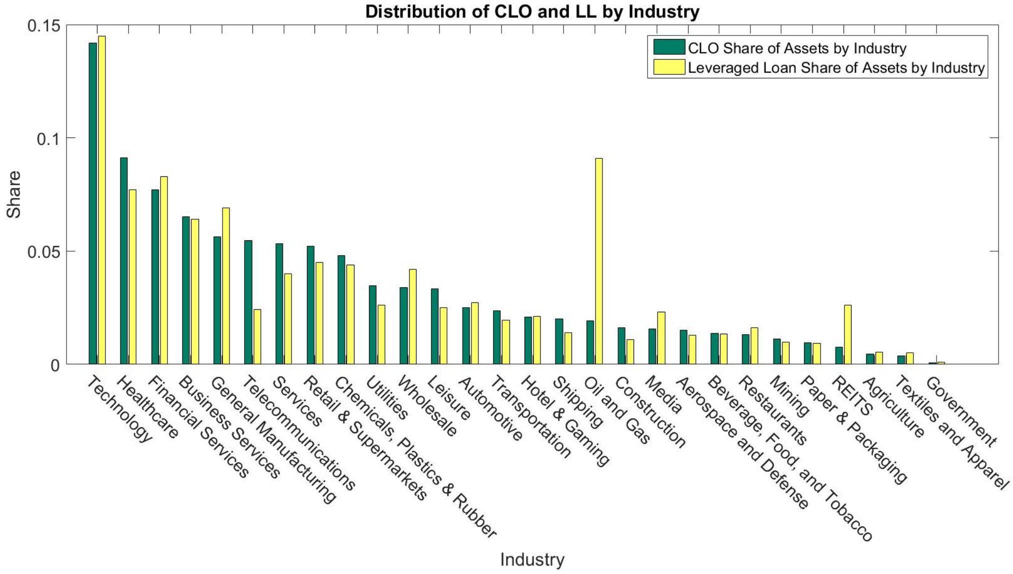
Notes: The figure shows the flow of funds and securities/loans in the risky corporate credit market. The dark blue arrows indicate the distribution of loans and securities, while the light blue arrows indicate the flow of funds. Source: Federal Stability Board (2019)

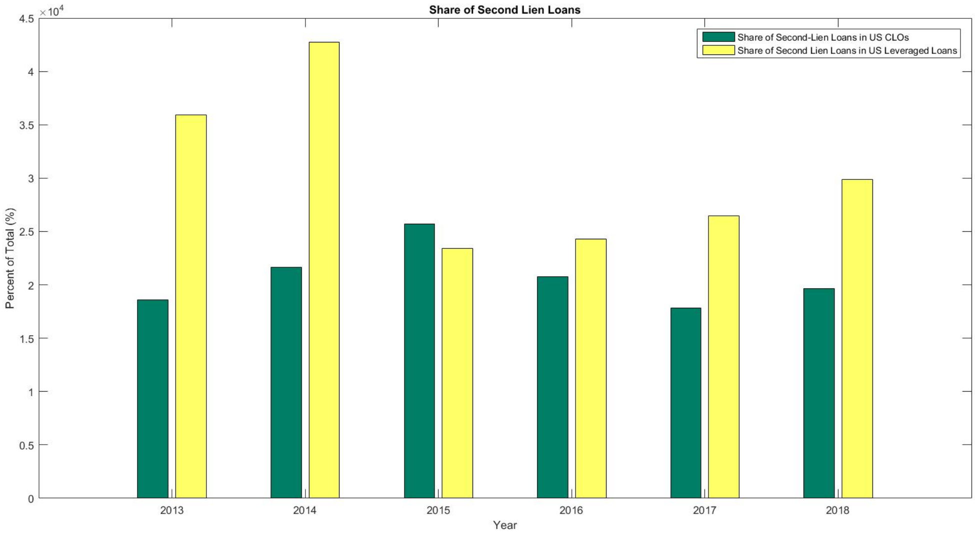
Figure 5.2: Leveraged Loan and CLO Outstanding and New Issuance



Notes: The top-left figure shows the gross leveraged loan issuance in comparison to the high-yield bond market in trillions. The top-right figure shows leveraged loans outstanding by geographic area. The bottom-left figure shows new CLO issuance in billions in the US and EU. The bottom-right figure shows the outstanding CLO volume in billions in the US and EU. The x-axis represents the year, and the y-axis represents the amount in all figures. Source: International Monetary Fund (2020)

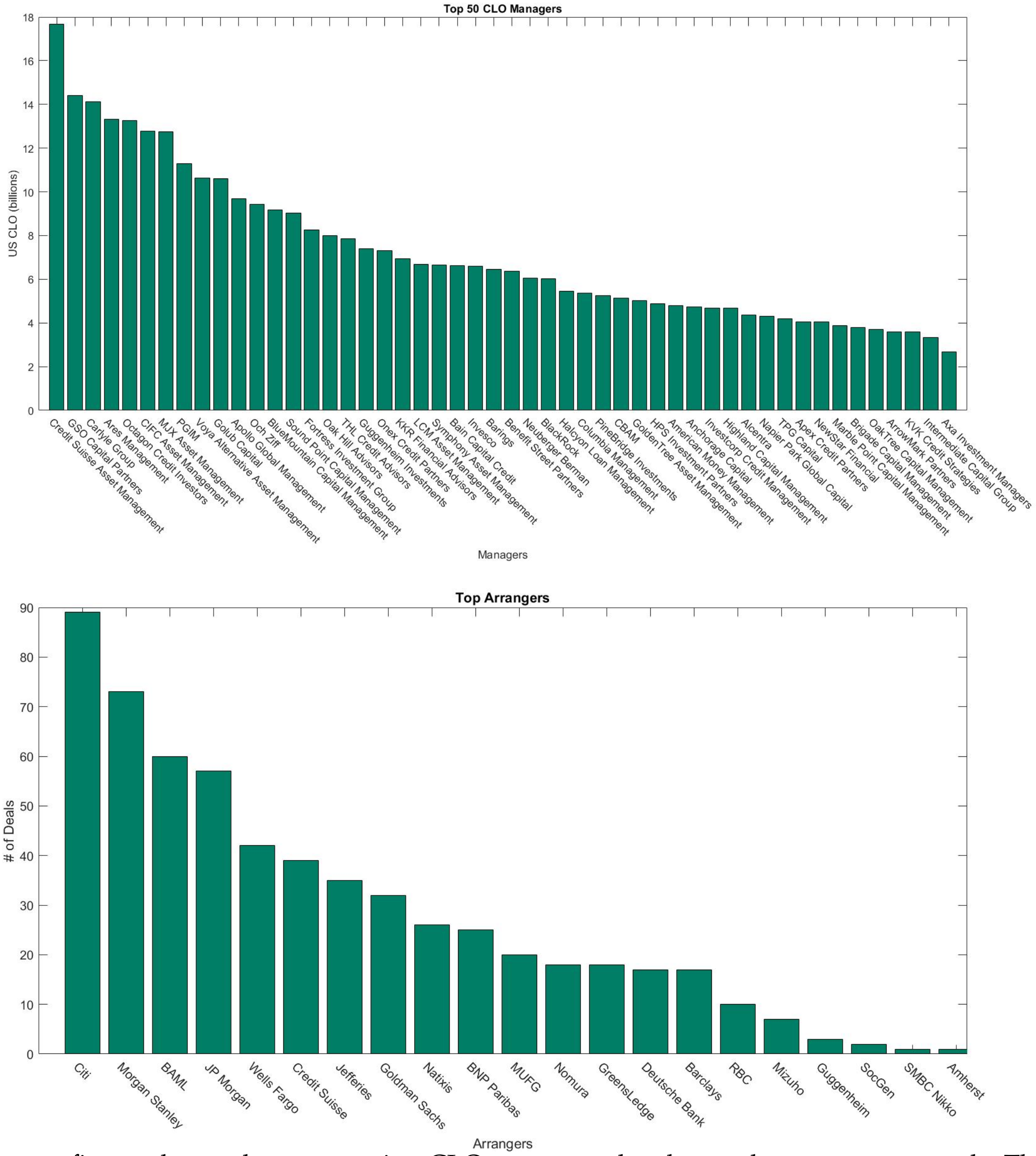
Figure 5.3: Evidence of Screening: Collateral Distribution of Leveraged Loans and CLOs





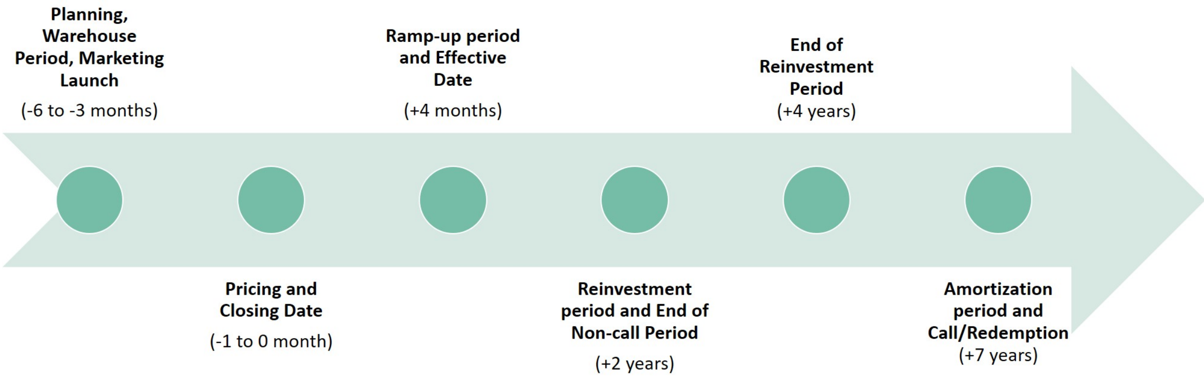
Notes: The top figure shows the industry distribution of leveraged loans at issuance, and leveraged loans in CLOs. The red bar indicates the share of leveraged loans by industry. The blue bar indicates the share of leveraged loans in CLOs by industry. The x-axis indicates the industry. The the y-axis indicates the share (out of 1). The bottom figure shows the percent of second-lien loans among new issuance of leveraged loans and CLO issuance. The red bar indicates the percent of second-lien loans in leveraged loans. The blue bar indicates the percent of second-lien loans in CLOs. The x-axis is the year. The y-axis is the percent. Source: Refinitiv LPC Loan Pricing Data

Figure 5.4: Most Active CLO Managers and Arrangers (2009-2018)



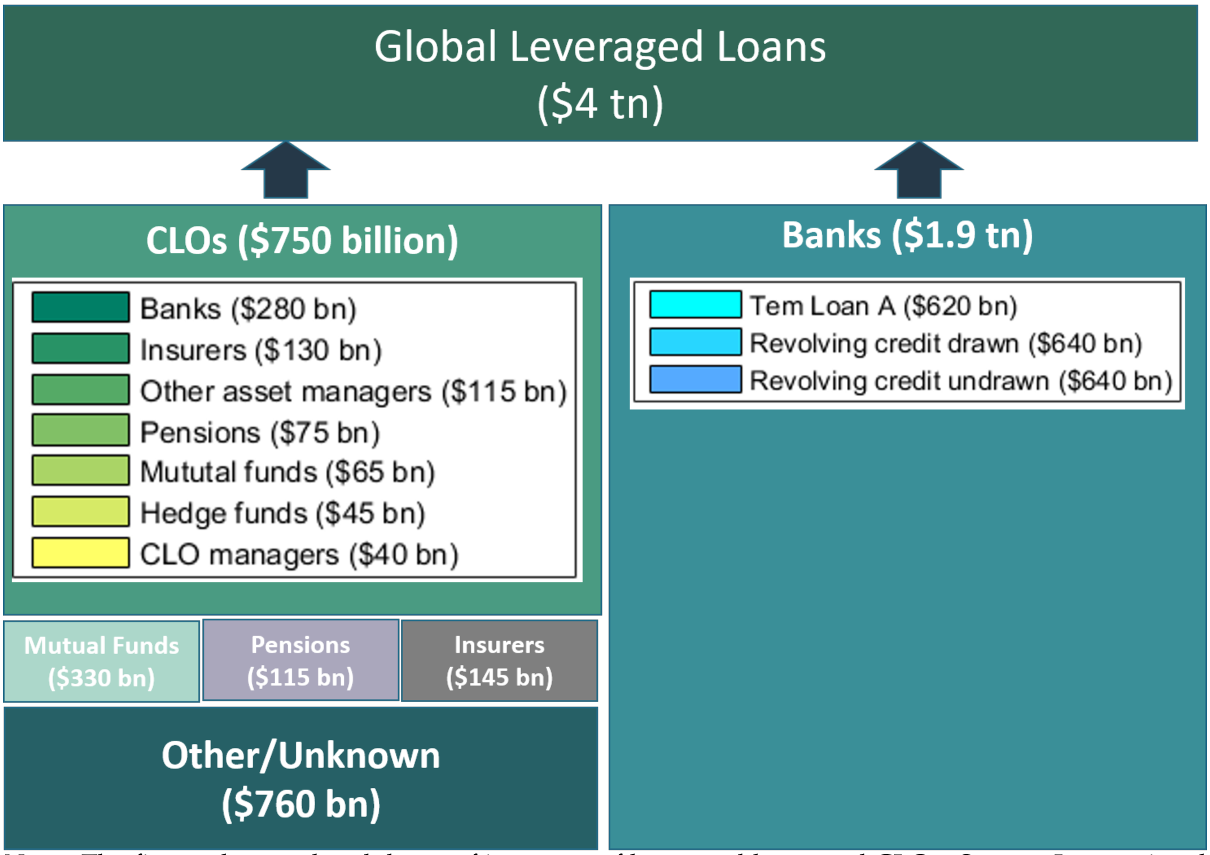
Notes: The top figure shows the most active CLO managers by the total amount managed. The x-axis presents the managers, and the y-axis represents the total amount managed in billions USD. The bottom figure shows the most active arrangers and underwriters of CLOs by number of deals. The x-axis presents the most active arrangers. The y-axis represents the number of deals. The data used to create this figure comes from Creditflux's CLO-i database and is discussed in detail in Kundu (2021*b*).

Figure 5.5: Lifecycle of CLOs



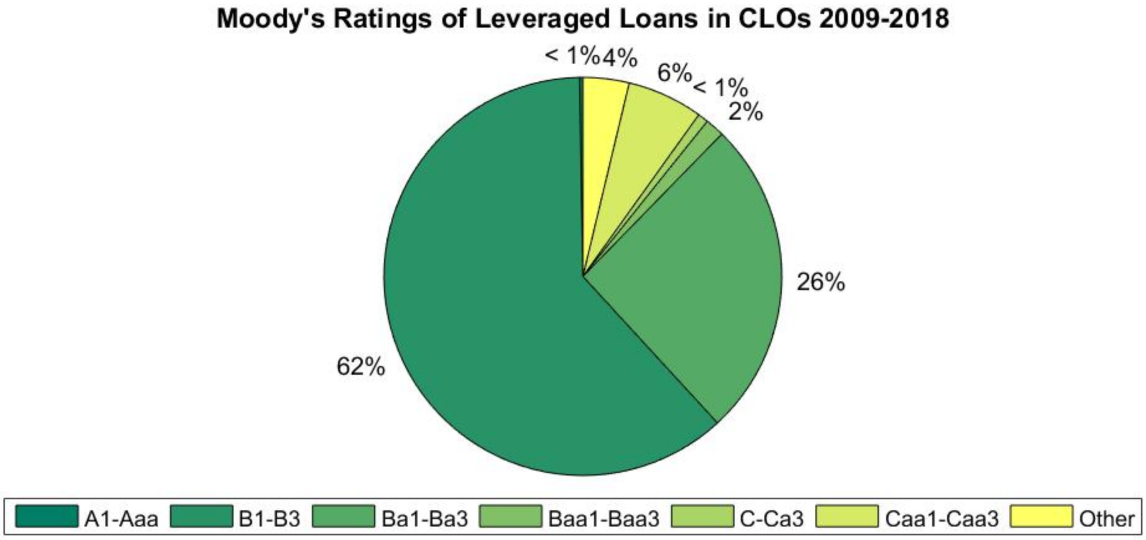
Notes: The figure shows the timeline of a CLO from planning to redemption. There are four main phases in a CLO's life: warehousing phase, effective phase, reinvestment period, and amortization. The figure above marks the six most salient events in a CLO's lifetime from planning to redemption.

Figure 5.6: Who holds CLOs and Leveraged Loans?



Notes: The figure shows a breakdown of investors of leveraged loans and CLOs. Source: International Monetary Fund (2020)

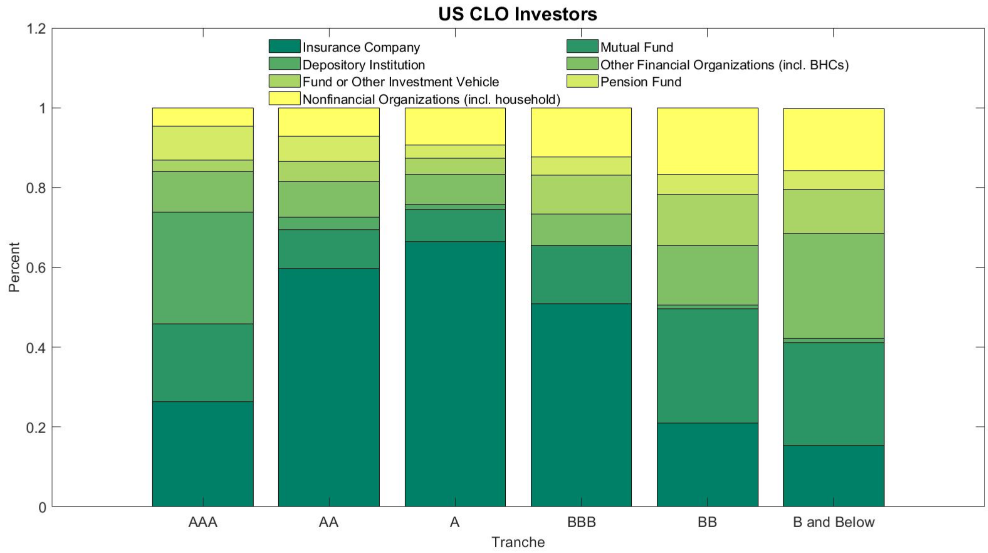
Figure 5.7: Ratings of Leveraged Loans and CLOs (Assets) (2009-2018)



S&P Rating	CLO Share	LL Share
A range	0.282%	-
BBB range	1.59%	1.11%
BB range	23.49%	17.17%
B range	68.99%	53.05%
C and below	5.64%	28.67%

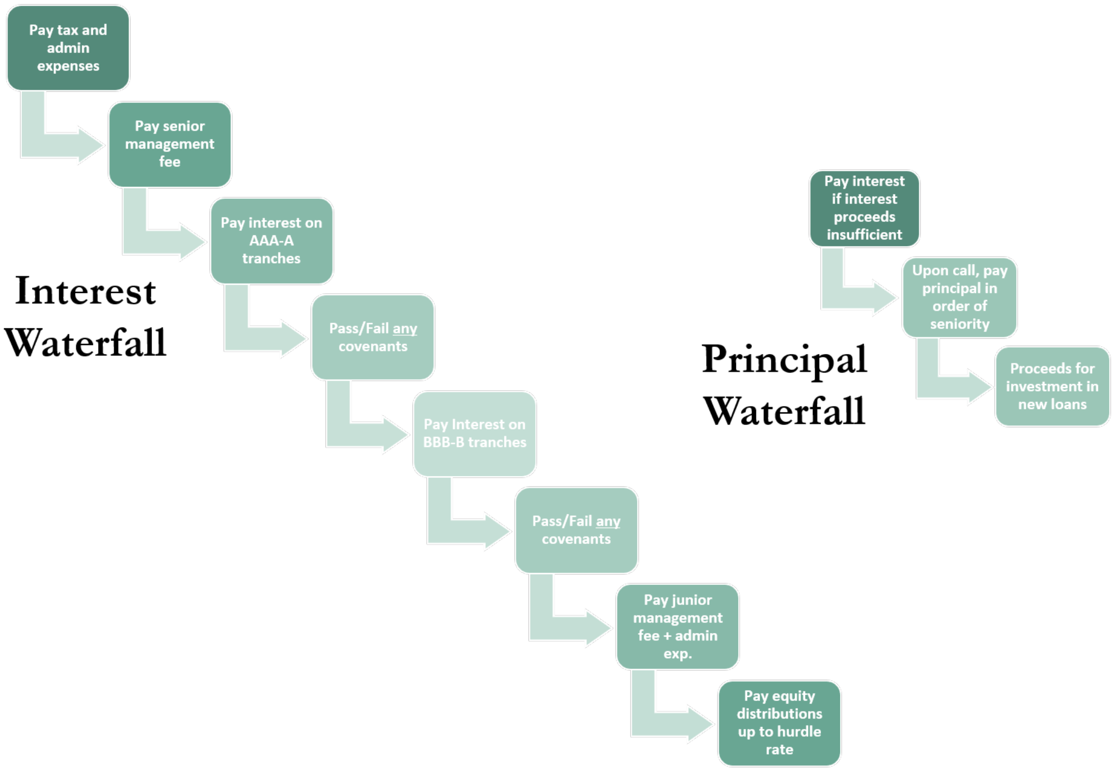
Notes: The figure shows the S&P ratings of CLO assets. The table compares the distribution of S&P ratings across CLO assets to leveraged loans. The data used to create this figure comes from Creditflux's CLO-i database and is discussed in detail in Kundu (2021*b*).

Figure 5.8: CLO Investors by Tranche



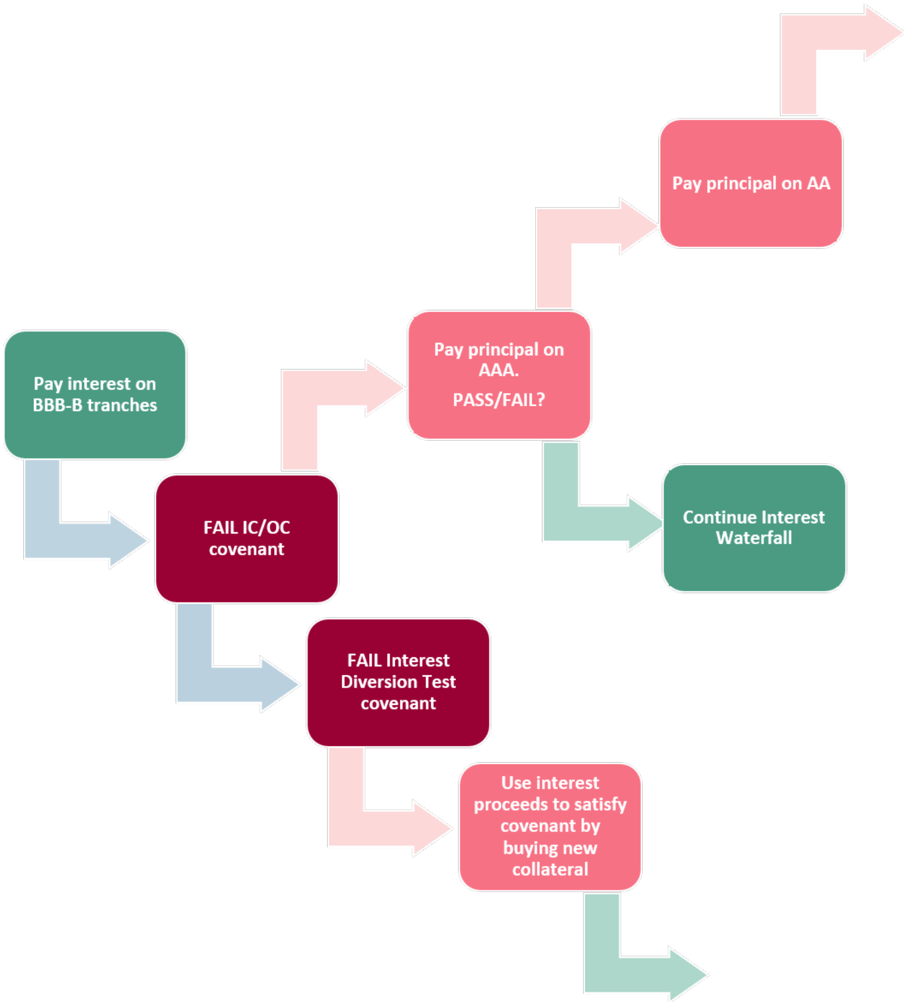
Notes: The figure shows a breakdown of investors of CLOs by tranche (debt). Source: International Monetary Fund (2020)

Figure 5.9: Cash Flows and Covenants: Sequence of Events



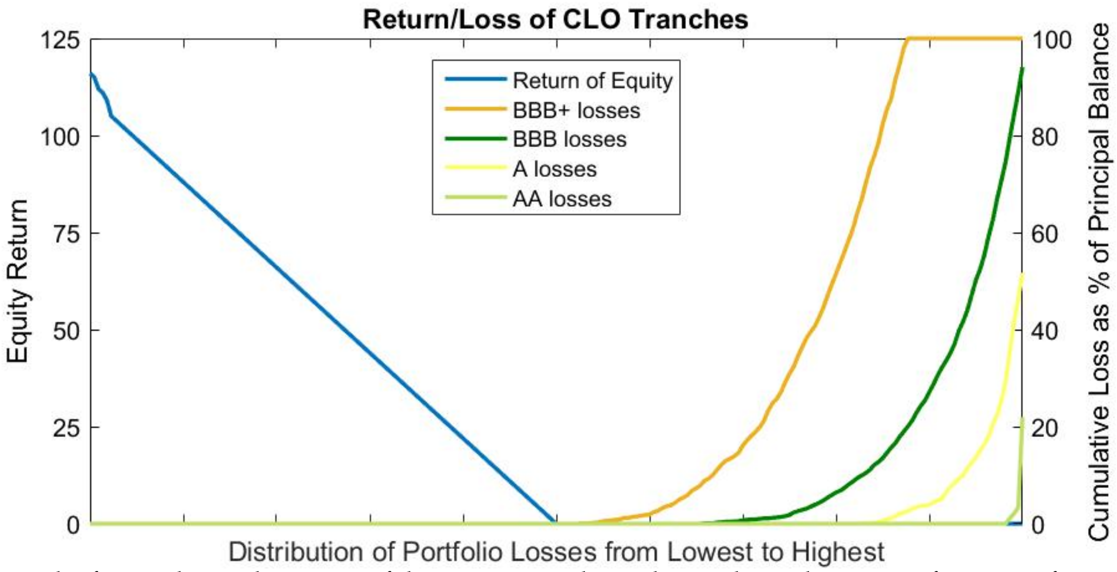
Notes: The figure shows the sequence of cash flow distributions from interest proceeds (left) and principal proceeds (right). The information to create this figure comes from Creditflux (2020).

Figure 5.10: Cash Flows and Events: Covenant Failures



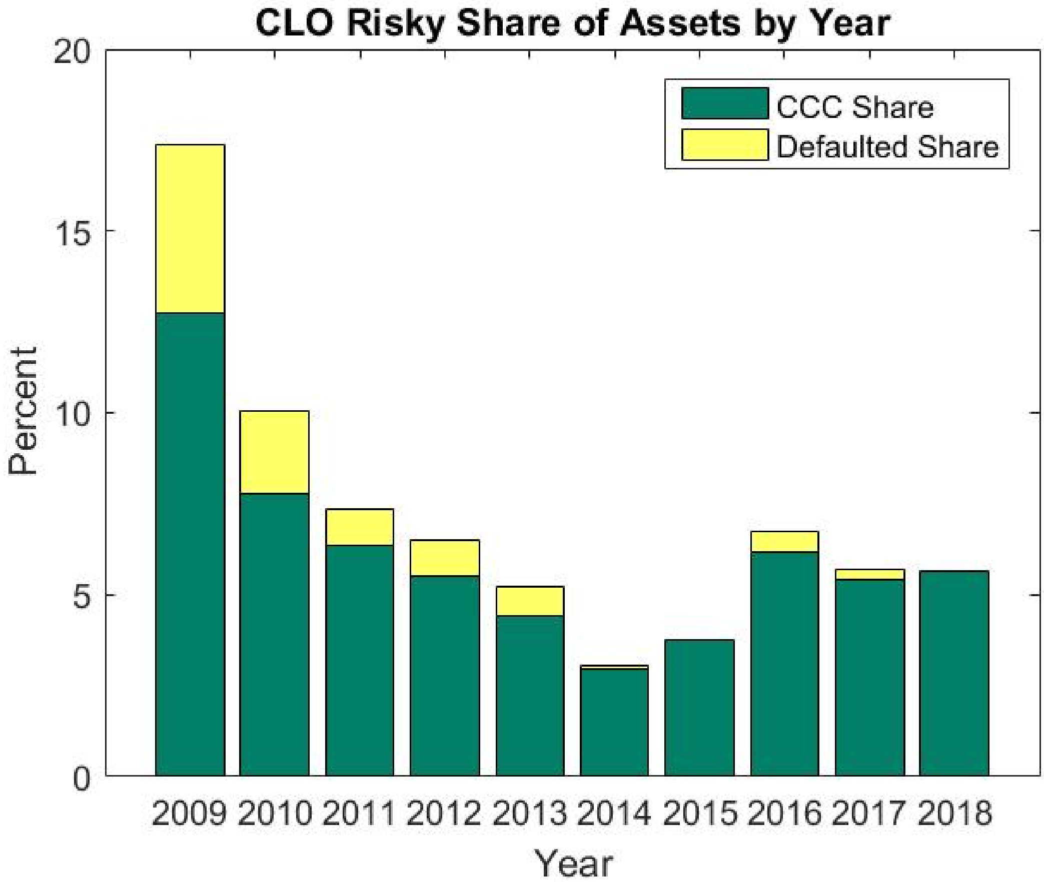
Notes: The figure shows the sequence of events prescribed to managers in event of coverage covenant breaches. The information to create this figure comes from Creditflux (2020).

Figure 5.11: Return/Loss of CLO Tranches



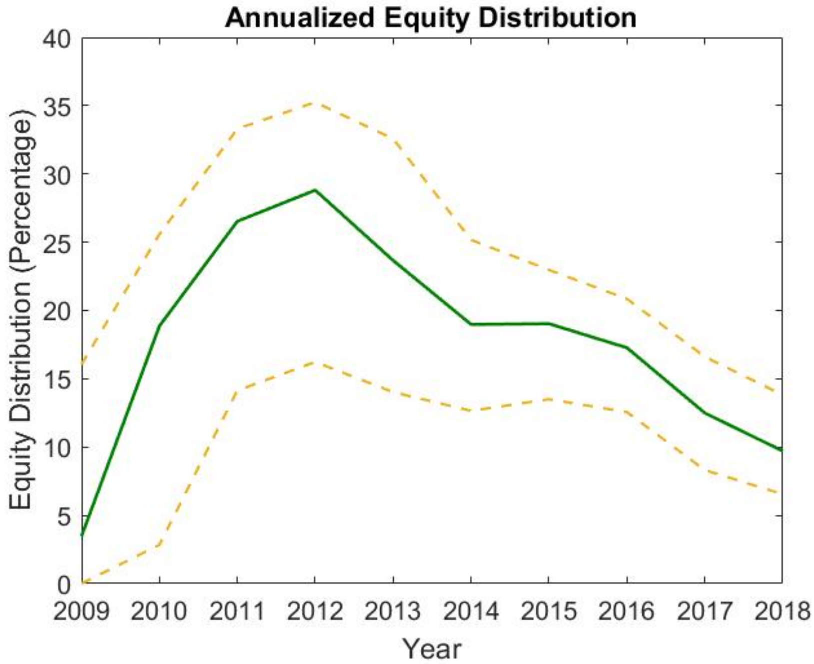
Notes: The figure shows the return of the equity tranche and cumulative losses as a function of portfolio losses. The x-axis plots the distribution of portfolio losses from lowest to highest. The left y-axis plots the equity return in percent. The right y-axis plots the cumulative loss as a percent of principal balance. The equity distribution is defined as follows: Equity Distribution $= \frac{\text{Interest payment} \times \frac{12}{\text{Payment frequency}}}{\text{Par value of equity}} \times 100$.
Source: International Monetary Fund (2020)

Figure 5.12: CLO Risky Share of Loans (2009-2018)



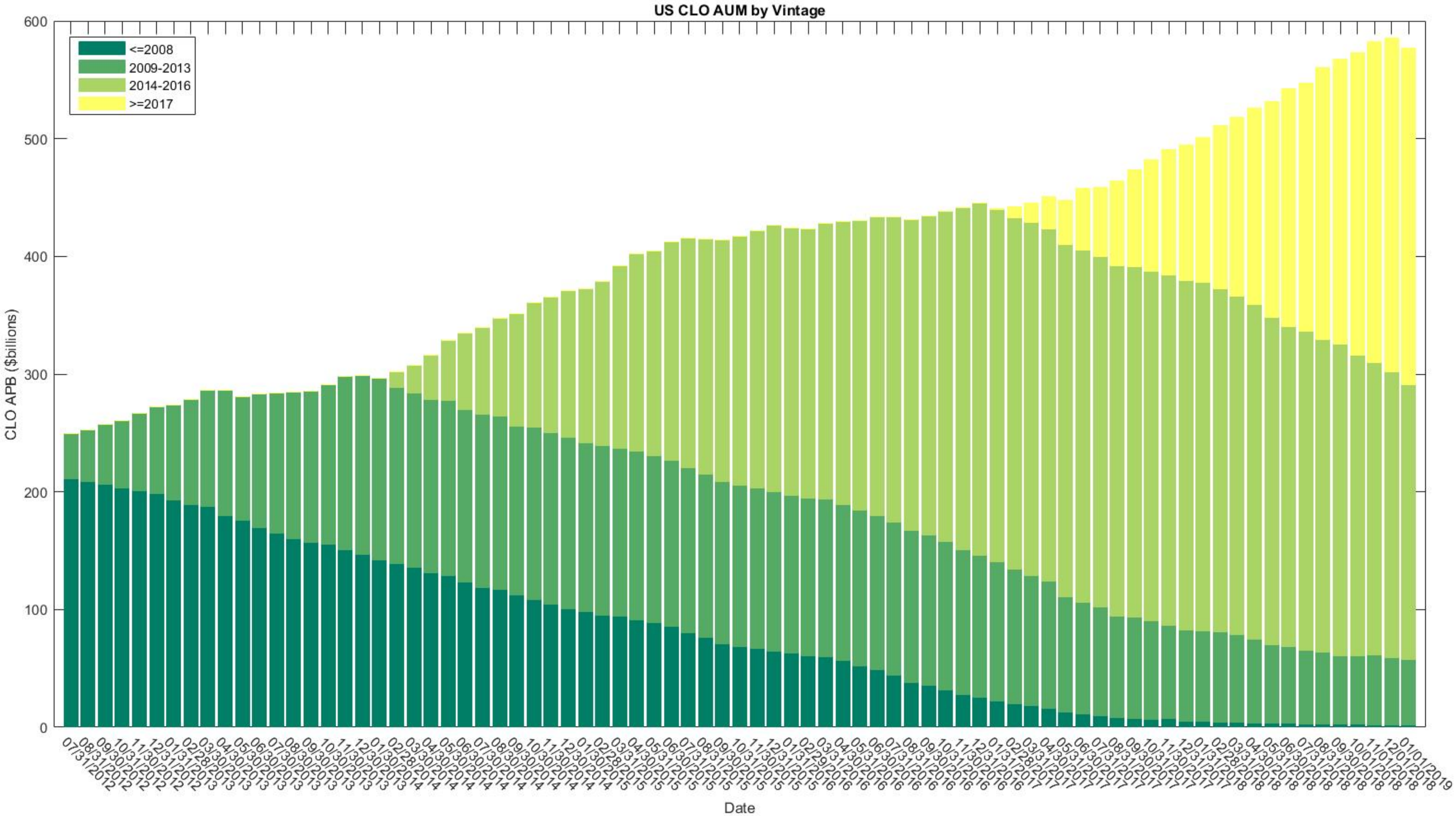
Notes: The figure shows the median CLO's share of risky loans by year. *Risky loans* are comprised of loans that constitute the CCC bucket (green) and the percent of defaulted loans and discount obligations (yellow). The data used to create this figure comes from Creditflux's CLO-i database and is discussed in detail in Kundu (2021*b*).

Figure 5.13: Equity Distribution (2009-2018)



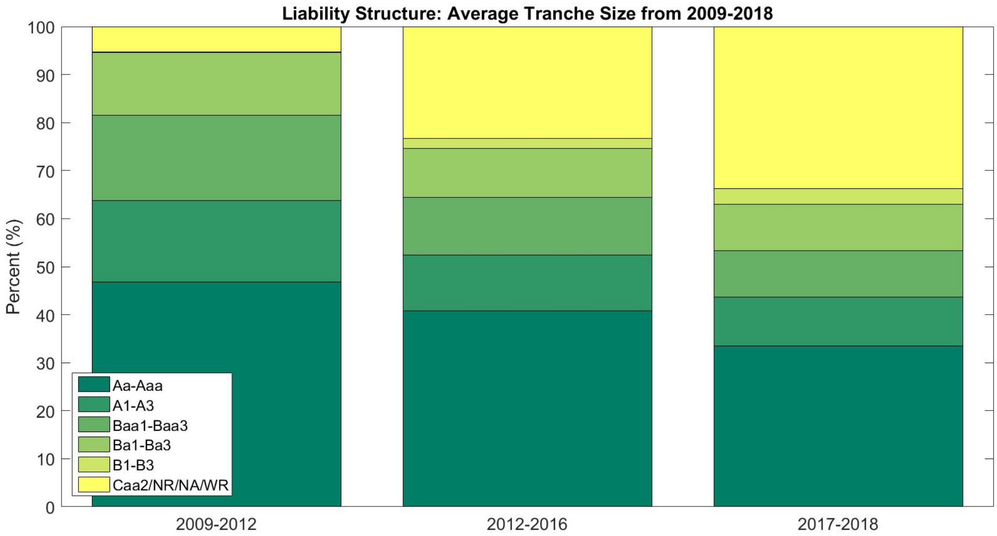
Notes: The figure shows the interquartile interval (dotted lines) of the CLOs' annual distribution to equity. The median value is plotted using a solid line. The equity distribution is defined as follows: Equity Distribution $= \frac{\text{Interest payment} \times \frac{12}{\text{Payment frequency}}}{\text{Par value of equity}} \times 100$. The data used to create this figure comes from Creditflux's CLO-i database and is discussed in detail in Kundu (2021*b*).

Figure 5.14: AUM by CLO Vintage (2012-2019)



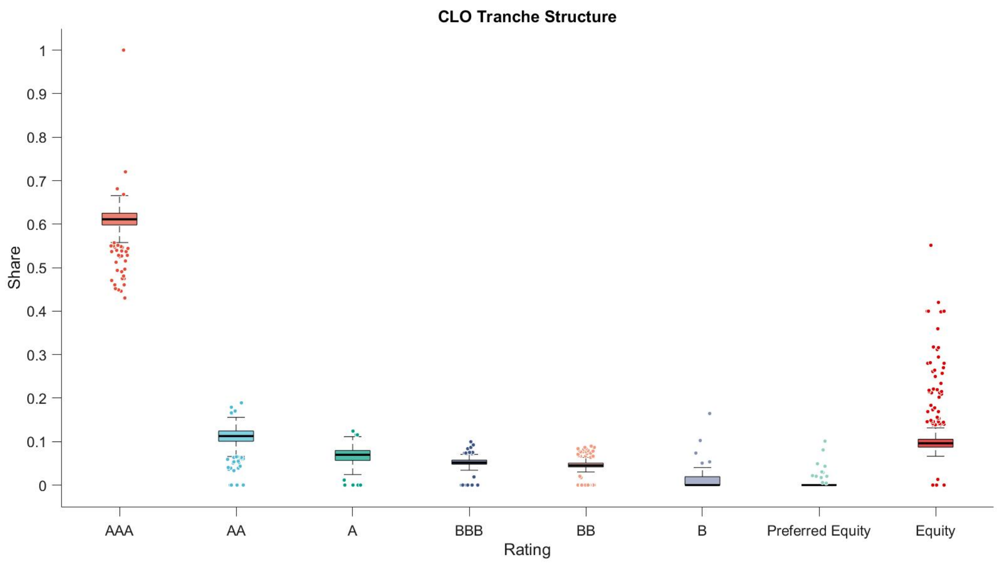
Notes: The figure shows the CLO AUM by vintage. At the start of 2019, late vintage CLOs represented 50% of all CLOs of AUM, while CLOs issued between 2014 and 2016 represented 40% of AUM. Source: Source: Refinitiv LPC Loan Pricing Data

Figure 5.15: Changes in Liability Structure (2009-2018)



Notes: The figure shows the distribution of tranches across all CLO liabilities by count. For example, this figure indicates that from 2009-2012, 47% of all CLO tranches were rated AA-Aaa as compared to 41% between 2012-2016 and 33% in 2017-2018. The data used to create this figure comes from Creditflux's CLO-i database and is discussed in detail in Kundu (2021*b*).

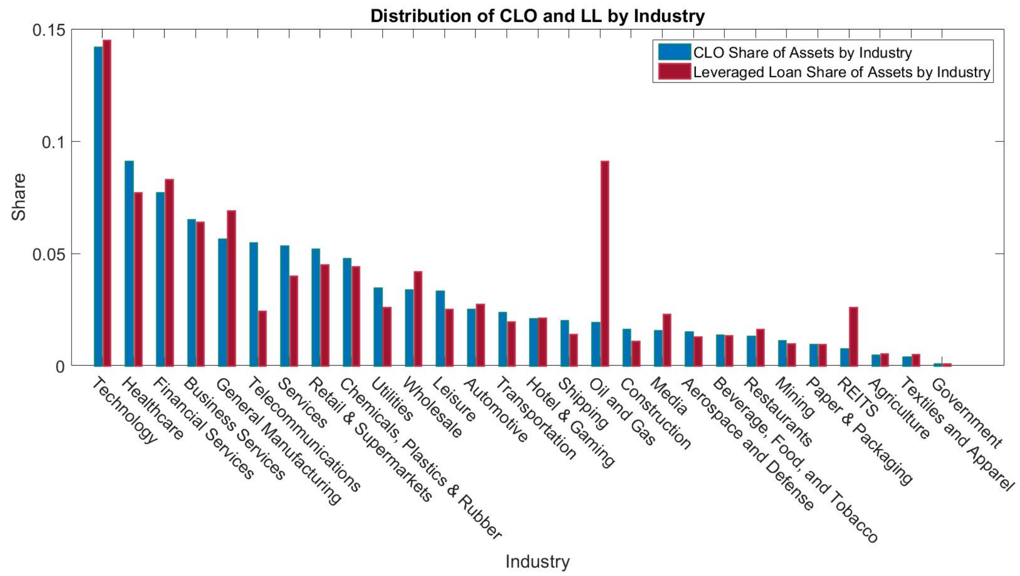
Figure 5.16: Distribution in CLO Liability Structure within CLOs (2011-2015)

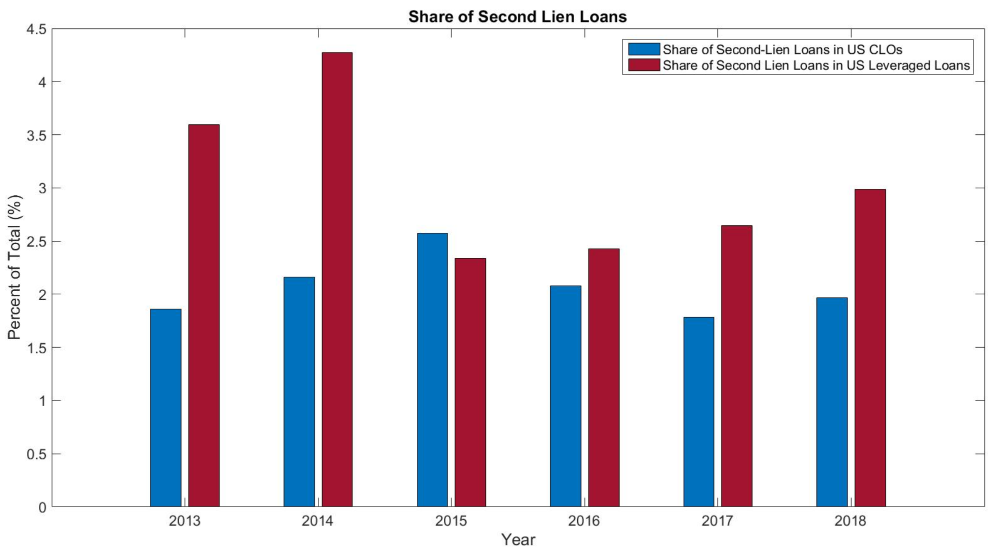


Notes: The figure exhibits the variability in tranche sizes within a CLO by size from 2011-2015. The black bar shows the median, while the box indicates the inter-quartile range. Outliers are outside the box. Source: S&P LCD CLO Data

5.2 Chapter 3: Financial Covenants and Fire Sales: Fractures in the Leveraged Loan Market

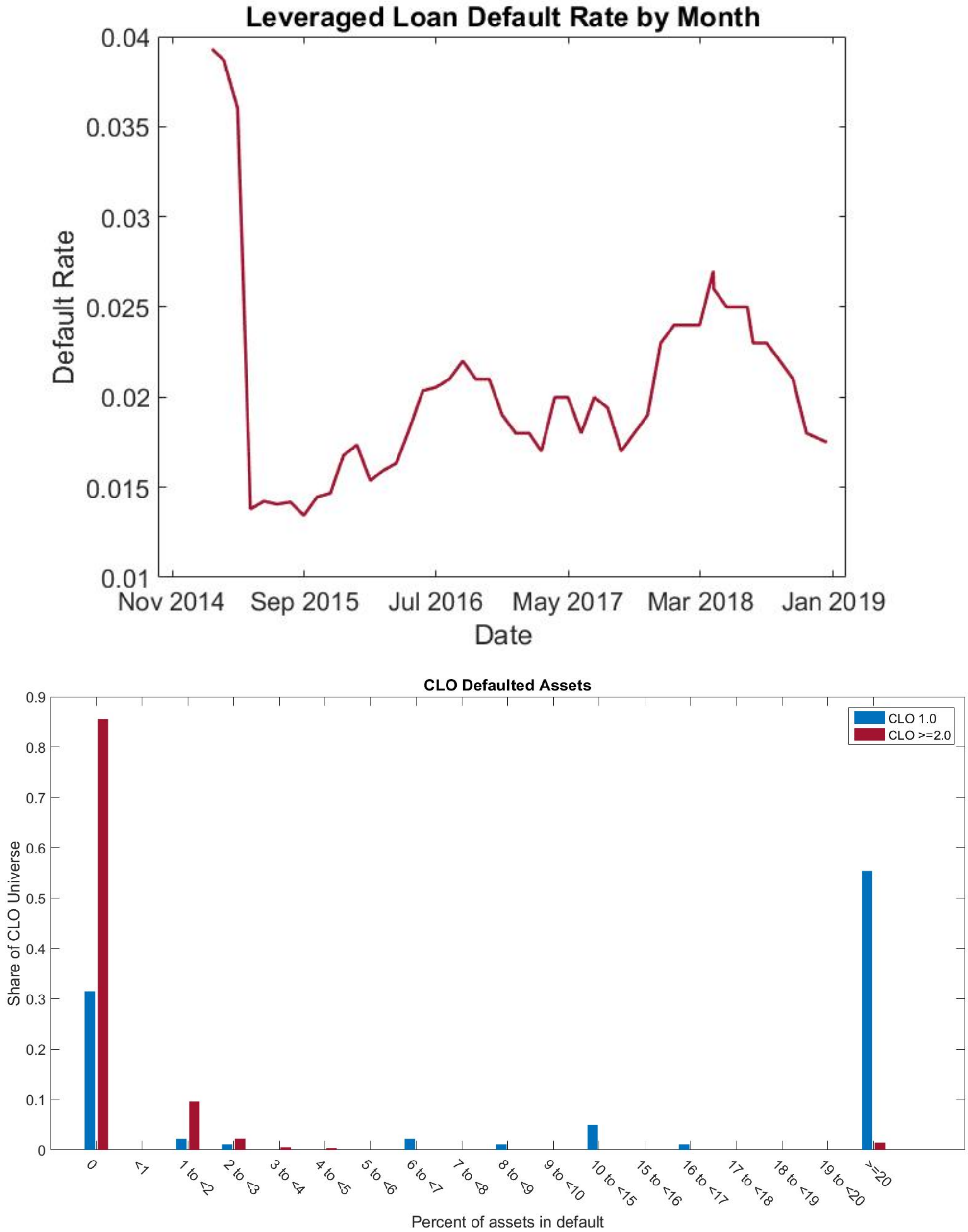
Figure 5.17: Evidence of Screening: Collateral Distribution of Leveraged Loans and CLOs





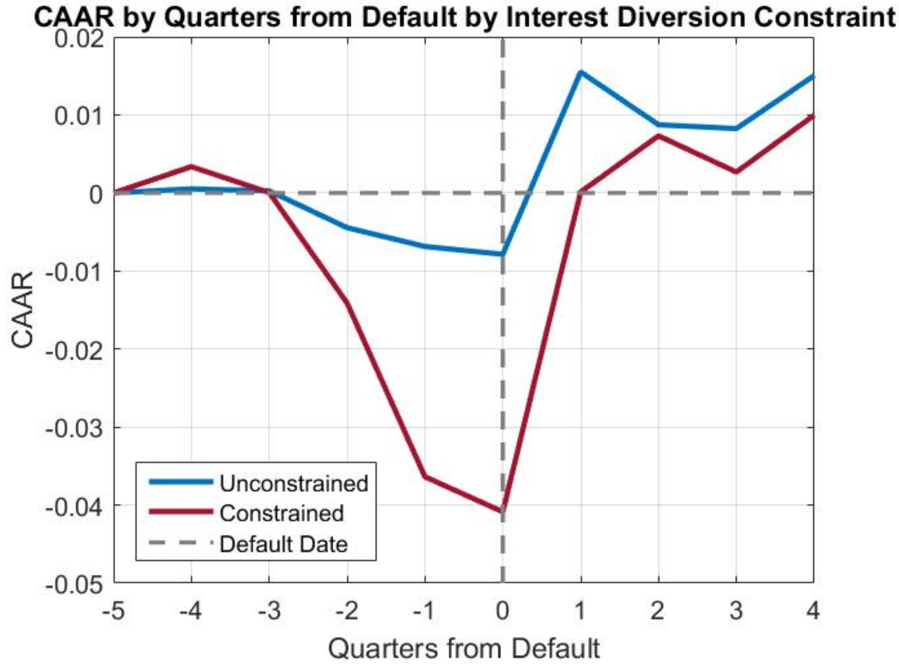
Notes: The top figure shows the industry distribution of leveraged loans at issuance, and leveraged loans in CLOs. The red bar indicates the share of leveraged loans by industry. The blue bar indicates the share of leveraged loans in CLOs by industry. The x-axis indicates the industry. The y-axis indicates the share (out of 1). The bottom figure shows the percent of second-lien loans among new issuance of leveraged loans and CLO issuance. The red bar indicates the percent of second-lien loans in leveraged loans. The blue bar indicates the percent of second-lien loans in CLOs. The x-axis is the year. The y-axis is the percent. Source: Refinitiv LPC Loan Pricing Data

Figure 5.18: Evidence of Monitoring: Default of Leveraged Loans and CLOs



Notes: The top figure shows the leveraged loan default rate from 2015 through 2018. The x-axis indicates the date. The y-axis indicates the default rate. The bottom figure shows the percent of assets in default by CLO vintage at the end of December 2018. The blue bar indicates CLO 1.0s. The red bar indicates CLO 2.0s. The x-axis indicates the percent of assets in default. The y-axis indicates the share of CLOs across the universe of CLOs.

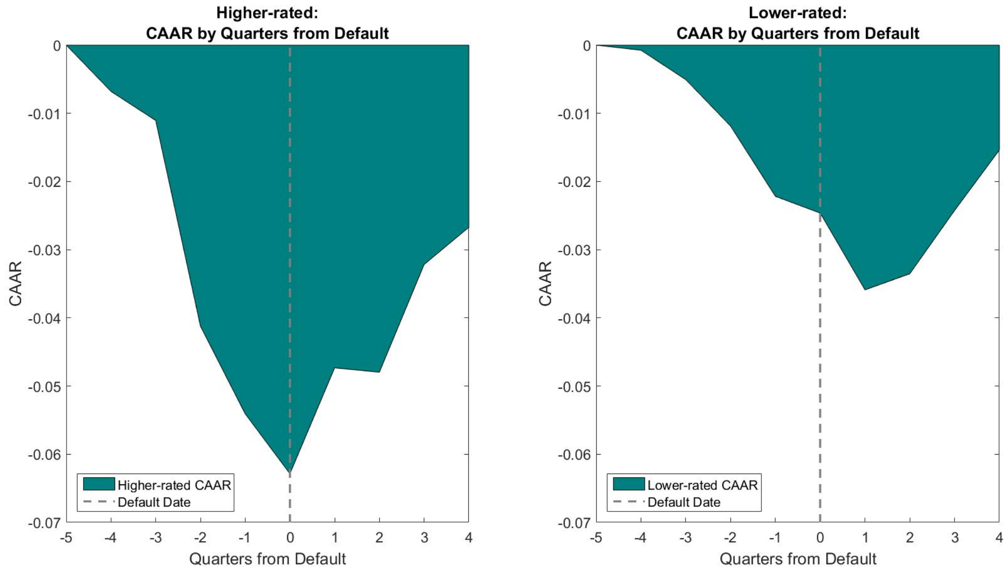
Figure 5.19: Constrained vs. Unconstrained CAAR by Interest Diversion Covenant Results



Quarterly Cumulative Average Abnormal Returns: Junior IC Ratio								
	Constrained			Unconstrained			Difference (Constrained-Unconstrained)	
Quarters	CAAR	N	t-statistic	CAAR	N	t-statistic	Δ CAAR	t-statistic
-4	0.0034	22	0.7691	0.0005	42	0.1902	0.0028	0.5896
-3	0.0001	42	0.0099	0.0003	65	0.0805	-0.0002	-0.0726
-2	-0.0141	19	-1.9867	-0.0045	86	-1.0319	-0.0096	-1.5638
-1	-0.0364	25	-4.6832	-0.0069	63	-1.2124	-0.0295	-6.2073
0	-0.0409	23	-4.5974	-0.0079	44	-1.0692	-0.0330	-4.4883
1	0.0001	14	0.0105	0.0155	16	1.5043	-0.0154	-1.5463
2	0.0073	31	0.5863	0.0087	15	0.6667	-0.0014	-0.1493
3	0.0027	33	0.1952	0.0082	20	0.6878	-0.0056	-0.8428
4	0.0100	57	0.8050	0.0151	47	1.1728	-0.0051	-1.7305

Notes: The figure plots the quarterly cumulative average abnormal return (CAAR) by quarters from default for loans that belong to Interest Diversion constrained CLOs (red) and Interest Diversion unconstrained CLOs (blue). Constrained CLOs are CLOs that have a Interest Diversion result below the median. Unconstrained CLOs are CLOs that have a Interest Diversion result above the median. The abnormal return is generated from the following regression: $ln(\frac{P_{i,t}}{P_{i,t-1}}) \approx \alpha + \beta Z_{i,t-1,t} + \gamma_0(Q_{i,t} - Q_{i,t-1}) + \gamma_1(Q_{i,t}ln(S_{i,t}) - Q_{i,t-1}ln(S_{i,t-1})) + \epsilon_{i,t-1,t}$, where P is the observed price, Z is a vector of fundamental value, Q is a purchase indicator, S is the trade size, ϵ is the error, i denotes the loan, and t denotes the day. These abnormal returns are averaged by quarters from default, and accumulated. The CAAR, five quarters from default, is normalized to be 0. The x-axis plots quarters from default. The y-axis plots the CAAR. Returns are winsorised at 3% level for each tail. The associated table tabulates the main results. The CAAR, t-statistic, and number of issuers is listed by quarters from default for loans belonging to constrained and unconstrained CLOs, respectively. Additionally, the difference (constrained CAAR minus unconstrained CAAR) and associated t-statistic are tabulated in the last two columns. The gray shading indicates that the CAAR is statistically significant above the 10% threshold.

Figure 5.20: CAAR for Loans of Higher vs. Lower Ratings

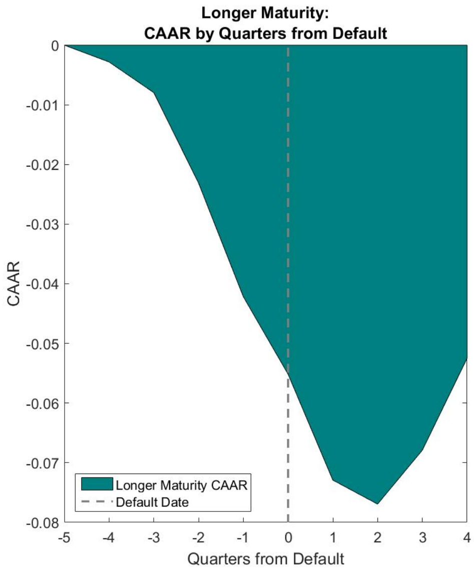


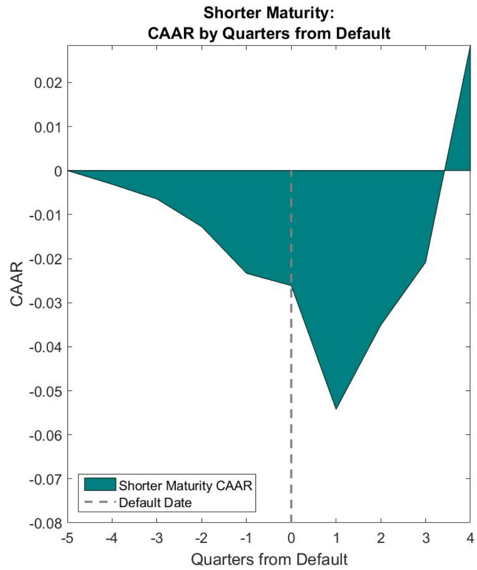
Quarterly Cumulative Average Abnormal Returns: Higher vs Lower Rated Loans

	Higher-Rated			Lower-Rated			Difference	
Quarters	CAAR	N	t-statistic	CAAR	N	t-statistic	Δ CAAR	t-statistic
-4	-0.0068	128	-1.7788	-0.0007	303	-0.3090	-0.0060	-1.3536
-3	-0.0111	72	-1.2218	-0.0051	295	-1.3246	-0.0060	-0.7653
-2	-0.0412	56	-2.5272	-0.0119	309	-2.4545	-0.0293	-3.2103
-1	-0.0541	44	-1.9155	-0.0222	239	-3.1519	-0.0319	-2.2844
0	-0.0629	64	-1.4947	-0.0246	174	-1.0817	-0.0382	-0.8449
1	-0.0473	36	-0.8602	-0.0359	97	-1.0461	-0.0114	-0.2528
2	-0.0480	59	-0.7461	-0.0335	124	-0.8712	-0.0144	-0.4155
3	-0.0322	58	-0.5076	-0.0243	111	-0.5814	-0.0079	-0.3676
4	-0.0267	173	-0.4168	-0.0154	149	-0.3408	-0.0113	-0.8082

Notes: The figure plots the quarterly cumulative average abnormal return (CAAR) by quarters from default for higher-rated loans (left figure) and lower-rated loans (right figure). Higher-rated loans are loans rated Baa3 and above. Lower-rated loans cover all other loans. The abnormal return is generated from the following regression: $ln(\frac{P_{i,t}}{P_{i,t-1}}) \approx \alpha + \beta Z_{i,t-1,t} + \gamma_0(Q_{i,t} - Q_{i,t-1}) + \gamma_1(Q_{i,t}ln(S_{i,t}) - Q_{i,t-1}ln(S_{i,t-1})) + \epsilon_{i,t-1,t}$, where P is the observed price, Z is a vector of fundamental value, Q is a purchase indicator, S is the trade size, ϵ is the error, i denotes the loan, and t denotes the day. These abnormal returns are averaged by quarters from default, and accumulated. The CAAR, five quarters from default, is normalized to be 0. The x-axis plots quarters from default. The y-axis plots the CAAR. The associated table tabulates the main results. The CAAR, t-statistic, and number of issuers is listed by quarters from default for higher- and lower-rated loans, respectively. Additionally, the difference (higher-rated CAAR minus lower-rated CAAR) and associated t-statistic are tabulated in the last two columns. The gray shading indicates that the CAAR is statistically significant above the 10% threshold.

Figure 5.21: CAAR for Loans of Longer vs. Shorter Remaining Maturities



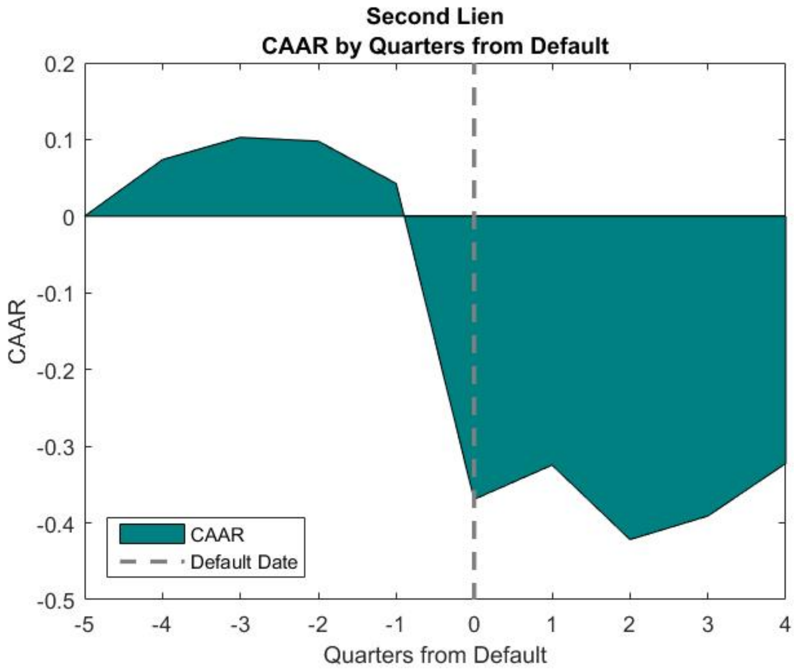


Quarterly Cumulative Average Abnormal Returns: Longer vs Shorter Remaining Maturity

	Longer Remaining Maturity			Shorter Remaining Maturity			Difference (Longer-Shorter)	
Quarters	CAAR	N	t-statistic	CAAR	N	t-statistic	Δ CAAR	t-statistic
-4	-0.0028	178	-0.8894	-0.0031	210	-1.0577	0.0003	0.0612
-3	-0.0080	131	-1.6199	-0.0065	159	-1.0952	-0.0015	-0.2482
-2	-0.0231	213	-3.3927	-0.0128	235	-1.7705	-0.0104	-1.4119
-1	-0.0422	158	-5.1690	-0.0233	169	-2.7731	-0.0188	-1.7264
0	-0.0552	106	-1.5450	-0.0261	131	-0.8849	-0.0290	-0.6326
1	-0.0729	31	-0.9312	-0.0542	47	-0.8801	-0.0187	-0.3602
2	-0.0769	40	-0.8140	-0.0351	42	-0.4472	-0.0418	-1.2032
3	-0.0679	40	-0.6060	-0.0208	54	-0.2676	-0.0471	-1.6959
4	-0.0525	51	-0.4314	0.0285	78	0.3330	-0.0810	-2.8274

Notes: The figure plots the quarterly cumulative average abnormal return (CAAR) by quarters from default for longer maturity loans (left figure) and shorter maturity loans (right figure). Longer maturity loans are loans with a remaining maturity above the median. Shorter maturity loans are loans with a remaining maturity below the median. The abnormal return is generated from the following regression: $ln(\frac{P_{i,t}}{P_{i,t-1}}) \approx \alpha + \beta Z_{i,t-1,t} + \gamma_0(Q_{i,t} - Q_{i,t-1}) + \gamma_1(Q_{i,t}ln(S_{i,t}) - Q_{i,t-1}ln(S_{i,t-1})) + \epsilon_{i,t-1,t}$, where P is the observed price, Z is a vector of fundamental value, Q is a purchase indicator, S is the trade size, ϵ is the error, i denotes the loan, and t denotes the day. These abnormal returns are averaged by quarters from default, and accumulated. The CAAR, five quarters from default, is normalized to be 0. The x-axis plots quarters from default. The y-axis plots the CAAR. The associated table tabulates the main results. The CAAR, t-statistic, and number of issuers is listed by quarters from default for longer- and shorter-maturity loans, respectively. Additionally, the difference (longer-maturity CAAR minus shorter-maturity CAAR) and associated t-statistic are tabulated in the last two columns. The gray shading indicates that the CAAR is statistically significant above the 10% threshold.

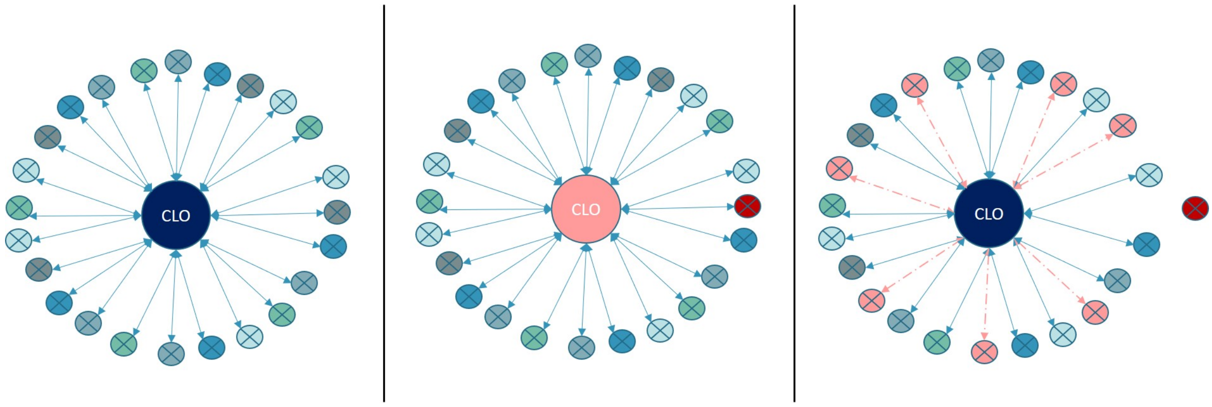
Figure 5.22: Second Lien CAAR



Notes: The figure plots the quarterly cumulative average abnormal return (CAAR) by quarters around default for second lien loans. The abnormal return is generated from the following regression: $ln(\frac{P_{i,t}}{P_{i,t-1}}) \approx \alpha + \beta Z_{i,t-1,t} + \gamma_0(Q_{i,t} - Q_{i,t-1}) + \gamma_1(Q_{i,t}ln(S_{i,t}) - Q_{i,t-1}ln(S_{i,t-1})) + \epsilon_{i,t-1,t}$, where P is the observed price, Z is a vector of fundamental value, Q is a purchase indicator, S is the trade size, ϵ is the error, i denotes the loan, and t denotes the day. These abnormal returns are averaged by quarters from default, and accumulated. Returns are winsorised at 1% level. The CAAR, five months from default, is normalized to be 0. The x-axis plots quarters from default. The y-axis plots the CAAR.

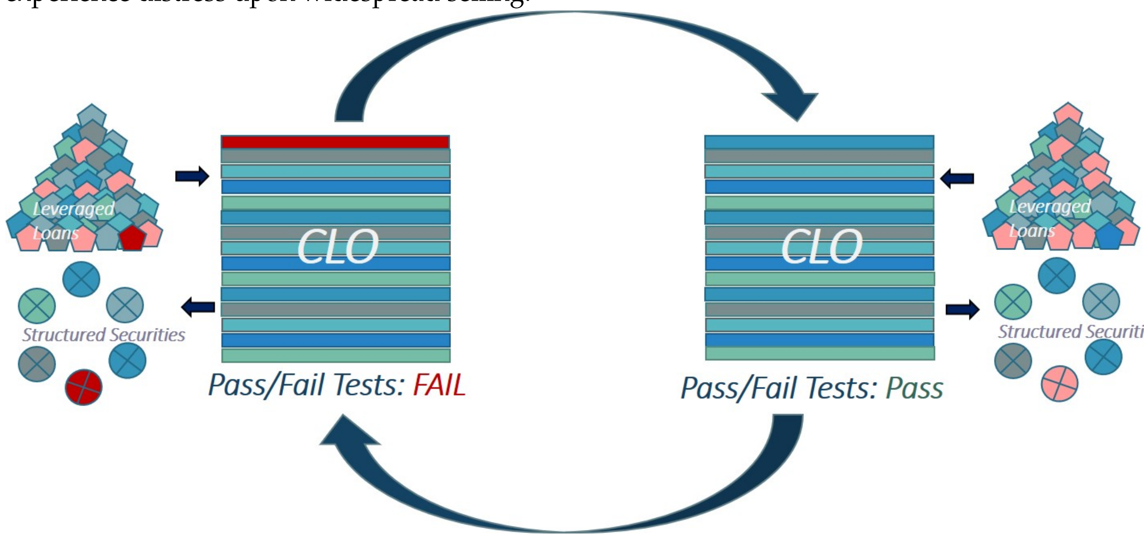
5.3 Chapter 4: The Externalities of Fire Sales: Evidence from Collateralized Loan Obligations

Figure 5.23: Research Setup: Potential for Financial Contagion



Network of Firms and CLOs

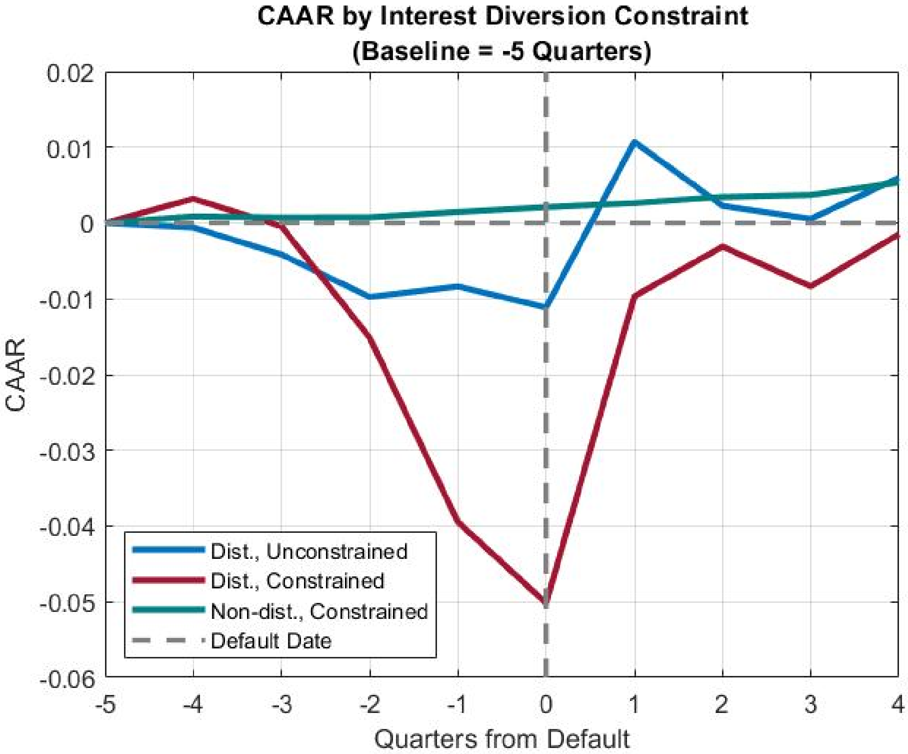
Notes: The diagram consists of the three figures which represent CLO portfolios. The center circle of each diagram represents a CLO while the outer circles represent firms. The spokes represent connections between firms and CLOs. Firms are connected to each other through the intermediary, the CLO. The 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.



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 may generate slack in the constraint 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).

Figure 5.24: Motivation: Heterogeneity in CAAR around Defaults

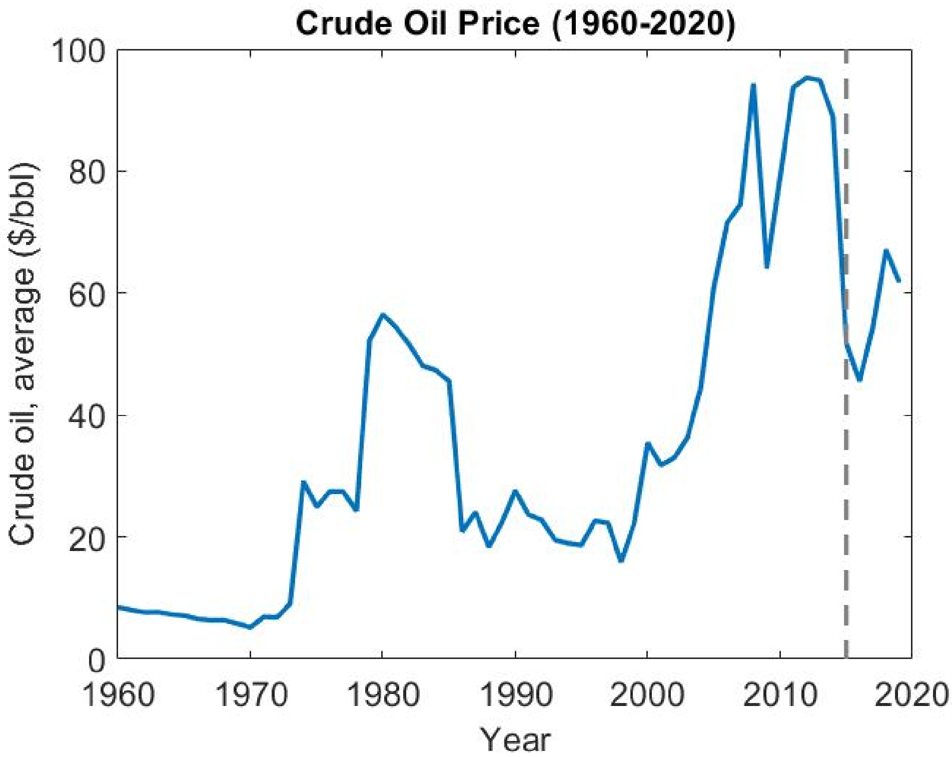


Notes: The figure compares the cumulative abnormal average returns (CAAR) for relatively constrained and unconstrained CLOs. The red line plots the CAAR for distressed loans held by constrained CLOs. The blue line plots the CAAR for distressed loans held by unconstrained CLOs. The green line plots the CAAR for non-distressed loans held by constrained CLOs. The sample of non-distressed loans held by constrained CLOs is generated by matching distressed firms to their non-distressed counterparts that operate in the same industry and size categories. *Constrained* and *unconstrained* are defined relative to the median. The abnormal return is generated from the following regression: $ln(\frac{P_{i,t}}{P_{i,t-1}}) \approx \alpha + \beta Z_{i,t-1,t} + \gamma_0(Q_{i,t} - Q_{i,t-1}) + \gamma_1(Q_{i,t}ln(S_{i,t}) - Q_{i,t-1}ln(S_{i,t-1})) + \epsilon_{i,t-1,t}$, where P is the observed price, Z is a vector of fundamental value of i, Q is a purchase indicator, S is the trade size, ϵ is the error, i denotes the loan, and t denotes the day. These abnormal returns are averaged by quarters from default, and accumulated. The CAAR, five quarters before default, is normalized to be 0. The x-axis plots months from default. The y-axis plots the CAAR.

Figure 5.25: Thought Experiment

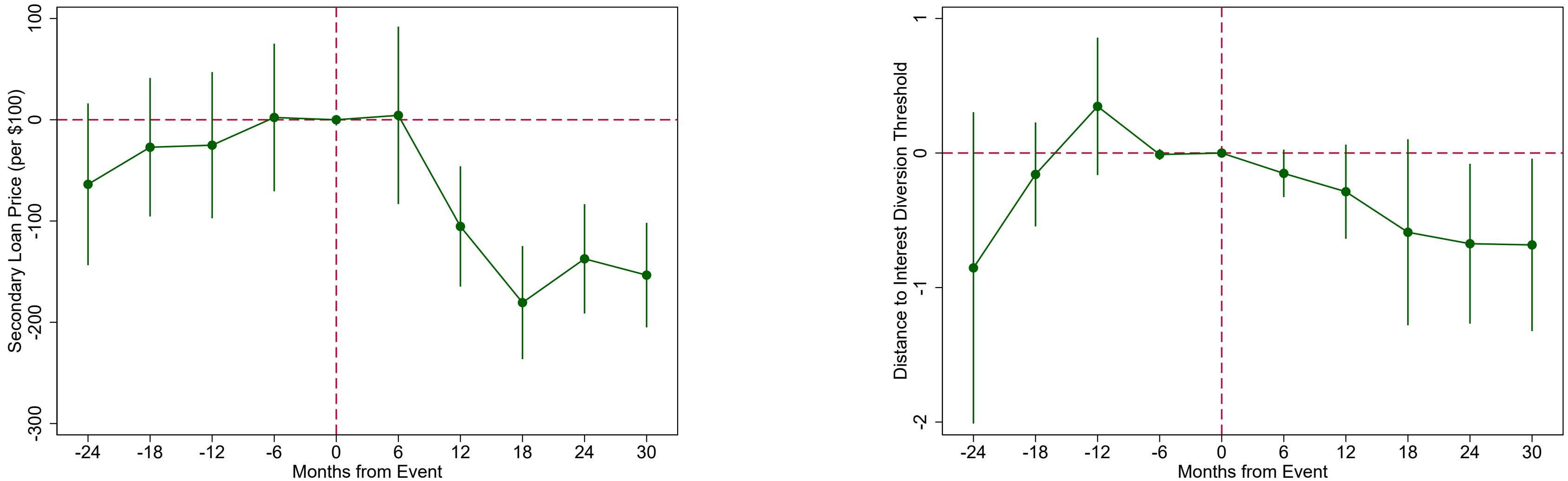
Notes: The figure illustrates the thought experiment belying the empirical strategy. There are two CLOs: CLO A and CLO B. CLO A does not hold any firms operating in the Oil & Gas industry ("Unconstrained"). CLO B has a sizeable exposure to firms in the O&G industry ("Constrained"). When the O&G price 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 5.26: 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 B.1.1.

Figure 5.27: Assessment of Pre-Trends: Secondary Loan Price and Interest Diversion Constraint



Secondary Loan Price

Distance to Interest Diversion Threshold

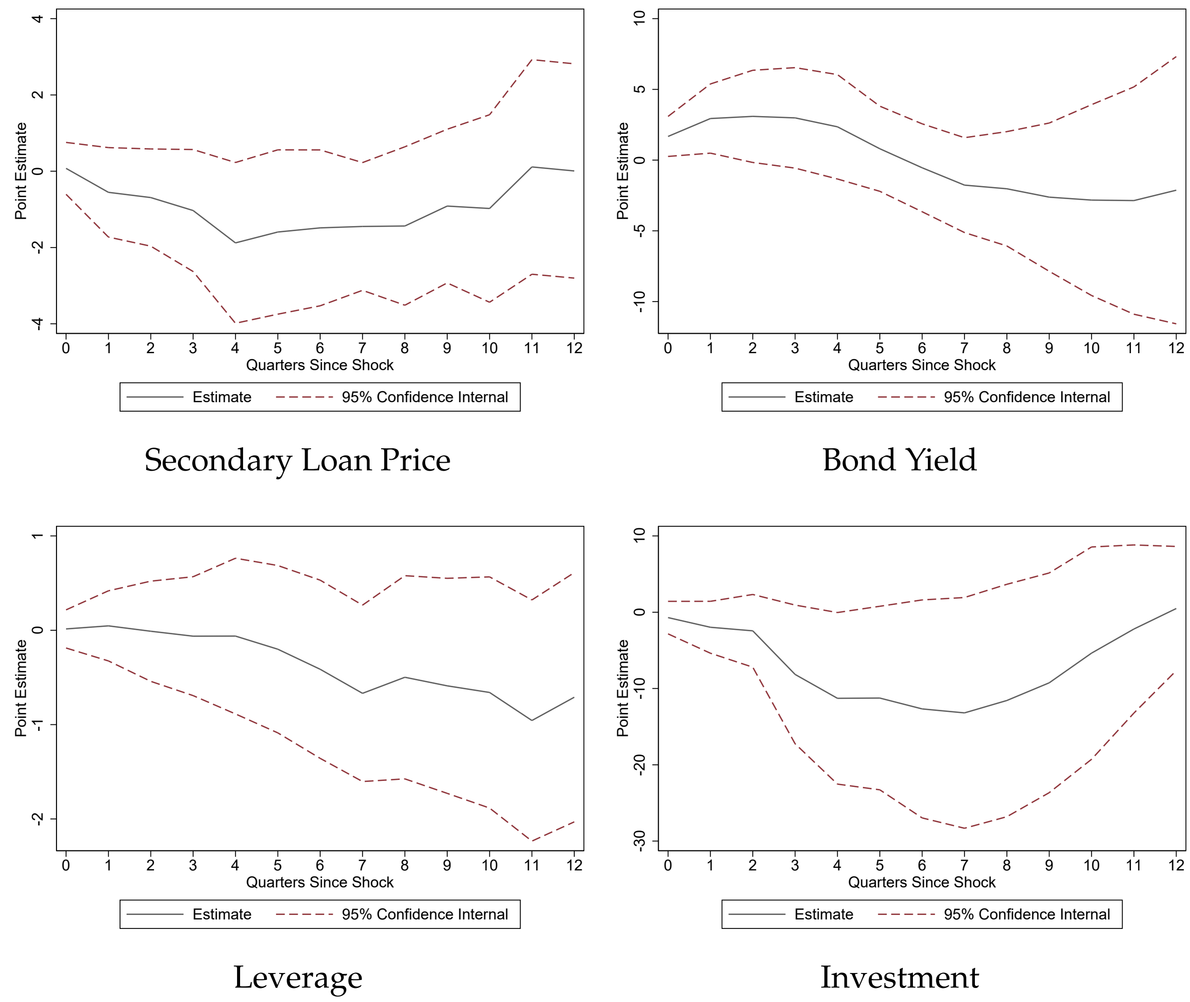
Notes: The figures present pre-trends. The baseline specifications of Figures 5.27 and Figure 5.27 take the following respective forms:

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

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

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, i denotes the loan, f denotes the (non-O&G) portfolio firm or issuer ($f \in c$), 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 O&G exposure measures. I exclude the last pre-treatment month to avoid perfect multicollinearity. The coefficients, β_i encapsulate the relation between the secondary loan price or distance to Interest Diversion threshold of non-O&G loans and CLO or firm O&G exposure before and after the shock. 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 5.27) and distance to the Interest Diversion threshold (Figure 5.27). Standard errors are two-way clustered by CLO and month-year.

Figure 5.28: 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 the secondary loan price (top left), 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 5.28. Standard errors are clustered by issuer in Figures 5.28, 5.28. and 5.28.

6
APPENDIX: TABLES

6.1 Chapter 2: The Anatomy of Collateralized Loan Obligations: On the Origins of Covenants and Contract Design

Table 6.1: Summary Statistics for Chapter 2: CLO, Issuer, and Transactions (2009-2018)

	N	Q1	Median	Q3	Mean	St. Dev.
Panel A: CLO Level Characteristics						
Outstanding principal (millions)	2,032	275	427	523	416	218
WARF	1,526	2,753.000	2,853.500	2,991.000	3,138.365	1,060.702
Annual Equity Distribution	1,604	12.885	16.625	20.785	17.087	6.327
Panel B: Issuer Level Characteristics						
	N	Q1	Median	Q3	Mean	St. Dev.
No. of CLOs	2,199	2.000	78.000	199.000	124.990	150.727
Principal (millions)	2,199	6.60	105	312	229	335
Panel C: Transaction Characteristics Characteristics						
	N	Q1	Median	Q3	Mean	St. Dev.
Transaction Sale/Purchase	978,204	-336,583	251,708	1,000,000	393,909	1,473,358
Price (% of notional par)	977,717	98.38	99.5	100	97.47	6.35

Notes: The table reports the summary statistics for the sample. The equity distribution is defined as follows: Equity Distribution $= \frac{\text{Interest payment} \times \frac{12}{\text{Payment frequency}}}{\text{Par value of equity}} \times 100$. The second column indicates the number of observations. The third column indicates the value at the 25$^{\text{th}}$ percentile. The fourth column indicates denotes the median value. The fifth column indicates the value at the 75$^{\text{th}}$ percentile. The sixth column indicates the mean. The seventh column indicates the standard deviation. For reference, a WARF of 1350 corresponds to a rating of Ba2. A WARF of 1766 corresponds to rating of Ba3. A WARF of 2220 corresponds to a rating of B1. A WARF of 2720 corresponds to a rating of B2. A WARF of 3490 corresponds to a rating of B3. A WARF of 4770 corresponds to a rating of Caa1. Source: Moody's Investors Service. The data used to create this table comes from Creditflux's CLO-i database and is discussed in detail in Kundu (2021*b*).

Table 6.2: Correlation of Covenants

	ID	JIC	JOC	SIC	SOC	WAL	WARF	WAS	CCC
Interest Diversion	1								
Junior Interest	0.292	1							
Junior OC	0.905	0.383	1						
Senior Interest	0.437	0.878	0.541	1					
Senior OC	0.399	0.127	0.428	0.478	1				
WAL	−0.233	−0.209	−0.233	−0.306	−0.286	1			
WARF	−0.017	−0.044	−0.025	0.076	0.32	−0.09	1		
WAS	0.123	0.601	0.185	0.516	0.091	−0.048	−0.101	1	
CCC	−0.126	−0.151	−0.086	−0.057	0.182	0.056	0.328	−0.081	1

Notes: The lower triangular matrix above presents the pairwise correlation of various covenant constraints. The columns and rows denote the covenants. Each matrix element presents the correlation of the constraints corresponding to that particular column, and that particular row. The darker shading indicates higher correlation. The lighter shading indicates lower correlation. The data used to create this table comes from Creditflux's CLO-i database and is discussed in detail in Kundu (2021*b*).

Table 6.3: Fee Structure Changes (2009-2018)

Senior Fee	Junior Fee
• From 2009-2012, the 25^{th} percentile of the senior fee was 12.5 bps. The median was 15 bps, and the 75^{th} percentile was 20 bps	• From 2009-2011, the 25^{th} percentile of the junior fee was 30 bps. The median was 35 bps, and the 75^{th} percentile was 40 bps
• The 25^{th} percentile of the senior fee increased in 2012 to 15 bps from which point onward, it remained 15 bps. The 50^{th} percentile of the senior fee increased to 20 bps in 2012 and 2013. It fell back to 15 bps in 2014	• The median junior fee declined steadily from 2011-2014, and remained stable from 2014-2018. The median junior fee fell to 33 bps in 2012. It fell slightly further in 2013 to 32.5 bps. Since 2014, the median junior fee has remained at 30 bps
• The 75^{th} percentile did not change	• The 75^{th} percentile of the junior fee declined to 37.5 bps in 2013. Since 2014, the 75^{th} percentile of the junior fee has been 35 bps
• Overall time, the standard deviation monotonically decreased from 9.334 bps in 2009 to 3.625 bps	• Over time, the standard deviation has decreased from 11.834 bps in 2009 to 7.973 bps in 2018

Notes: The table reports the numerical changes in senior and junior fees from 2009-2008. The data used to create this table comes from Creditflux's CLO-i database and is discussed in detail in Kundu (2021*b*).

Table 6.4: CLO Composition (2011-2018)

Changes in Composition of CLOs (2011-2018)									
Issue Type	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**All**
Term Loan A	3.43	3.82	4.03	2.99	1.51	1.27	1.29	1.1	2.08
Term Loan B	37.83	37.55	36.45	34.74	35.4	38.66	44.18	45.72	29.03
Term Loan C	4.47	4.23	3.43	1.95	1.29	1.08	1.45	1.19	2.05
Term Loan D	0.81	0.69	0.8	0.75	0.43	0.37	0.32	0.29	0.50
Term Loan (Other)	39.55	41.36	44.52	49.59	53.84	53.45	48.71	47.32	48.82
Bond	5.01	5.22	5.05	3.31	1.42	0.73	0.32	0.23	2.06
Credit Default Swap	0.01	0.01	0	0	0	0	0	0	0
DIP	0.03	0.06	0.07	0.14	0.16	0.16	0.08	0.03	0.11
Equity	0.79	0.61	0.54	1.01	0.62	0.52	0.44	0.4	0.59
Letter of Credit	1.48	0.85	0.53	0.28	0.13	0.04	0.01	0	0.30
Mezzanine	0.26	0.09	0.03	0.01	0	0	0	0	0.04
Revolver	1.08	0.69	0.5	0.31	0.19	0.13	0.14	0.12	0.32
Second Lien	2.83	2.53	2.08	3.02	3.99	2.98	2.75	3.39	2.98
Third Lien	0.01	0	0	0	0	0	0	0.01	0
Other	2.42	2.28	1.98	1.91	1.03	0.61	0.31	0.21	1.12

Notes: The table reports the annual mean percent of each issue for each year. The last column reports the mean share across all years. The data used to create this table comes from Creditflux's CLO-i database and is discussed in detail in Kundu (2021*b*).

6.2 Chapter 3: Financial Covenants and Fire Sales: Fractures in the Leveraged Loan Market

Table 6.5: Projected Default Rates by Closing Year

Year	**Projected Default Rate**
2011	2.37%
2012	1.73%
2013	3.27%
2014	3.78%
2015	3.73%
2016	3.37%
2017	3.25%
2018	4.04%

Notes: The table reports the median projected default rate across all CLOs if CLOs were unable to trade from the closing date to maturity. The closing year is reported in the left column. The right column reports the corresponding the projected default rate.

Table 6.6: Summary Statistics for Chapter 3: Covenants and Outcome Variables

	N	Q1	Median	Q3	Mean	Std. Dev
Interest Diversion	7,482	1.0245	1.0320	1.0378	1.0320	0.0198
Junior IC	16,742	1.7011	2.0957	3.6171	2.7282	1.4409
Junior OC	16,701	1.0343	1.0429	1.0551	1.0525	0.0400
Senior IC	18,516	2.0941	2.8731	5.8178	4.0742	2.5709
Senior OC	20,905	1.0767	1.0881	1.1519	1.2052	0.3595
WA Life	18,997	0.7108	0.8880	1.0358	1.1961	1.6459
WARF	19,545	0.8780	0.9358	0.9872	0.9471	0.1203
WAS	18,358	1.0757	1.2067	1.4033	1.2723	0.2572
Equity Dist. (annual)	18,582	9.7900	17.6300	25.0900	19.4681	17.8275
CLO size (millions)	38,422	213	397	512	401	300

Notes: The table reports the summary statistics of the constraints – a distance to the constraints, measured as the ratio of covenant performance to covenant trigger – CLO size, and annualised equity distribution. The variables are listed in the first column. The second column indicates the number of observations. The third column indicates the value at the 25^{th} percentile. The fourth column indicates denotes the median value. The fifth column indicates denotes the value at the 75^{th} percentile. The sixth column denotes the mean. The seventh column indicates the standard deviation. The frequency of observations is monthly.

Table 6.7: Extensive Margin: Distressed Loans and Covenant Results

Risky Sale and Covenant Result							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\mathbb{1}_{\text{Risky Sale, ct}}$	WAS	WA Life	Interest Div.	Junior IC	Junior OC	Senior IC	Senior OC
Covenant Result	0.0065	-0.0189***	-0.0300***	0.0328***	-0.0380***	-0.0122	-0.0318***
	(0.0097)	(0.0048)	(0.0095)	(0.0119)	(0.0053)	(0.0105)	(0.0057)
Manager-Year FE	✓	✓	✓	✓	✓	✓	✓
Arranger FE	✓	✓	✓	✓	✓	✓	✓
Trustee FE	✓	✓	✓	✓	✓	✓	✓
N	13,933	14,820	5,209	12,388	13,072	13,656	14,959
R^2	0.0957	0.0942	0.1393	0.1068	0.1069	0.1030	0.0990

Standard errors in parentheses, and two-way clustered at the Manager Month-Year Level
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between a CLO's decision to sell risky assets and quality and coverage covenant results. The regression specification follows a linear probability model: $\mathbb{1}_{risky,ct} = \alpha + \beta \times \Delta Result_{ct} + \gamma_{my} + \delta_a + \delta_w + \epsilon_{ct}$. $\mathbb{1}_{risky,ct}$ takes on the value 1 if there is a decline in the share of risky assets (sum of defaulted and CCC-rated loans) between consecutive months, ϵ is the error, c denotes CLO, t denotes the month-year pair, m denotes CLO manager, y denotes the year, a denotes the arranger, and w denotes the trustee. The columns denote different covenant results (standardized); Weighted Average Spread covenant, Weighted Average Life covenant, Interest Diversion covenant, Junior IC covenant, Junior OC covenant, Senior IC covenant, and Senior OC covenant (Column 1-7, respectively).

Table 6.8: Intensive Margin: Distressed Loans and Covenant Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Risky Share$_t$ and Covenant Result$_t$							
Risky Share$_t$	WAS	WA Life	Interest Div.	Junior IC	Junior OC	Senior IC	Senior OC
Covenant Result$_t$	0.3580	-0.0185	-0.2916	-1.7149***	-0.1888	-0.7715**	0.6295*
	(0.3631)	(0.2002)	(0.2231)	(0.2791)	(0.3069)	(0.3256)	(0.3203)
Size Control	✓	✓	✓	✓	✓	✓	✓
Performance Control	✓	✓	✓	✓	✓	✓	✓
Age Control	✓	✓	✓	✓	✓	✓	✓
Manager-Year FE	✓	✓	✓	✓	✓	✓	✓
Arranger FE	✓	✓	✓	✓	✓	✓	✓
Trustee FE	✓	✓	✓	✓	✓	✓	✓
N	4,533	4,453	1,598	4,142	4,137	4,443	4,860
R^2	0.7200	0.6470	0.5001	0.7762	0.6927	0.7496	0.6541
Panel B: Δ Risky Share$_{t+1}$ and Covenant Result$_t$							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ΔRisky Share$_{t+1}$	WAS	WA Life	Interest Div.	Junior IC	Junior OC	Senior IC	Senior OC
Covenant Result$_t$	-0.5801*	-0.0468	-0.2773	-1.0587***	0.2636	-0.4080***	0.3420
	(0.3467)	(0.1925)	(0.2546)	(0.2603)	(0.1899)	(0.1511)	(0.2106)
Size Control	✓	✓	✓	✓	✓	✓	✓
Performance Control	✓	✓	✓	✓	✓	✓	✓
Age Control	✓	✓	✓	✓	✓	✓	✓
Manager-Year FE	✓	✓	✓	✓	✓	✓	✓
Arranger FE	✓	✓	✓	✓	✓	✓	✓
Trustee FE	✓	✓	✓	✓	✓	✓	✓
N	3,750	3,647	1,315	3,421	3,444	3,665	4,021
R^2	0.1880	0.1435	0.1616	0.2455	0.1570	0.1515	0.1464
Panel C: Δ Covenant Result$_t$ and Δ Risky Share$_t$							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Δ Covenant Result$_t$	WAS	WA Life	Interest Div.	Junior IC	Junior OC	Senior IC	Senior OC
ΔRisky Share$_t$	0.0106*	-0.0002	-0.0005	-0.0088**	-0.0017	-0.0058**	0.0009
	(0.0057)	(0.0004)	(0.0004)	(0.0036)	(0.0022)	(0.0025)	(0.0034)
Size Control	✓	✓	✓	✓	✓	✓	✓
Performance Control	✓	✓	✓	✓	✓	✓	✓
Age Control	✓	✓	✓	✓	✓	✓	✓
Manager-Year FE	✓	✓	✓	✓	✓	✓	✓
Arranger FE	✓	✓	✓	✓	✓	✓	✓
Trustee FE	✓	✓	✓	✓	✓	✓	✓
N	3,207	3,132	1,027	2,820	2,885	3,059	3,425
R^2	0.1837	0.1787	0.1988	0.1750	0.2065	0.1550	0.1769

Standard errors in parentheses, and two-way clustered at the manager and month-year levels
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between distressed loans and quality and coverage covenant results. Panel A tests the relation between the risky share and standardized covenant results. The regression specification is: $Risky_{ct} = \alpha + \beta \times Result_{ct} + \Gamma Z_{ct} + \gamma_{my} + \delta_a + \delta_w + \epsilon_{ct}$. Panel B tests the relation between the change in risky share in the subsequent period and current standardized covenant results. The regression specification is: $\Delta Risky_{ct+1} = \alpha + \beta \times Result_{ct} + \Gamma Z_{ct} + \gamma_{my} + \delta_a + \delta_w + \epsilon_{ct}$. Panel C tests the relation between the change in risky share and change in standardized covenant result. The regression specification is: $\Delta Risky_{ct} = \alpha + \beta \times \Delta Result_{ct} + \Gamma Z_{ct} + \gamma_{my} + \delta_a + \delta_w + \epsilon_{ct}$. $Risky_{ct}$ is the risky share, $\Delta Risky_{ct+1}$ is the change in the risky share in the subsequent period, $\Delta Risky_{ct}$ is the change in the risky share in the current period, *Result* denotes the covenant results, Z contains all control variables, including size, performance, and age, ϵ is the error, c denotes CLO, t denotes the month-year pair, m denotes CLO manager, y denotes the year, a denotes the arranger, and w denotes the trustee. The columns denote different covenant restrictions; Weighted Average Spread covenant, Weighted Average Life covenant, Interest Diversion covenant, Junior IC covenant, Junior OC covenant, Senior IC covenant, and Senior OC covenant (Column 1-7, respectively).

Table 6.9: CLO Size and Covenant Threshold

$Size_t$	(1) WAS	(2) WARF	(3) WA Life	(4) Junior IC	(5) Low OC	(6) Senior IC	(7) Senior OC
$Threshold_t$	-0.0302*	0.0205	0.0044	0.1539**	0.1227*	0.1876*	0.1181
	(0.0166)	(0.0184)	(0.0035)	(0.0760)	(0.0648)	(0.1016)	(0.1074)
Performance Control	✓	✓	✓	✓	✓	✓	✓
Age Control	✓	✓	✓	✓	✓	✓	✓
Manager-Year FE	✓	✓	✓	✓	✓	✓	✓
Arranger FE	✓	✓	✓	✓	✓	✓	✓
Trustee FE	✓	✓	✓	✓	✓	✓	✓
N	4,595	4,823	4,569	4,221	6,076	4,492	4,911
R^2	0.5641	0.5625	0.5632	0.5878	0.5963	0.6033	0.5710

Standard errors in parentheses, and two-way clustered at the manager and month-year levels.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between a CLO's size and quality and coverage thresholds. The regression specification is: $Size_{ct} = \alpha + \beta \times \Delta Threshold_{ct} + \Gamma Z_{ct} + \gamma_{my} + \delta_a + \delta_w + \epsilon_{ct}$. $Size_{ct}$ is the size (standardized), Z contains all control variables, including performance and age, ϵ is the error, c denotes CLO, t denotes the month-year pair, m denotes CLO manager, y denotes the year, a denotes the arranger, and w denotes the trustee. The columns denote different covenant results (standardized); Weighted Average Spread threshold, Weighted Average Rating Factor threshold, Weighted Average Life threshold, Junior IC threshold, Interest Diversion/Junior OC threshold, Senior IC threshold, and Senior OC threshold (Column 1-7, respectively).

Table 6.10: Equity Distribution and Covenant Result

Equity Distribution$_t$	(1) WAS	(2) WARF	(3) WA Life	(4) Interest Div.	(5) Junior IC	(6) Junior OC	(7) Senior IC	(8) Senior OC	(9) Junior IC
Covenant Result$_t$	0.3214*	0.4695***	0.1044	0.0118	0.6697***	-0.0700	0.3256**	-0.0311	0.7629***
	(0.1644)	(0.1394)	(0.0859)	(0.0600)	(0.1541)	(0.0834)	(0.1561)	(0.0396)	(0.2460)
Size Control	✓	✓	✓	✓	✓	✓	✓	✓	✓
Age Control	✓	✓	✓	✓	✓	✓	✓	✓	✓
CLO-Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Arranger FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Trustee FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
N	4,107	4,296	4,009	1,428	3,764	3,888	3,994	4,354	984,455
R^2	0.6452	0.6543	0.5882	0.7654	0.6743	0.6425	0.6880	0.6917	0.7576

Standard errors in parentheses, and two-way clustered at the manager and month-year levels
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between a CLO's equity distribution and quality and coverage covenant results. The regression specification is: $Distribution_{ct} = \alpha + \beta \times \Delta Result_{ct} + \Gamma Z_{ct} + \gamma_{cy} + \delta_a + \delta_w + \epsilon_{ct}$. $Distribution_{ct}$ is the equity distribution (standardized), Z contains all control variables, including size and age, ϵ is the error, c denotes CLO, t denotes the month-year pair, c denotes CLO, y denotes the year, a denotes the arranger, and w denotes the trustee. The columns denote different covenant results (standardized); Weighted Average Spread covenant, Weighted Average Rating Factor, Weighted Average Life covenant, Interest Diversion covenant, Junior IC covenant, Junior OC covenant, Senior IC covenant, and Senior OC covenant (Column 1-8, respectively). In Column (9), I represent the results from the "leave-one-out" methodology, in which I iterate through each firm and recompute the Junior IC ratio without accounting for the presence of that particular firm.

6.3 Chapter 4: The Externalities of Fire Sales: Evidence from Collateralized Loan Obligations

Table 6.11: Summary Statistics for Chapter 4

	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	99.75	100	97.6138	9.4910
All-in-Drawn Spread (Term Loans)	1,515	325	400	500	431.2657	185.8061
Facility Maturity (Term Loans)	1,529	59	72	84	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
Equity Returns	6,543	-0.0433	0.0107	0.0639	0.0125	0.1143
Firm Liquidity Growth	2,159	0.2181	0.5965	0.8544	0.5373	0.3458
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
Payout	2,874	0.0000	0.0049	0.0260	0.0217	0.0425
Real Sales Growth	3,106	-0.0008	0.0000	0.0006	-0.0001	0.0028
Acquisitions	2,895	0.0000	0.0000	0.0042	0.0277	0.1408
Investment	2,951	2.3889	3.6350	4.9624	3.6293	2.0316
R&D	1,054	0.0000	0.0030	0.0194	0.0181	0.0470
Investment Growth	2,863	-0.5396	0.3737	0.6084	0.0007	0.9948
R&D Growth	961	0.0000	0.0000	0.0255	0.0075	0.1424
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
CCC Share	10,433	1.9208	3.5312	5.4370	4.2946	3.9729
Defaulted Share	9,961	0.0000	0.5455	1.9578	3.7893	12.5261
Risky Share	9,953	3.0481	4.8052	7.6096	8.2925	13.2265

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} value, median, 75^{th} quartile value, mean, and standard deviation in Columns 2-7.

Table 6.12: Distance to Interest Diversion Covenant and O&G Exposure

Distance to ID Threshold	(1)	(2)	(3)	(4)	(5)
O&G Share × Post	-8.4685***	-6.8861***	-4.8620**	-5.3021***	-5.0278***
	(2.7227)	(2.2409)	(2.0709)	(1.7027)	(1.7324)
O&G Share	-4.4361	-1.1044	2.6474		
	(9.1609)	(6.4653)	(5.1389)		
Post	0.4342***	0.1336		0.2251***	
	(0.1475)	(0.1269)		(0.0689)	
CLO Controls		✓	✓		
CLO FE				✓	✓
Manager FE	✓	✓	✓		✓
Arranger FE					✓
Trustee FE					✓
Year FE		✓		✓	
Month-Year FE			✓		✓
N	2,074	2,074	2,073	2,071	2,071
R^2	0.3321	0.3761	0.4600	0.6516	0.6590

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 $Y_{c,t} = \beta_0 + \beta_1(\text{CLO O\&G Exposure})_c + \beta_2(\text{Oil Shock})_t + \beta_3(\text{CLO O\&G Exposure}_c \times \text{Oil Shock}_t) + \gamma_0' X_{c,t} + \epsilon_{c,t}$ 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, 3) and CLO size (Column 3). 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 6.13: Transaction-Level Trading Effects

Transaction Amount	(1)	(2)	(3)	(4)	(5)	(6)
O&G Share × Post	-10.6236***	-10.6611***	-10.5829***	-18.1895***	-14.6684***	-15.4259***
	(3.1164)	(3.1178)	(3.0750)	(3.1357)	(3.4942)	(3.6833)
O&G Share	8.8026***	8.8774***	8.7749***	18.3566***		
	(2.7668)	(2.7589)	(2.7474)	(3.0193)		
Post	0.1474	0.2108**			0.2641**	
	(0.0901)	(0.0938)			(0.1112)	
Manager FE			✓			
Rating-Industry FE				✓		
Issuer-Loan Type FE					✓	✓
Year FE		✓			✓	
Month-Year FE			✓	✓		✓
N	129,420	129,420	129,417	117,829	129,132	129,132
R^2	0.0041	0.0045	0.0360	0.0276	0.0758	0.0809

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 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 and month-year.

Table 6.14: Secondary Loan Price and O&G Exposure

Transaction Price (per \$100 par)	(1)	(2)	(3)	(4)	(5)	(6)
O&G Share × Post	-183.2513**	-182.2391**	-167.3053**	-117.6534**	-80.1203**	-67.2475*
	(87.0920)	(87.2499)	(76.8085)	(53.7648)	(37.8763)	(38.3255)
O&G Share	203.5656**	202.2806**	176.1811**	28.8967		
	(79.1487)	(79.3677)	(68.5560)	(41.9329)		
Post	5.8047**	5.4327**			2.0054	
	(2.5469)	(2.6602)			(1.2828)	
	(2.3205)					
Manager FE			✓			
Rating-Industry FE				✓		
Issuer-Loan Type FE					✓	✓
Year FE		✓			✓	
Month-Year FE			✓	✓		✓
N	57,866	57,866	57,860	52,778	57,593	57,593
R^2	0.0096	0.0097	0.0712	0.4039	0.5963	0.6037

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 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 and month-year.

Table 6.15: Primary Institutional Loan Spread and O&G Exposure

All-In-Drawn Spread	(1)	(2)	(3)	(4)	(5)	(6)
O&G Share × Post	1330.7793*	1836.0276**	1950.0807**	2298.1633**	2011.9126***	1805.9003**
	(664.3646)	(824.2271)	(858.0182)	(905.7835)	(719.3401)	(751.5813)
Post	-51.0069**	-67.6588**	-56.5767	-47.2713	-50.9940	
	(23.4295)	(27.7596)	(36.9653)	(37.6329)	(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	615	589	589	586	567	567
R^2	0.7007	0.6774	0.6809	0.9103	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-Drawn 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 6.16: Bond Credit Spread and O&G Exposure

Bond Credit Spread	(1)	(2)	(3)	(4)	(5)
O&G Share × Post	34.9984*	34.6940*	35.3794*	27.9393*	27.6554*
	(18.6704)	(18.5913)	(18.8925)	(14.4879)	(14.4997)
Post	-0.3541	-0.4753	-0.4942	-0.2478	
	(0.4036)	(0.4719)	(0.4683)	(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	10,072	10,072	10,072	9,876	9,876
R^2	0.5235	0.5314	0.5600	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. 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 6.17: Firm Liquidity and O&G Exposure

	(1) ΔUndrawn	(2) ΔUndrawn	(3) ΔUndrawn	(4) ΔDrawn	(5) ΔDrawn	(6) ΔDrawn
O&G Share × Post	-2.7562***	-2.7586***	-2.8037***	3.4348**	3.4228*	3.4679*
	(0.7305)	(0.6779)	(0.6180)	(1.5346)	(1.6450)	(1.6166)
Post	0.0395	0.0335		-0.0699*	-0.1524***	
	(0.0280)	(0.0798)		(0.0332)	(0.0300)	
Issuer FE	✓	✓	✓	✓	✓	✓
Industry FE			✓			✓
Year FE		✓			✓	
Quarter-Year FE			✓			✓
N	2,111	2,111	2,111	2,111	2,111	2,111
R^2	0.0278	0.0279	0.0345	0.0240	0.0252	0.0311

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 $\Delta(\frac{\text{Unused}}{\text{Total Firm Liquidity}})$ in Columns 1-3, and $\Delta(\frac{\text{Drawn}}{\text{Total Firm Liquidity}})$ 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 two-way clustered by issuer and quarter-year.

Table 6.18: Firm Adjustments and O&G Exposure

	(1) Debt Growth	(2) Cash Flow	(3) Real Sales Growth	(4) Acquisitions	(5) Investment	(6) R&D Growth	(7) Emp. Growth
O&G Share × Post	-4.2969*	-3.0319*	-0.0107**	-0.0672**	-3.7776*	-8.6594***	-4.4707**
	(2.5110)	(1.5647)	(0.0046)	(0.0322)	(2.1020)	(2.9319)	(2.1782)
Issuer FE	✓	✓	✓	✓	✓	✓	✓
Industry FE	✓	✓	✓	✓	✓	✓	✓
Quarter-Year FE	✓	✓	✓	✓	✓	✓	✓
N	2,867	2,860	3,098	2,883	2,981	518	2,899
R^2	0.1117	0.8981	0.0738	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), real sales growth (Column 3), acquisitions (Column 4), investment (Column 5), R&D growth (Column 6), and employment growth (Column 7). Standard errors are clustered by issuer.

Table 6.19: Equity Returns and O&G Exposure

Equity Returns	(1)	(2)	(3)	(4)	(5)
O&G Share × Post	-0.2976*	-0.2948*	-0.2918*	-0.2921*	-0.2923*
	(0.1614)	(0.1610)	(0.1701)	(0.1705)	(0.1705)
Post	-0.0222*	-0.0035	-0.0017	-0.0021	-0.0026
	(0.0124)	(0.0188)	(0.0069)	(0.0059)	(0.0060)
R_f			-2.1825***	-1.2951**	-1.4222**
			(0.6329)	(0.4971)	(0.5846)
$R_m - R_f$			0.0111***	0.0109***	0.0108***
			(0.0009)	(0.0007)	(0.0007)
SMB				0.0036***	0.0035***
				(0.0008)	(0.0009)
HML				-0.0003	-0.0006
				(0.0009)	(0.0013)
RMW					-0.0005
					(0.0011)
CMA					0.0007
					(0.0022)
Issuer FE	✓	✓	✓	✓	✓
Year FE		✓	✓	✓	✓
N	6,543	6,543	6,543	6,543	6,543
R^2	0.0616	0.0670	0.1748	0.1815	0.1815

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 equity returns for non-O&G firms. The baseline regression specification takes the form $Y_{f,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \beta_4 R_f + \beta_5(R_m - R_f) + \beta_6 SMB + \beta_7 HML + \beta_7 RMW + \beta_7 CMA + \alpha_y + \alpha_f + \epsilon_{f,t}$ where $Y_{f,t}$ is the equity return firm f at time t, ($f \in$ CLO 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, 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 6.20: Investment in the Cross-Section and O&G Exposure

	Bond Access		**Size**		**Age**		**Sector**		**Loan Refinancing**	
Investment	Access	No Access	Large	Small	Old	Young	Non-Tradable	Tradable	After Shock	Before Shock
O&G Share × Post	0.6071	-10.1692***	-1.0910	-8.3904**	-3.4139	-6.6943*	-3.5808	-4.1799*	-6.8414	-10.8335**
	(1.8207)	(3.8819)	(2.1925)	(3.8836)	(2.7878)	(4.0073)	(3.2080)	(2.3159)	(8.3901)	(4.6397)
Issuer FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Industry FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Quarter-Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
N	1,661	1,320	1,710	1,271	1,037	957	1,961	1,020	441	708
R^2	0.1645	0.1961	0.2050	0.1547	0.1553	0.1694	0.1531	0.2395	0.2920	0.1924

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, sector, 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 (standardized) 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 based on sector; firms in the nontradable sector are in Column 7 and firms in the tradable sector (2-digit NAICS codes of 31, 32, 322, 11, 21, 55) are in Column 8. In Columns 9 and 10, I segment firms without access to the bond-market based on timing of loan refinancing; firms which had last refinanced before the shock in the sample period are in Column 9 and firms which had last refinanced after the shock in the sample period are in Column 10. Standard errors are clustered by issuer.

Table 6.21: Selling Propensity by Secondary Loan Price Relative to Par and O&G Exposure

Panel A					
$1_{(\text{loan price}>100)}$	(1)	(2)	(3)	(4)	(5)
O&G Share × Post	-4.1718*	-4.2856*	-10.6127***	-10.1198***	-8.2741***
	(2.2533)	(2.2552)	(2.0205)	(2.0834)	(2.0135)
O&G Share	4.8383**	4.8588**	10.2958***		
	(1.9162)	(1.9243)	(1.9891)		
Post	0.0257	-0.0290		0.0800	
	(0.0792)	(0.0745)		(0.0743)	
	(0.0565)				
Rating-Industry FE			✓		
Issuer-Loan Type FE				✓	✓
Year FE		✓		✓	
Month-Year FE			✓		✓
N	57,867	57,867	52,779	57,594	57,594
R^2	0.0106	0.0143	0.1683	0.2567	0.3234
Panel B					
$1_{(\text{loan price}<90)}$	(1)	(2)	(3)	(4)	(5)
O&G Share × Post	4.0665**	4.0575**	2.7707**	2.3389***	2.0049**
	(1.7222)	(1.7377)	(1.0981)	(0.8326)	(0.8445)
O&G Share	-3.9977**	-3.9910**	0.1073		
	(1.5206)	(1.5387)	(0.8197)		
Post	-0.1156**	-0.1160**		-0.0696**	
	(0.0495)	(0.0530)		(0.0264)	
Rating-Industry FE			✓		
Issuer-Loan Type FE				✓	✓
Year FE		✓		✓	
Month-Year FE			✓		✓
N	57,867	57,867	52,779	57,594	57,594
R^2	0.0061	0.0061	0.3231	0.5565	0.5656

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 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 $\mathbb{1}_{(price \leqslant p)_{i,t}} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \alpha_{f,l} + \gamma_0 Z_f + \alpha_{m,y} + \epsilon_{i,t}$ where $\mathbb{1}_{(price \leqslant p)_{i},t}$ 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 p =\$100 in Panel A, and below p =\$90 in Panel B per \$100 of notional par, 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 and month-year.

Table 6.22: Interest Rate of Loans and O&G Exposure

Interest Rate	(1)	(2)	(3)	(4)	(5)	(6)	(7)
O&G Share × Post	-9.4742***	-9.5623***	-10.0295***	-10.8229***	-11.6142**	-11.1660**	-12.6541**
	(3.2362)	(3.1641)	(3.0074)	(2.9103)	(4.3163)	(4.1978)	(4.8578)
Post	0.2504**	0.2414**	0.2154**	0.2351**	0.2696**		
	(0.0928)	(0.0921)	(0.0899)	(0.0871)	(0.1222)		
Tenor							0.0004***
							(0.0000)
Manager FE		✓					
CLO-Issuer-Loan Type FE						✓	✓
CLO-Issuer FE					✓		
Issuer FE	✓	✓	✓	✓			
CLO FE			✓	✓			
Loan Type FE				✓	✓		
Index FE	✓	✓	✓	✓	✓	✓	✓
Rating FE							✓
Year FE	✓	✓	✓	✓	✓		
Month-Year FE						✓	✓
N	2,754,178	2,754,177	2,754,176	2,750,126	2,738,751	2,733,737	2,477,250
R^2	0.7366	0.7388	0.7434	0.8185	0.9098	0.9388	0.9404

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 firm O&G exposure and transaction amount for 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 indicators. 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 and month-year.

Table 6.23: CLO Defaulted Loans and O&G Exposure

$\mathbb{1}_{\text{defaulted loan}}$	(1)	(2)	(3)	(4)	(5)	(6)
O&G Share × Post	-0.2164**	-0.2281**	-0.2013**	-0.3316***	-0.2391**	-0.1632*
	(0.1022)	(0.1003)	(0.0893)	(0.0908)	(0.0974)	(0.0891)
Post	0.0027	0.0030	0.0045*	0.0086***	0.0075***	
	(0.0026)	(0.0026)	(0.0023)	(0.0024)	(0.0026)	
Manager FE		✓				
CLO-Issuer-Loan Type FE						✓
CLO-Issuer FE					✓	
Issuer FE	✓	✓	✓	✓		
CLO FE			✓	✓		
Loan Type FE				✓	✓	
Year FE	✓	✓	✓	✓	✓	
Month-Year FE						✓
N	3,416,878	3,416,878	3,416,874	3,411,591	3,398,147	3,390,168
R^2	0.5641	0.5661	0.5734	0.5895	0.7632	0.8091

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 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 indicators. 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 and month-year.

Table 6.24: CLO Risk and O&G Exposure

	Default Share			Risky Share		
O&G Share × Post	-5.6612***	-5.6461***	-5.5190***	-3.2446*	-3.3366*	-3.2747*
	(1.8225)	(1.8251)	(1.8317)	(1.7255)	(1.7313)	(1.7409)
Post	0.3598***	0.2479***		0.2274***	0.1236*	
	(0.0736)	(0.0756)		(0.0627)	(0.0641)	
CLO FE	✓	✓	✓	✓	✓	✓
Manager FE			✓			✓
Trustee FE			✓			✓
Arranger FE			✓			✓
Year FE		✓			✓	
Month-Year FE			✓			✓
N	9,941	9,941	9,852	9,933	9,933	9,844
R^2	0.6254	0.6275	0.6328	0.7077	0.7096	0.7148

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 distressed and risky assets. The baseline regression specification takes the form $Y_{c,t} = \beta_0 + \beta_1(\text{CLO O\&G Exposure})_c + \beta_2(\text{Oil Shock})_t + \beta_3(\text{CLO O\&G Exposure}_c \times \text{Oil Shock}_t) + \gamma_0' X_c + \alpha_{m,y}\epsilon_{c,t}$ where $Y_{c,t}$ is the (standardized) percent of distressed loans (Columns 1-3) and (standardized) percent of risky loans (Columns 4-6) in CLO c at time t, m, y denote the month and year respectively, and X denotes the vector of time-invariant controls, consisting of current CLO, manager, trustee, and arranger indicators. 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 6.25: Comparison of Effects by Risk and O&G Exposure

	Secondary Loan Price		**All-In-Drawn Spread**		**Investment**	
	Non-Risky	Risky	Non-Risky	Risky	Non-Risky	Risky
O&G Share × Post	33.7732	-232.3941***	1088.0890	5648.7368*	-2.1211	-12.1223**
	(31.3956)	(84.2303)	(732.2927)	(2883.8527)	(2.0926)	(5.0355)
Maturity Control			✓	✓		
Issuer-Loan Type FE	✓	✓				
Issuer FE			✓	✓	✓	✓
Secured FE			✓	✓		
Purpose FE			✓	✓		
Distribution FE			✓	✓		
Seniority FE			✓	✓		
Loan Type FE			✓	✓		
Country of Syndication FE			✓	✓		
Industry FE					✓	✓
Rating FE					✓	✓
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 $Y_{i,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \beta_4\text{Maturity} + \gamma_0 X_i + \alpha_{m/q,y} + \alpha_f + \alpha_I + \epsilon_{i,t}$ where $Y_{i,t}$ is the secondary loan price per \$100 par in Columns 1 and 2, All-In-Drawn spread in Columns 3 and 4, and investment growth in Columns 5 and 6 for firm f at time t ($f \in$ 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, I denotes the industry, and $m/q, y$ 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 *risky* firms which are firms that have a rating CCC or below, or are defaulted. The results for *non-risky firms* are reported in Columns 1, 3, and 5. Standard errors are two-way clustered by CLO and month-year (Col. 1, 2), issuer and month-year (Col. 3, 4), and issuer (Col. 5, 6) in parentheses.

Table 6.26: 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.

APPENDIX A
APPENDIX FOR CHAPTER 3: FINANCIAL COVENANTS AND FIRE SALES: FRACTURES IN THE LEVERAGED LOAN MARKET

A.1 CAAR SEs and Persistence of Baseline Effect

In this section, I first describe how I compute the standard errors associated with the cumulative abnormal average returns. Next, I show that there is persistence in the CAAR of constrained and unconstrained CLOs – unconstrained CLOs perform significantly better than constrained CLOs after the shock. This difference widens after the shock.

Assumptions:

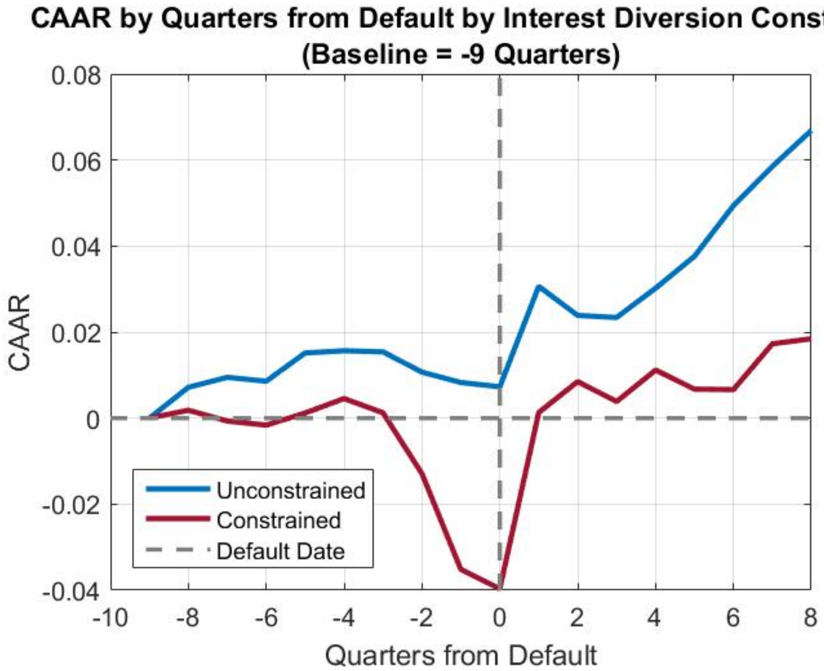
1. For a given day d of month/quarter i, abnormal return, $AR_d^i \sim D^i(0, \sigma_i^2)$
2. Abnormal return for a given day is uncorrelated with the abnormal returns on another day, i.e., AR_d^i and $AR_{d \neq j}^i$ are uncorrelated in a given month/quarter
   - $\Rightarrow AAR^i = \frac{1}{N^d} \sum_{d=1}^{D} AR_d^i$ where AAR denotes average abnormal return, N^d denotes the number of days in a month/quarter
   - Asymptotically, $AAR^i \sim D(0, \frac{\sigma_i^2}{N^d})$
3. AAR^i is correlated with AAR^j where $j \neq 0$ where i and j denote a different month/quarter

Estimating SE:

1. Estimate factor model for daily log returns at issuer-level
2. Take abnormal returns (ARs) and average them at the monthly or weekly level
3. Cumulate the average abnormal returns (AARs) at monthly or quarterly level
4. Standard errors of AARs are $\frac{\sigma}{\sqrt{N-1}}$ of residuals
5. Standard errors of cumulative abnormal average returns (CAAR) are standard errors of sum of means of data $X_1 \ldots X_N$

$$SE(\sum_{i=1}^{N} AAR_i) = \sqrt{\sum_{i=1}^{N} SE(AAR_i)^2 + \sum_{\substack{j \neq i \\ j=1}}^{N} \sum_{i}^{N} \frac{cov(X_i, X_j)}{\sqrt{(N_i - 1)}\sqrt{(N_j - 1)}}}$$

Figure A.1.1: Persistence in CAAR between Constrained and Unconstrained



Notes: The figure plots the quarterly cumulative average abnormal return (CAAR) by quarters from default for loans that belong to Interest Diversion constrained CLOs (red) and Interest Diversion unconstrained CLOs (blue). Constrained CLOs are CLOs that have a Interest Diversion result below the median. Unconstrained CLOs are CLOs that have a Interest Diversion result above the median. The abnormal return is generated from the following regression: $ln(\frac{P_{i,t}}{P_{i,t-1}}) \approx \alpha + \beta Z_{i,t-1,t} + \gamma_0(Q_{i,t} - Q_{i,t-1}) + \gamma_1(Q_{i,t}ln(S_{i,t}) - Q_{i,t-1}ln(S_{i,t-1})) + \epsilon_{i,t-1,t}$, where P is the observed price, Z is a vector of fundamental value, Q is a purchase indicator, S is the trade size, ϵ is the error, i denotes the loan, and t denotes the day. These abnormal returns are averaged by quarters from default, and accumulated. The CAAR, 9 months from default, is normalized to be 0. The x-axis plots quarters from default. The y-axis plots the CAAR for loans belonging to constrained and unconstrained CLOs. The red line indicates constrained CLOs. The blue line indicated unconstrained CLOs.

A.2 Aggregate Price Patterns

In Figure A.2.2, I present the price of loans issued by distressed firms around bankruptcy defaults. To construct this figure, I plot the kernel-weighted local polynomial of the median price of an issuer's loans for each day surrounding default. The figure shows that there is a precipitous drop in the price around bankruptcy – the price of a loan falls to 70 cents on the dollar at bankruptcy. However, there is nearly full recovery, as the price rebounds to its pre-distressed price. This pattern withstands additional testing. To verify that the pattern holds within issuer, I absorb issuer fixed effects, and plot the residual price in Figure A.2.1.

For each issuer-month, I compute the monthly average abnormal return (AAR). I normalize the AAR 13 months before bankruptcy default to zero. The AARs are accumulated to CAARs by months from default in the baseline specification.

The baseline CAAR result is shown in Figure A.2.3. This figure shows a steady decline in the CAAR from twelve months before default until one month after default. After the trough is reached one month after default, the CAAR increases, approaching zero, one year after the default. The table associated with this figure reports the CAAR estimate, number of issuer-month pairs, and associated t-statistic.[1] The table indicates that the CAAR twelve months before default is -0.25%, -13.53% one month after default, and -0.46% twelve months after default. The CAAR is statistically significant for a contiguous period, starting nine months before default until one month after.

The results show that price declines are succeeded by reversals. This is consistent with the price pressure hypothesis. If information revelation informed selling behavior, the price would fall to a new level and stabilize at a permanent lower level. The lack of "flattening" in prices suggests that trades are not driven by new information, and lends credence to the price pressure hypothesis – trading can result in trades at fire sale prices, followed by subsequent positive abnormal returns that compensate liquidity providers.

Next, I study the changes in quantity around default. Observing whether the trading patterns match the price patterns can elucidate if CLO managers are price-takers.

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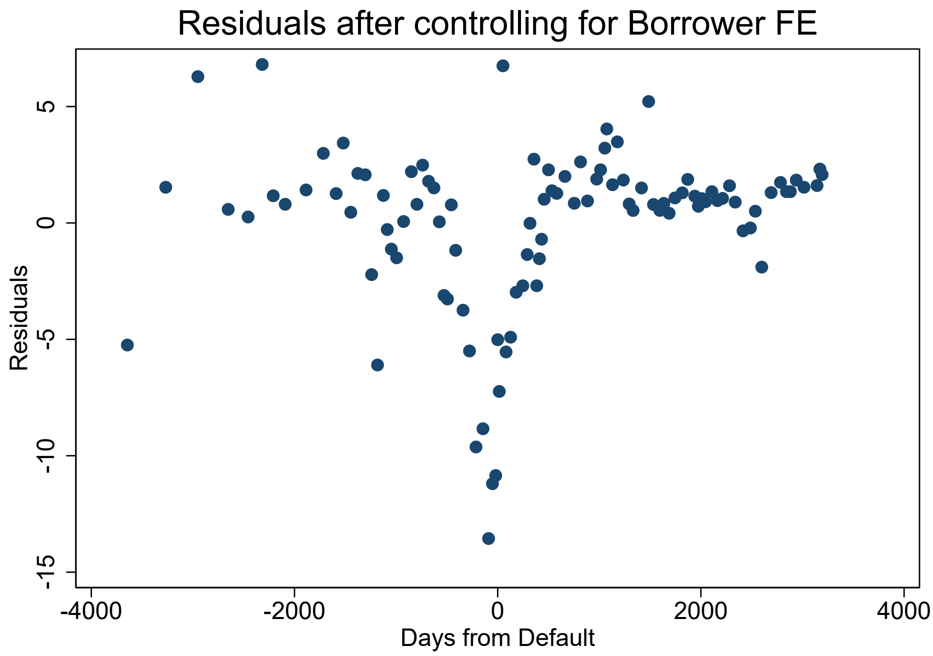
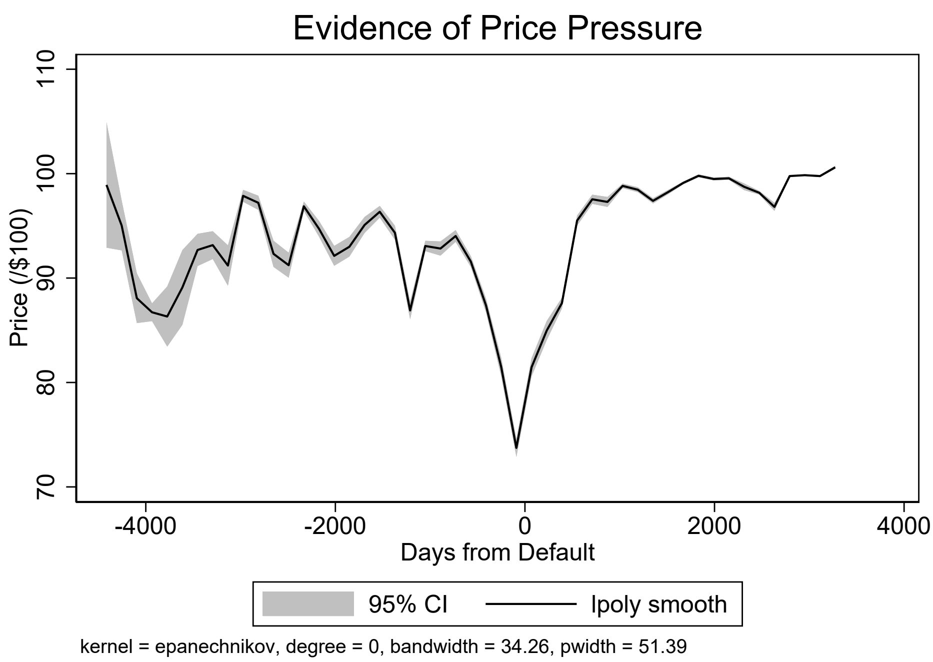
1. Note that N is the number of issuers whose loans are traded x months around default, where x is the corresponding month around default. It is not the number of trades in a given month, which would be $\sum_{i=1}^{N} T_{i,m}$ where $T_{i,m}$ is the number of trades of issuer i's loans in month m.

Figure A.2.1: Residuals After Absorbing Issuer FE



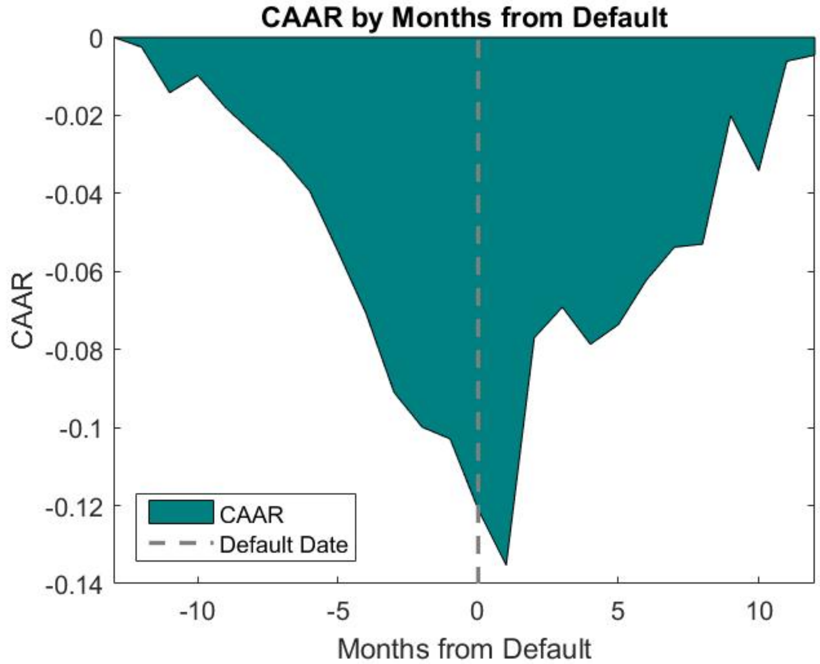
Notes: The figure plots the residual of the following regression: $Price_{lt} = \alpha + \delta_f + \epsilon_{lt}$ where l denotes the loan, t denotes the day from default, and f denotes the firm. The x-axis plots the days from default. The y-axis plots the residual value.

Figure A.2.2: Price Patterns around Bankruptcy



Notes: The figure plots the kernel-weighted local polynomial of median price of loans issued by defaulted firms by the days from default. 1% of observations in the tails are trimmed. The gray shading indicates the 95% confidence interval. The solid line presents the estimate. The x-axis represents the days from default. The y-axis represents the price per $100.

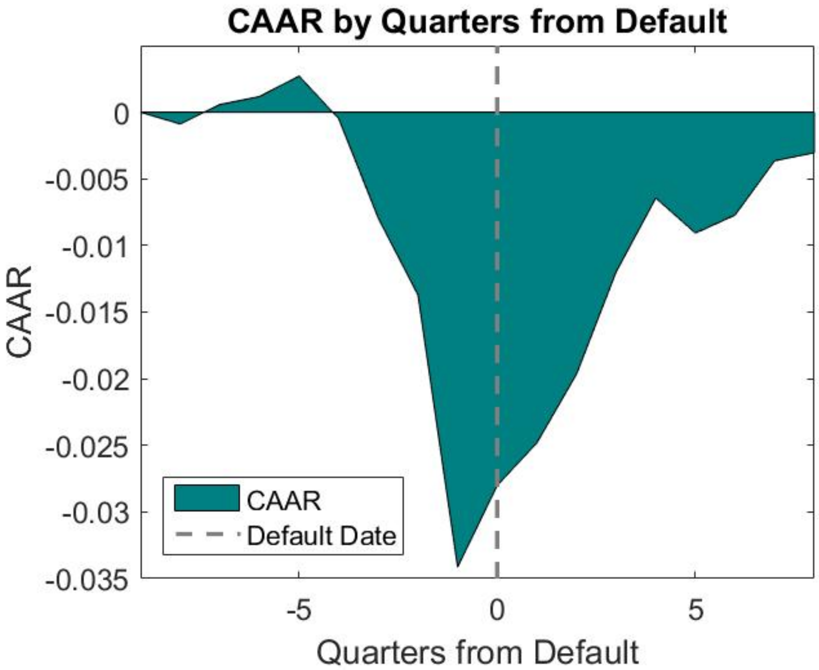
Figure A.2.3: CAAR by Month



Monthly Cumulative Average Abnormal Returns							
Months	CAAR	N	t-statistic	Months	CAAR	N	t-statistic
-12	-0.0025	96	-0.5742	1	-0.1353	77	-2.6114
-11	-0.0142	90	-2.6462	2	-0.0770	74	-1.4241
-10	-0.0098	122	-1.4680	3	-0.0692	37	-1.0706
-9	-0.0180	117	-2.4404	4	-0.0787	75	-1.1318
-8	-0.0247	131	-2.4232	5	-0.0736	84	-1.0076
-7	-0.0310	89	-2.1535	6	-0.0622	47	-0.7332
-6	-0.0395	151	-2.6281	7	-0.0538	68	-0.6327
-5	-0.0548	131	-2.8828	8	-0.0530	122	-0.6045
-4	-0.0707	116	-3.3901	9	-0.0201	93	-0.2296
-3	-0.0910	125	-4.1438	10	-0.0342	108	-0.3917
-2	-0.0999	90	-3.5531	11	-0.0061	95	-0.0631
-1	-0.1029	177	-3.3078	12	-0.0046	76	-0.0477
0	-0.1210	126	-3.4603				

Notes: The figure plots the monthly cumulative average abnormal return (CAAR) by months from default. The abnormal return is generated from the following regression: $ln(\frac{P_{i,t}}{P_{i,t-1}}) \approx \alpha + \beta Z_{i,t-1,t} + \gamma_0(Q_{i,t} - Q_{i,t-1}) + \gamma_1(Q_{i,t}ln(S_{i,t}) - Q_{i,t-1}ln(S_{i,t-1})) + \epsilon_{i,t-1,t}$, where P is the observed price, Z is a vector of fundamental value, Q is a purchase indicator, S is the trade size, ϵ is the error, i denotes the loan, and t denotes the day. The abnormal returns are averaged by months from default, and accumulated. The CAAR, 13 months before default, is normalized to be 0. The x-axis plots months from default. The y-axis plots the CAAR. The associated table tabulates the main results. The CAAR, t-statistic, and number of issuers is listed by months from default. The gray shading indicates that the CAAR is statistically significant above the 10% threshold.

Figure A.2.4: CAAR by Quarters



Notes: The figure plots the monthly cumulative average abnormal return (CAAR) by quarters from default. The abnormal return is generated from the following regression: $ln(\frac{P_{i,t}}{P_{i,t-1}}) \approx \alpha + \beta Z_{i,t-1,t} + \gamma_0(Q_{i,t} - Q_{i,t-1}) + \gamma_1(Q_{i,t}ln(S_{i,t}) - Q_{i,t-1}ln(S_{i,t-1})) + \epsilon_{i,t-1,t}$, where P is the observed price, Z is a vector of fundamental value, Q is a purchase indicator, S is the trade size, ϵ is the error, i denotes the loan, and t denotes the day. These abnormal returns are averaged by months from default, and accumulated. The CAAR, 5 months before default, is normalized to be 0. The x-axis plots months from default. The y-axis plots the CAAR.

A.3 Trading Effects

In this section, I investigate whether the trading volume mirrors the price pattern, and potential amplifying or mitigating factors that may influence the baseline result.

The binscatter diagrams in Figure A.3.1 illustrate how the net transaction size of distressed loans varies around bankruptcy. To limit the influence of outliers, I winsorsize 1% of each tail in the distribution of the transaction sizes. Figure A.3.2 exhibits the binned estimates of the net amount transacted across all CLOs for distressed issuers -8/+8 quarters around bankruptcy. Figure A.3.3 exhibits the binned estimates of the net amount transacted across all CLOs for distressed issuers -12/+12 months around bankruptcy. Managers start selling distressed loans before bankruptcy default. Further, a quadratic pattern fits the selling behavior around default; the largest amount of selling occurs in the immediate period around bankruptcy. As time from bankruptcy increases, the amount of selling declines. After a point, CLOs become net buyers.

This relation is codified through a regression framework. I regress the monthly net transaction size of each distressed issuers' loans, aggregated either by manager ("manager-level") or CLO ("CLO-level") on month dummies, signifying months surrounding distress. For ease of interpretation, I scale the monthly point estimates by the constant which represents the average monthly net transaction size. This yields a measure of the *relative* amount transacted on a monthly basis. Figure A.3.4 plots the point estimates by month and the associated 95% confidence interval for each estimate. As the regression is estimated at either the manager-month year level or CLO-month year level, the residuals are likely to be correlated at these levels. For this reason, standard errors are two-way clustered at either the manager and month year levels or CLO and month year levels, depending on the level of the regression. The point estimates from the manager-level and CLO-regressions track one another, albeit, the confidence interval from the manager-level regression is generally, slightly larger. This figure demonstrates that there is a monotonic increase in the amount of selling that occurs in the months preceding bankruptcy default. One month before bankruptcy, a manager sells at approximately four times the intensity of purchases in an average month. The magnitude of sales declines starting from the default month, until 10 months after default, after which, managers and CLOs do not exhibit any statistically significant deviation in the amount transacted, relative to the mean.

I investigate what may potentially drive the baseline trading effect. First, I examine whether the selling pattern is correctly identified, or driven by unobserved heterogeneity in various dimensions. Second, I investigate whether the selling pattern is only apparent for PE-affiliated managers. Third, I study if trading decisions may reflect information about the firm's ability to emerge from bankruptcy. Fourth, I study whether the trading dynamics are unique to particular periods of the CLO's lifespan. Fifth, I study whether managers are aware of market impact – a sign of sophistication. Lastly, I run two placebo tests to ensure that the results are not driven by omitted variable bias, and to check whether the timing of default is endogenous to the issuer. The two randomizations are: (1) randomize default dates from a uniform distribution while maintaining the same set of issuers, and, (2) randomize the issuers while maintaining the default dates.

Inter- and intra-issuer variation: In Figure A.3.6, I first compare how the *same* issuer's assets are traded month-to-month around default. Second, I exploit within issuer-year variation to ensure that the baseline effect is not driven by time-varying characteristics of issuers. Third, in addition to the issuer fixed effect, I consider how manager fixed effects and month-year fixed effects alter the estimated monthly point estimates. This regression specification is interpreted as a within manager estimator that controls for both time-invariant and time-varying characteristics. By fully absorbing issuer-specific and time-specific heterogeneity, the estimated difference is intended to capture a given manager's transacting patterns around default. Lastly, the most stringent specification includes issuer-manager fixed effects and month-year fixed effects. This is interpreted as a within issuer-manager estimator with time controls, providing the most conservative estimate of the effect of trade size on month dummies. The analogue of the latter two specifications for regressions at the CLO-level include issuer, CLO, and month-year fixed effects, and, issuer-CLO and month-year fixed effects, respectively. These results are shown in Figure A.3.7. The addition of fixed effects do not drastically change the results; the same monotonic patterns that are depicted in the baseline specification are exhibited in these figures. This suggests that the regression specification plausibly identifies the associated effect of transacting in a particular month.

Private equity affiliation: As Figure 4 of Kundu (2021*a*) indicates that a large share of the most active CLO managers are affiliated with private equity firms, I compare how the results differ for managers affiliated with private equity firms relative to unaffiliated managers. There are two possible hypotheses, explaining potential differences in the trading patterns between these two groups. The first hypothesis is that managers affiliated with PE firms may hold onto loans because they are better equipped to maneuver bankruptcy. Alternatively, managers affiliated with PE firms may sell loans more aggressively because of private information. I do not find any conclusive evidence of differences between managers in either groups. I plot the most conservative regression estimates, accounting for issuer-manager and month-year fixed effects in Figure A.3.9, and, issuer-CLO and month-year fixed effects in Figure A.3.10. The trading patterns for the two groups are similar, disputing both of the aforementioned hypotheses.

Superior information: I consider whether trading decisions reflect information about the firm's ability to weather restructuring. The *superior information hypothesis* posits that managers utilize information on the quality of issuers, i.e., which loans are projected to fall in value and which are projected to increase in future. Under this conjecture, it is hypothesized that managers will purchase loans from distressed firms that emerge from bankruptcy and sell loans from distressed firms that do not recover. I test this directly. Figure A.3.11 shows that managers sell loans issued by distressed firms which do successfully exit bankruptcy, invalidating the hypothesis. Hence, managers do not base trading decisions based on the prospect of emergence. This result also seems to suggest that managers do not possess private information on the recovery of the firm.

CLO age considerations: I consider whether the trading dynamics examined so far, are unique to particular periods of the CLO's lifespan. It may be plausible that earlier in a CLO's life, when a CLO has not experienced any losses, a manager may be more willing to take on greater risk. Conversely, towards the end of a CLO's life, a manager may be less diligent about satisfying covenants, and risk-shift. I add age decile fixed effects to absorb age-specific differences in the transaction size. Figure A.3.12 shows that there is little change in the relation between transaction size and months to default, thereby dispelling the hypothesis that the baseline trading effect is unique to particular periods in the CLO's life.

Intensive margin: Additionally, I look at individual transactions to examine if the intensive margin is affected. While managers may want to reduce exposure to particular issuers, they may choose to do so strategically to avoid market impact, by increasing the number of transactions and maintaining the size. The results contradict this hypothesis as shown in Figure A.3.13. The trend in individual transaction size mimics the trend for monthly net purchases at both the manager- and CLO-level, even with the inclusion of various levels of fixed effects. This demonstrates that the baseline result is robust to a more diffuse measure of transaction size. It also intimates that managers do not internalize consequences of market impact.

Placebo tests: Two placebo tests are studied to ensure that the results are not driven by anomalous features of the data, or, capture a spurious relationship. In the first placebo test, I randomize the default dates from a uniform distribution while maintaining the same set of issuers. I use this test to check that omitted variable bias is not driving the results. In the second placebo test, I randomize the distressed issuers while maintaining the same set of default dates, to make sure that the timing of default is endogenous to the issuer. This process is replicated 1,000 times. A histogram of the β point estimates associated with each month around default are shown in Figures A.3.15 and A.3.16. The "true" β value from the baseline regression is represented by a dashed red line (when it fits in the frame). All the β estimates are centered at 0. In many instances, the minimum estimate is above the baseline point estimate. The inability to distinguish β from 0 indicates a failure to reject the null hypothesis. Hence, it can be ruled out that the results reflect alternative aspects of the data.

Cumulative effect: The estimated cumulative amount transacted, starting from 12 months prior to bankruptcy is shown in Figure A.3.17. The figure exhibits a marked change in the slope of the cumulative transaction size pre- and post-bankruptcy, suggesting that CLOs are less aggressive in offloading assets after bankruptcy as compared with before. Moreover, the figure shows that CLOs sell almost $30 million of an issuer's assets in the year surrounding bankruptcy (blue line). Based on the median statistic reported in Table 1 of Kundu (2021*a*), CLOs divest of 30% of an issuer's assets within 12 months of bankruptcy. Considering that bankruptcy is only one type of adverse credit event that a firm can experience, often after experiencing several other events including missed interest/principal and distressed exchanges, 30% provides a lower bound of the size of the total amount of divestiture. In addition, considering that CLOs are the largest buyers of leveraged loans, widespread selling can be consequential to other investors. This is investigated further, below.

Other credit events: Thus far, it has been shown that CLO managers preemptively sell loans issued by distressed borrowers before the filing date. However, are these trading patterns are unique for bankruptcy events? To answer this, I focus on a smaller set of credit events which typically precede downgrades: missed interest and/or missed principal payment. Figure A.3.18 shows the net transaction size of loans issued by distressed borrowers around dates of missed interest and principal payments. Both figures show a quadratic pattern similar to Figure A.3.1, with the trough coinciding with the missed payment period. Similar to Figure A.3.4, Figure A.3.21 shows that CLO managers sell loans in anticipation of adverse credit events.

Similar price patterns occur with other adverse credit events, including missed interest/principal payments, which often portend downgrades.[2] There are three potential differences between these "intermediate" events and bankruptcy defaults: (1) magnitude of adverse credit event, (2) scarcity of capital among potential buyers, and (3) duration. First, if the missed payments are reflective of business cycle fluctuations, or, downgrades are not drastic or below a certain level, the effect on a CLO manager's trading behavior may be limited – impact on the capital and liquidity constraints may be limited. Second, as trading often occurs among CLOs, under more adverse scenarios, a greater share of potential CLO buyers may also become constrained, making capital more scarce with greater price impact. Therefore, variation in the degree of price pressure is contingent on the magnitude of stress. This can explain why fire sale risk may be greater with defaults than downgrades. Lastly, while intermediate events like missed payments and downgrades are relatively abrupt events, the restructuring process may be protracted, extending and exacerbating the capital and liquidity constraints of CLOs. Thus, managers may manage different adverse credit events differentially.

Hence, the result applies across the board – regardless of CLO age, affiliation, identity of CLO or manager, time of trade, or quality of underlying issuers.

Figure A.3.1: Binscatters of Managerial Trading Behavior around Bankruptcy

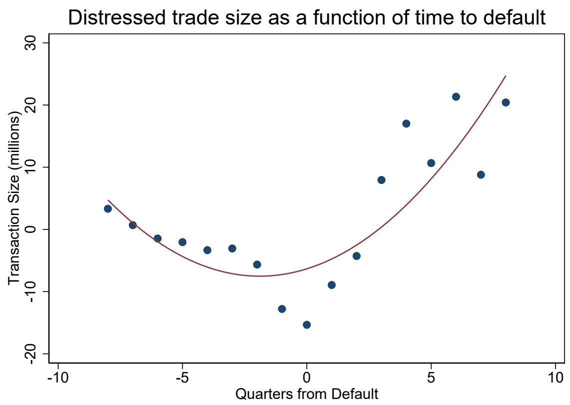


Figure A.3.2: Quarters

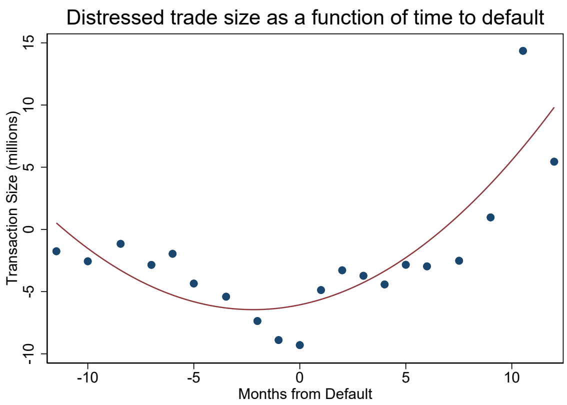
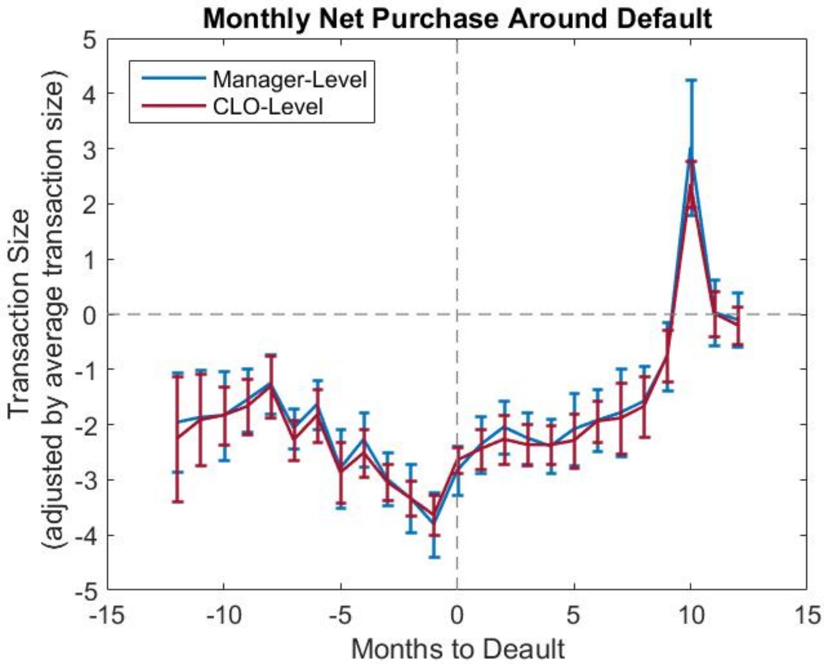


Figure A.3.3: Months

Notes: The binscatter diagrams show the net transaction size of distressed loans around bankruptcy. The left diagram exhibits the binned estimates of the total amount transacted across all CLOs for each distressed issuer -8/+8 quarters around bankruptcy. The right diagram exhibits the binned estimates of the total amount transacted across all CLOs for each distressed issuer -12/+12 months around bankruptcy. The x-axis indicates the time from bankruptcy. The y-axis indicates the net transaction size (in millions).

2. The analysis is replicated for a smaller sample of interest/principal payments which exhibit similar price patterns.

Figure A.3.4: Monthly Net Purchase around Default



Notes: The figure plots the month βs and the associated 95% confidence interval from regressing the monthly transaction size at the manager-and CLO-levels on month dummy variables. The regression specification is: $y_{im} = \alpha + \sum_{t=-12}^{12} \beta_{t+13} \mathbb{1}_{m==t} + \epsilon_{im}$ where y denotes the monthly net purchase, i denotes the issuer, m denotes the month, *year* denotes the year, and t indexes time around bankruptcy default. The red line indicates the results of the CLO-level regression. The blue line indicates the results of the manager-level regression. The x-axis indicates months to default. The y-axis indicates the monthly transaction size at the manager- or CLO-level, adjusted by the average transaction size. Standard errors are two-way clustered at the manager and month-year levels, and CLO and month-year levels for the manager-level and CLO-level regressions respectively.

Figure A.3.5: Monthly Net Purchase around Bankruptcy Default with Fixed Effects

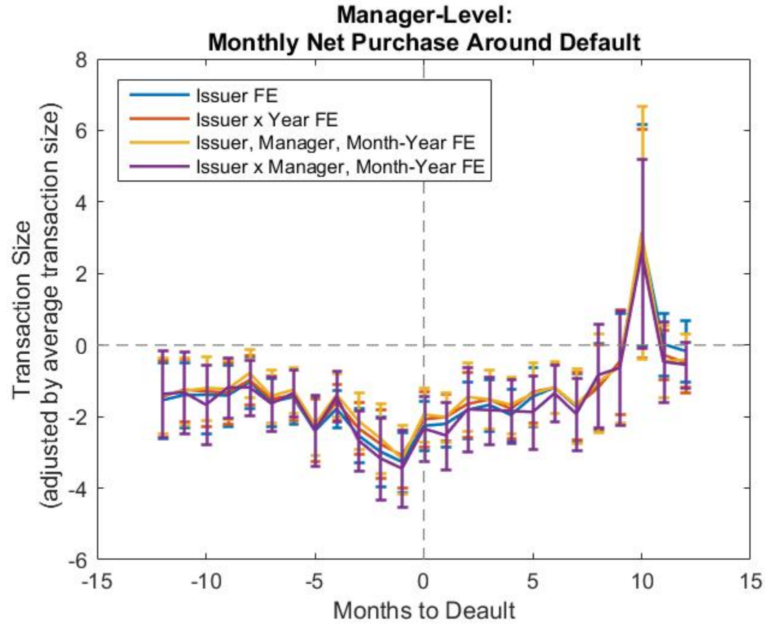


Figure A.3.6: Manager-level

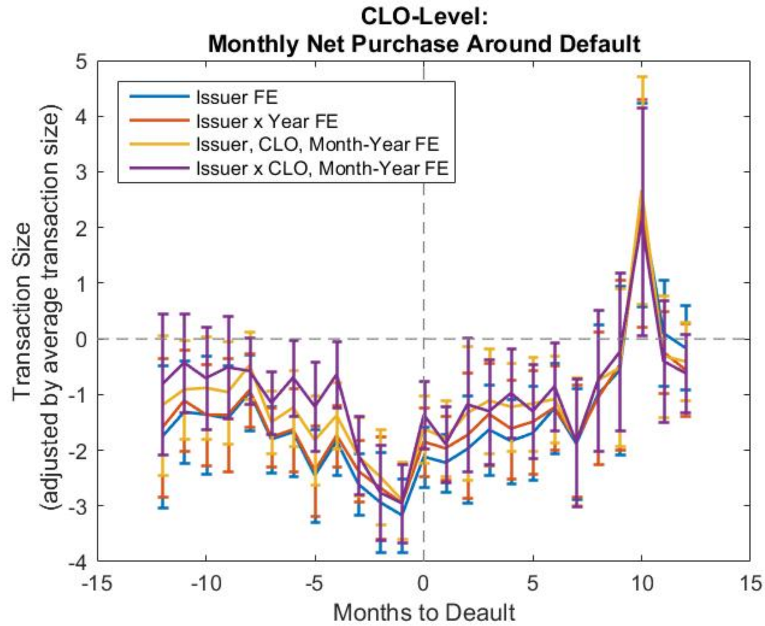


Figure A.3.7: CLO-level

Notes: The figures plot the month βs and the associated 95% confidence interval from regressing the monthly transaction size at the manager-level (top figure) and CLO-level (bottom figure) on month dummy variables with fixed effects. The regression specification is: $y_{im} = \alpha + \sum_{t=-12}^{12} \beta_{t+13} \mathbb{1}_{m==t} + \alpha_i + \alpha_{iy} + \alpha_c + \alpha_{ic} + \theta_{my} + \epsilon_{im}$ where y denotes the monthly net purchase, i denotes the issuer, m denotes the month, *year* denotes the year, c denotes manager (top figure) or CLO (bottom figure), and t indexes time around bankruptcy default. In both figures, the blue line indicates the inclusion of issuer fixed effects; the red indicates issuer-year fixed effects. In the top figure, the yellow line indicates the inclusion of issuer, manager, and month-year fixed effects; purple indicates issuer-manager, and month-year fixed effects. In the bottom figure: the yellow line indicates the inclusion of issuer, CLO, and month-year fixed effects; purple indicates issuer-CLO, and month-year fixed effects. The x-axis indicates months to default. The y-axis indicates the monthly transaction size at the manager- or CLO-level, adjusted by the average transaction size. Standard errors are two-way clustered at the manager and month-year levels, and, CLO and month-year levels, in the top and bottom figures, respectively.

Figure A.3.8: Monthly Net Purchase around Bankruptcy Default: Private Equity Comparison

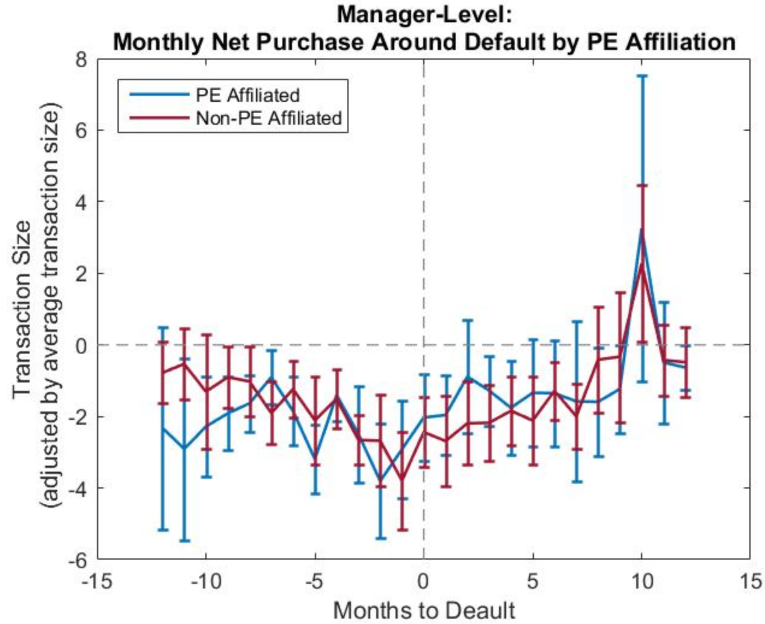


Figure A.3.9: Manager-level

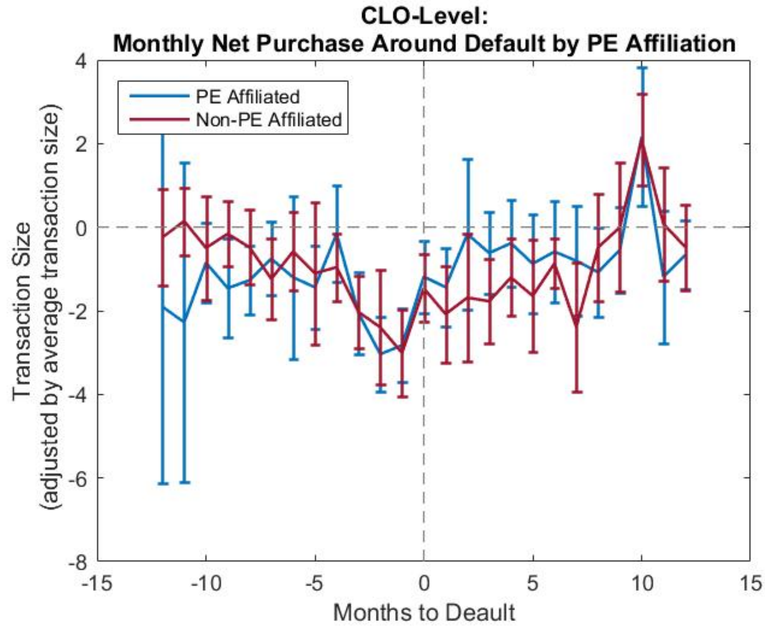
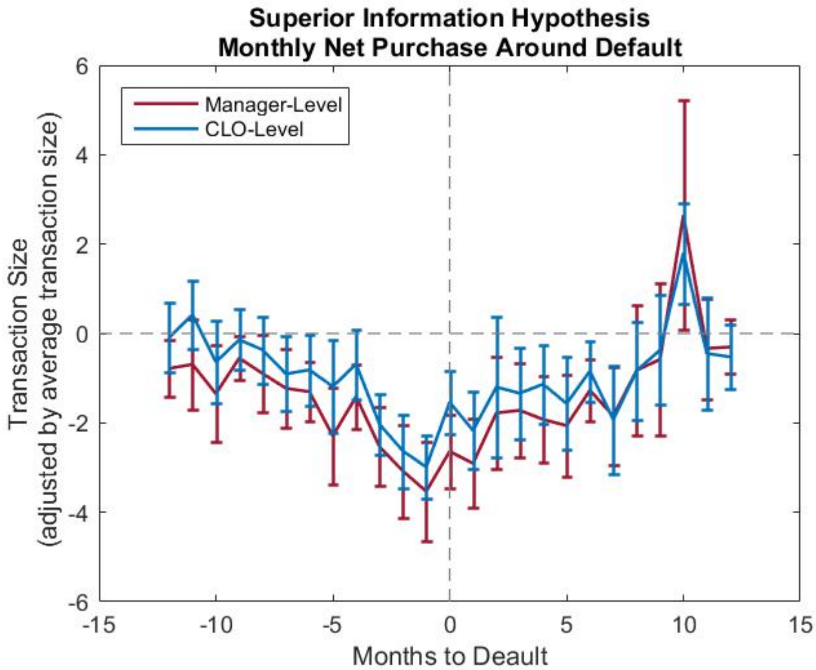


Figure A.3.10: CLO-level

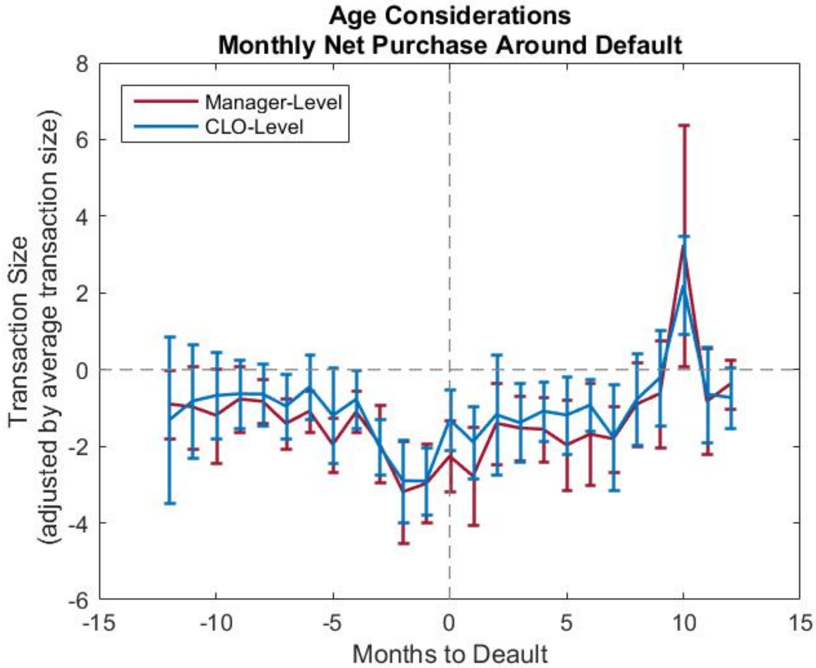
Notes: The top figure plots the month βs and the associated 95% confidence interval from regressing the monthly transaction size at the manager-level on month dummy variables with issuer-manager, and month-year fixed effects. The regression specification is: $y_{im} = \alpha + \sum_{t=-12}^{12} \beta_{t+13} \mathbb{1}_{m==t} + \alpha_{ig} + \theta_{my} + \epsilon_{im}$ where y denotes the monthly net purchase, i denotes the issuer, m denotes the month, *year* denotes the year, c denotes manager (top figure) or CLO (bottom figure), and t indexes time around bankruptcy default. The bottom figure plots the month βs and the associated 95% confidence interval from regressing the monthly transaction size at the CLO-level on month dummy variables with issuer-CLO, and month-year fixed effects. The blue line indicates if the CLO is affiliated with a private equity firm. The red line indicates if the CLO is not affiliated with a private equity firm. The x-axis indicates months to default. The y-axis indicates the monthly transaction size at the manager- or CLO-level, adjusted by the average transaction size. Standard errors are two-way clustered at the manager and month-year levels in top figure, and CLO and month-year levels in the bottom figure.

Figure A.3.11: Monthly Net Purchase around Bankruptcy Default: Super Information Hypothesis



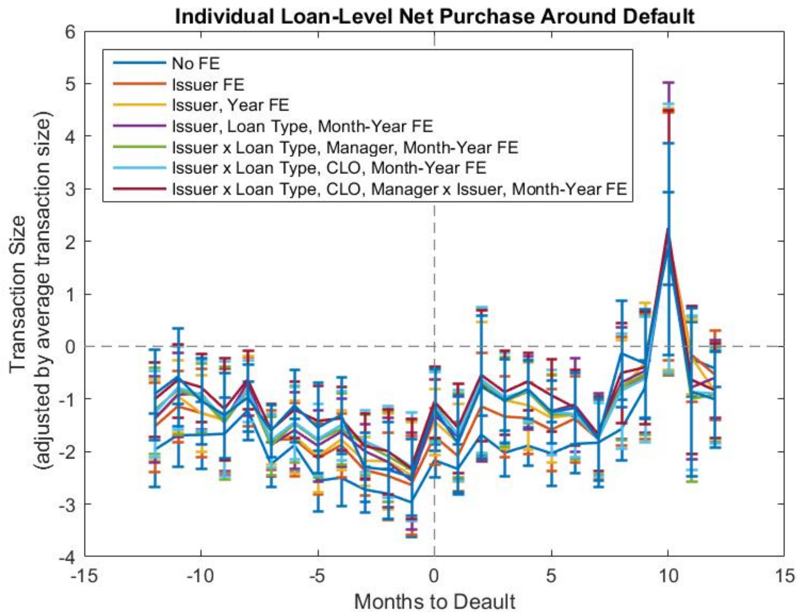
Notes: The top figure plots the month βs and the associated 95% confidence interval from regressing the monthly transaction size at the manager- and CLO-level on month dummy variables with issuer-manager, and month-year fixed effects, and issuer-CLO, and month-year fixed effects, respectively – restricted to the subset of firms that emerge from bankruptcy. The regression specification is: $y_{im} = \alpha + \sum_{t=-12}^{12} \beta_{t+13} \mathbb{1}_{m==t} + \alpha_{ig} + \theta_{my} + \epsilon_{im}$ where y denotes the monthly net purchase, i denotes the issuer, m denotes the month, *year* denotes the year, c denotes manager (red) or CLO (blue), and t indexes time around bankruptcy default. The red line indicates that the regression is at the manager-level. The blue line indicates that the regression is at the CLO-level. The x-axis indicates months to default. The y-axis indicates the monthly transaction size at the manager- or CLO-level, adjusted by the average transaction size. Standard errors are two-way clustered at the manager and month-year levels, and CLO and month-year levels for the manager-level and CLO-level regressions, respectively.

Figure A.3.12: Monthly Net Purchase around Bankruptcy Default: Consideration of Age



Notes: The top figure plots the month βs and the associated 95% confidence interval from regressing the monthly transaction size at the manager- and CLO-level on month dummy variables with issuer-manager, month-year, and age decile fixed effects, and issuer-CLO, month-year, and age decile fixed effects, respectively. The regression specification is: $y_{im} = \alpha + \sum_{t=-12}^{12} \beta_{t+13} \mathbb{1}_{m==t} + \alpha_{ig} + \theta_{my} + \epsilon_{im}$ where y denotes the monthly net purchase, i denotes the issuer, m denotes the month, $year$ denotes the year, c denotes manager (red) or CLO (blue), and t indexes time around bankruptcy default. The red line indicates that the regression is at the manager-level. The blue line indicates that the regression is at the CLO-level. The x-axis indicates months to default. The y-axis indicates the monthly transaction size at the manager- or CLO-level, adjusted by the average transaction size. Standard errors are two-way clustered at the manager and month-year levels, and CLO and month-year levels for the manager-level and CLO-level regressions, respectively.

Figure A.3.13: Individual Transactions around Bankruptcy Default



Notes: The figure plots the transactions βs and the associated 95% confidence interval from regressing the monthly transaction size at the manager- and CLO-level on month dummy variables with various levels of fixed effects. The regression specification is: $y_{loan,m} = \alpha + \sum_{t=-12}^{12} \beta_{t+13} \mathbb{1}_{m==t} + \alpha_i + \theta_y + \alpha_l + \alpha_{il} + \theta_{my} + \alpha_c + \alpha_g + \alpha_{gi} + \epsilon_{loan,m}$ where $loan$ denotes loan (loan $\in$ issuer), y denotes the monthly net purchase, i denotes the issuer, m denotes the month, $year$ denotes the year, l denotes the loan type, c denotes the CLO, g denotes the manager, and t indexes time around bankruptcy default. The blue line indicates there are no fixed effects. The red line indicates the inclusion of issuer fixed effects. The yellow line indicates the inclusion of issuer and year fixed effects. The purple line indicates the inclusion of issuer, loan type, and month-year fixed effects. The green line indicates the inclusion of issuer-loan type, manager, and month-year fixed effects. The cyan line indicates the inclusion of issuer-loan type, CLO, and month-year fixed effects. The magenta line indicates the inclusion of issuer-loan type, CLO, manager-issuer, and month-year fixed effects. The x-axis indicates months to default. The y-axis indicates the transaction size, adjusted by the average transaction size. Standard errors are two-way clustered at the manager and month-year levels.

Figure A.3.14: Placebo

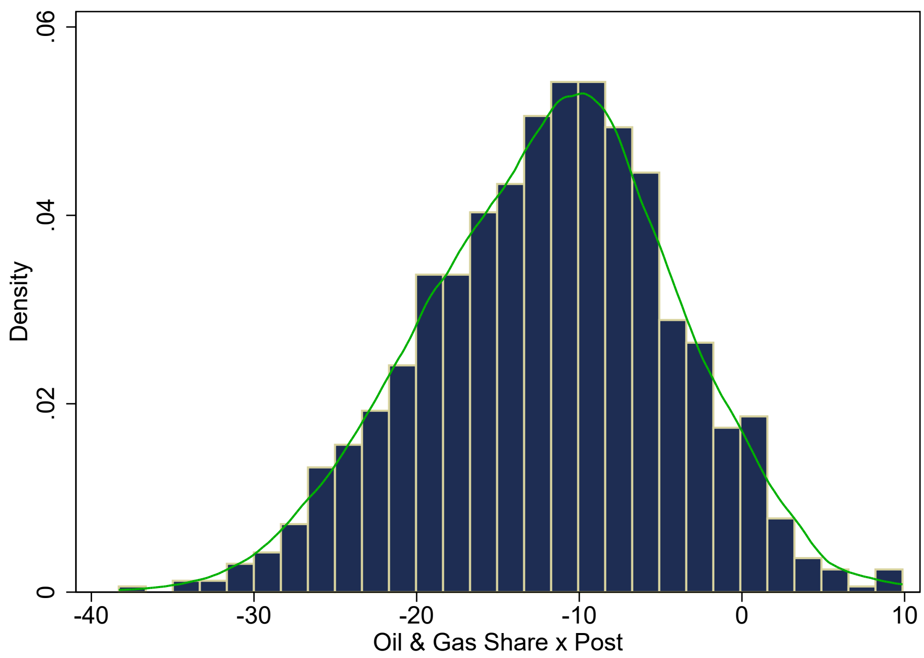


Figure A.3.15: Randomization of timing

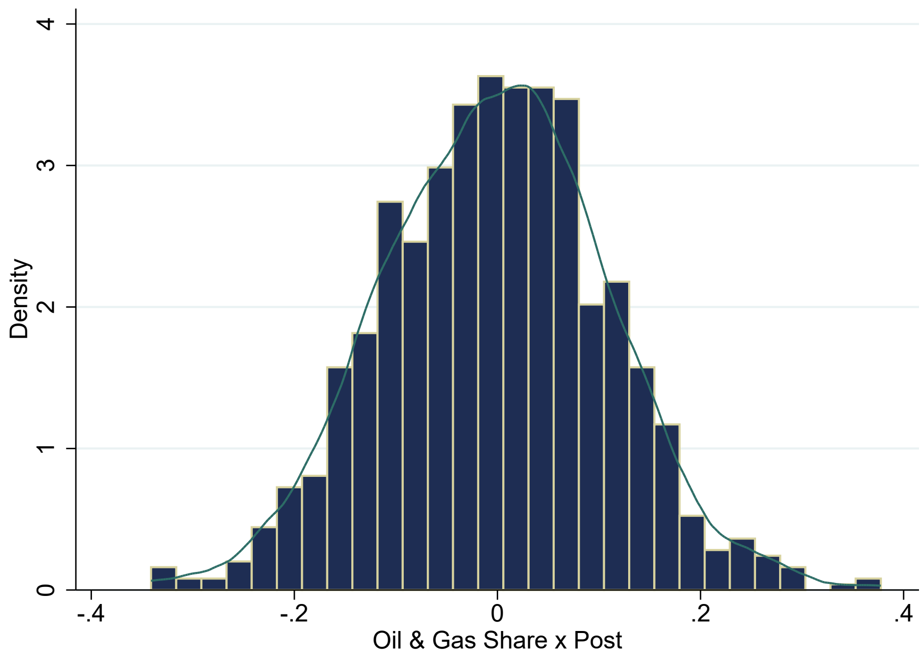
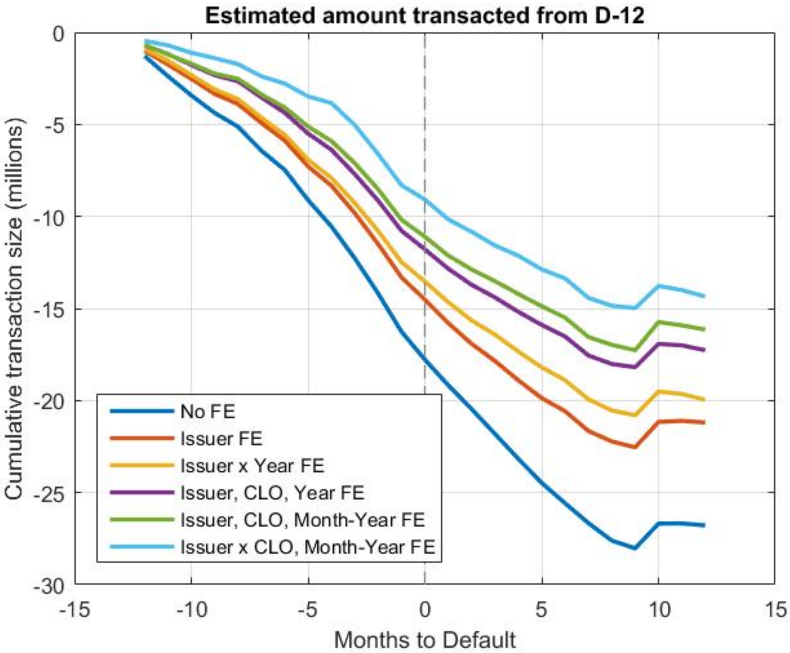


Figure A.3.16: Randomization of distress

Notes: The figures show the distribution of βs for each month with placebo testing. The regression specification is: $y_{im} = \alpha + \sum_{t=-12}^{12} \beta_{t+13} \mathbb{1}_{m==t} + \theta_{my} + \alpha_{gi} + \epsilon_{im}$ where y denotes the monthly net purchase, i denotes the issuer, m denotes the month, *year* denotes the year, g denotes the manager, and t indexes time around bankruptcy default. In the top figure, I report the baseline regression results after randomizing the timing of default. In the bottom figure, I report the baseline regression results after randomizing the distressed issuers. The histogram of β values are plotted for -12/+12 months around bankruptcy, with 1000 repetitions. The dashed red line is the "true" β value from the baseline regression. Disclaimer: the red line may appear "off the chart."

Figure A.3.17: Cumulative Results



Notes: The figure reports the cumulative βs of the CLO-level regression, in consideration of various fixed effects. The regression specification is: $y_{im} = \alpha + \sum_{t=-12}^{12} \beta_{t+13} \mathbb{1}_{m==t} + \alpha_i + \alpha_{iy} + \alpha_c + \theta_y + \alpha_{ic} + \theta_{my} + \epsilon_{im}$ where y denotes the monthly net purchase, i denotes the issuer, m denotes the month, *year* denotes the year, and c denotes the CLO. The *beta* coefficients are aggregated to the month m from $t - 12$ and plotted above. The blue line indicates no fixed effects. The red line indicates the inclusion of issuer fixed effects. The yellow line indicates the inclusion of issuer-year fixed effects. The purple line indicates the inclusion of issuer, CLO, and year fixed effects. The green line indicates the inclusion of issuer, CLO, and month-year fixed effects. The cyan line indicates the inclusion of issuer-CLO and month-year fixed effects. The x-axis indicates the months to default. The y-axis indicates the cumulative transaction size (millions).

Figure A.3.18: Binscatter of Managerial Trading Behavior around missed interest and principal payments

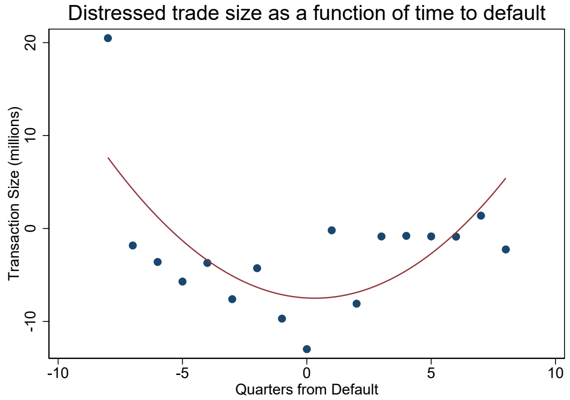


Figure A.3.19: Quarters

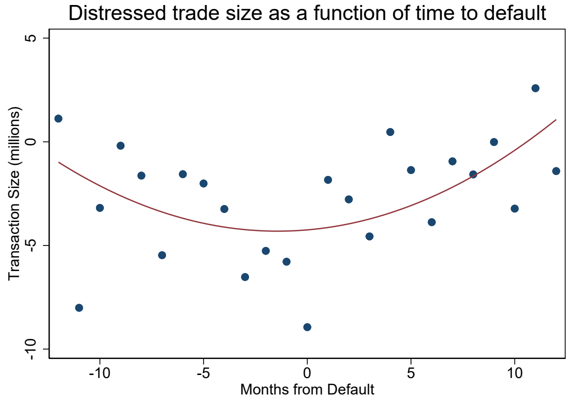


Figure A.3.20: Months

Notes: The binscatter diagrams show the net transaction size of distressed loans around other default events, namely, missed interest and principal payments – precursors of downgrades. The left diagram exhibits the binned estimates of the total amount transacted across all CLOs for each distressed issuer -8/+8 quarters around missed interest and principal payments. The right diagram exhibits the binned estimates of the total amount transacted across all CLOs for each distressed issuer -12/+12 months around missed interest and principal payments. The x-axis indicates the time from the default event. The y-axis indicates the net transaction size (in millions).

Figure A.3.21: Preemptive Selling for Missed Interest and Principal Events

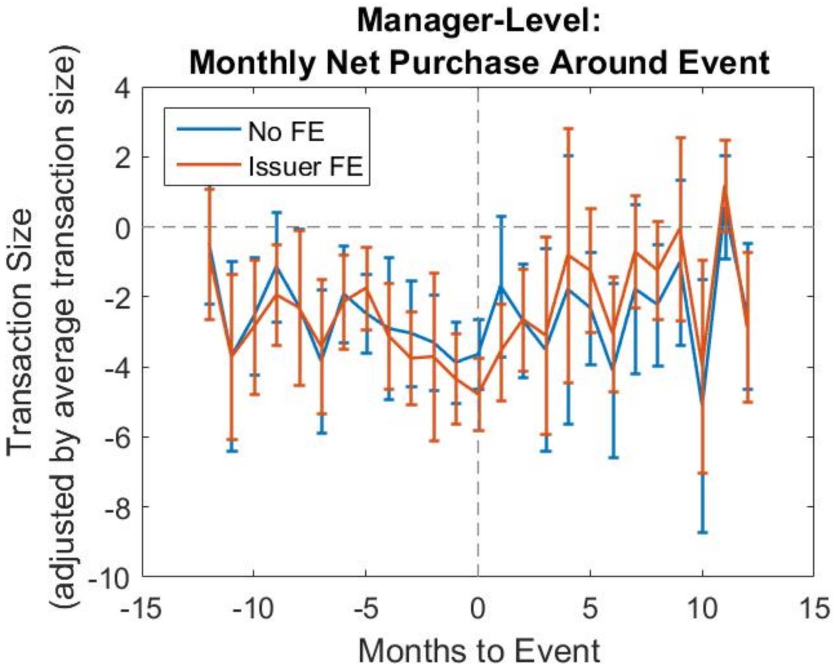


Figure A.3.22: Manager-level

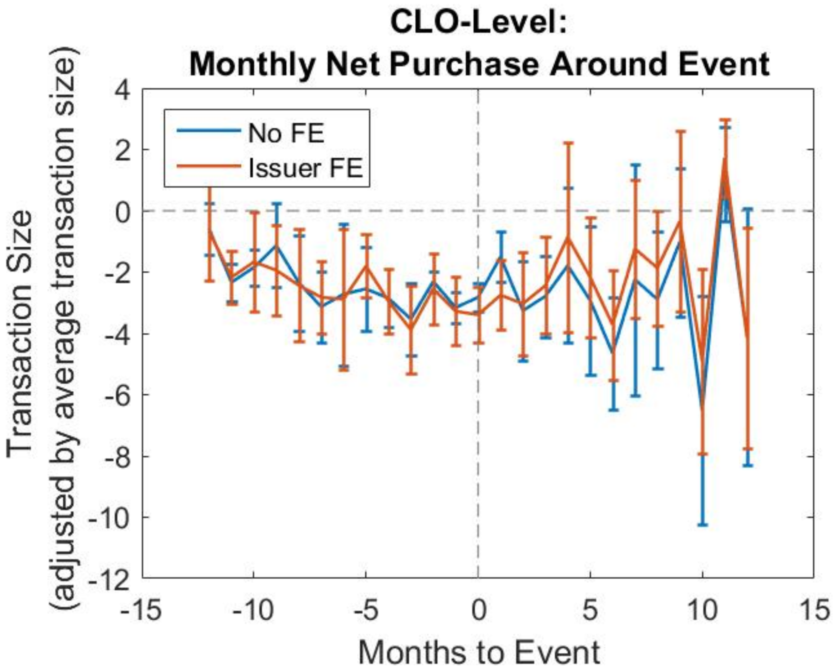


Figure A.3.23: CLO-level

Notes: The top figure plots the month βs and the associated 95% confidence interval from regressing the monthly transaction size at the manager level on month dummy variables. The bottom figure plots the month βs and the associated 95% confidence interval from regressing the monthly transaction size at the CLO level on month dummy variables. The regression specification is: $y_{im} = \alpha + \sum_{t=-12}^{12} \beta_{t+13} \mathbb{1}_{m==t} + \alpha_i + \epsilon_{im}$ where i denotes the issuer and m denotes the month. The red line indicates the inclusion of fixed effects in the regression. The blue line indicates that the there are no fixed effects. The x-axis indicates months to default. The y-axis indicates the monthly transaction size at the manager- or CLO-level, adjusted by the average transaction size. Standard errors are two-way clustered at the manager and month-year levels, and CLO and month-year levels for the manager-level and CLO-level regressions, respectively.

A.4 Robustness of Covenants

I examine whether these findings on the extensive and intensive margins are robust to alternative specifications. In Table A.4.1, I consider how the results vary under different outcome variables, and empirical methodologies. Using a linear probability model, Columns 1-3 indicate that a one standard deviation change in the capital constraints, relative to the respective means, is associated with a decline in the likelihood that a manager sells defaulted loans by 2.55-3.84 percentage points. Columns 4-5 indicate that a one standard deviation change in the capital constraints, relative to the respective means, is associated with a decline in the likelihood that a manager sells defaulted loans by 2.34-2.68%. In Columns 5-7, I apply a "leave-one-out" strategy, iterating through each firm and recomputing the covenant performance in the absence of that particular firm.[3] The adjusted covenant performance measures provide a measure of potential constraint rather than realized constraint. Based on Columns 5-7, a one standard deviation change in the junior capital constraints, relative to the means, is associated with a decline in the likelihood that a manager sells risky loans by 11.02-24.95%. For the most senior of the capital constraints, this estimate is 2.42%.

While capital constraints are a large determinant of whether CLO managers sell risky loans in the subsequent period, the amount of risky loans exhibits greatest sensitivity to the liquidity constraints. To show this, I replicate the analysis using two alternative measures of distressed loans: the percent of defaulted loans, and the percent of loans rated CCC in Tables A.4.2 and A.4.3, respectively.

Consistent with the main result, I find that the Junior IC covenant performance, the tightest of CLO liquidity constraints, is strongly associated with trades of risky loans. Panel A of Tables A.4.2 and A.4.3 confirm that a one standard deviation increase in the Junior IC covenant performance (Column 4), relative to the mean, is associated with a 1.08 percent points reduction in the share of defaulted loans, and 0.62 percent point reduction in the share of CCC loans. Panel B of Tables A.4.2 and A.4.3 confirm that a one standard deviation increase in the Junior IC covenant performance (Column 4), relative to the mean, is associated with a 0.28 percentage points decline in the subsequent amount of defaulted loans transacted, and a 0.67 percentage points decline in the subsequent amount of CCC loans.[4] In Panel C of Table A.4.3, I do not find that changes in the amount of CCC loans transacted are related to tangible changes in the liquidity constraints. However, a 1 percentage point increase in the amount of defaulted loans transacted is associated with a reduction of 0.01 standard deviations of the Junior IC covenant performance and 0.004 standard deviations of the Senior IC covenant performance, relative to their respective means.

Further, I replicate the baseline regressions, examining the intensive margin, after applying the leave-one-out strategy – iterating through each firm and recomputing the

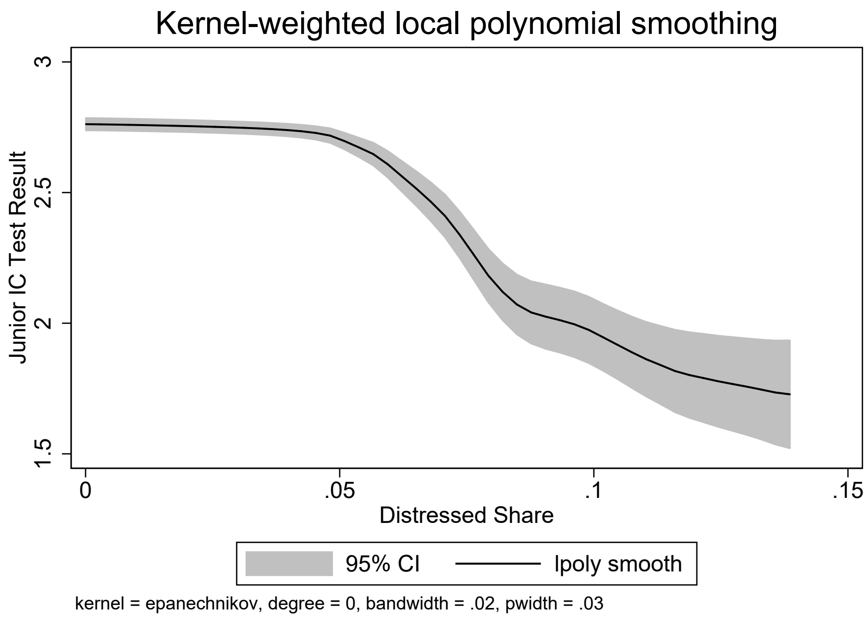
3. The assumption in applying this methodology is that the firm has the same adjustment factor in recomputing the capital constraint as the liquidity constraint.

4. While the point estimate for the Junior IC covenant performance in Panel B of A.4.2 is not statistically significant, the R^2 value is the highest among all capital and liquidity results, and there is significance in the Senior IC covenant performance, which is indicative that managers exhibit sensitivity to liquidity performance measures. Specifically, a one standard deviation increase in the Senior IC covenant performance, relative to the mean, is associated with a 0.24 percentage points in the subsequent amount of loans transacted. Given the hierarchy in thresholds, significance in the Senior IC covenant performance strongly implies the importance of the Junior IC covenant performance.

Junior IC covenant performance in the absence of that particular firm – in Table A.4.4. A one standard deviation increase in the Junior IC covenant performance, relative to the mean, is associated with a decrease of 0.38-0.55 percentage points in the share of risky loans, 0.33-0.58 percentage points decline in the subsequent amount transacted, 0.27-0.38 percentage points decline in the share of defaulted loans, and 0.23-0.28 percentage points decline in the share of CCC loans. For further confirmation of this result, I use an a posteriori method of defining *risky* loans to study if the relation to liquidity performance bears scrutiny. Loans are *risky* if they are issued by firms that file for bankruptcy at some point in the sample period. The graphical results in Figure A.4.1 exhibit a negative relation. Thus, the result is robust.

These results suggest that covenants affect CLO trading decisions, providing an explanation for the price and volume patterns presented thus far.

Figure A.4.1: Distressed Share and Junior IC Covenant Result



Notes: The figure shows the kernel-weighted local polynomial of the Junior IC result as a function of the share of distressed loans. A loan is designated as distressed if its issuer files for bankruptcy in the sample period. The gray shading denotes the 95% confidence interval. The solid black line plots the estimate.

Table A.4.1: Extensive Margin: Risky Loans and Covenant Results

	Risky Sale and Covenant Result						
	$\mathbb{1}_{\text{Defaulted Sale}}$		$\mathbb{1}_{\text{CCC Sale}}$		$\mathbb{1}_{\text{Risky Sale}}$ (Leave-one-out)		
	Low OC	Senior OC	Low OC	Senior OC	Interest Diversion	Junior OC	Senior OC
Covenant Result	-0.0384***	-0.0255***	-0.0234***	-0.0268***	-0.2495***	-0.1102***	-0.0242***
	(0.0054)	(0.0035)	(0.0056)	(0.0048)	(0.0631)	(0.0353)	(0.0071)
Size Control					✓	✓	✓
Performance Control					✓	✓	✓
Age Control					✓	✓	✓
Manager-Year FE	✓	✓	✓	✓	✓	✓	✓
Arranger FE	✓	✓	✓	✓	✓	✓	✓
Trustee FE	✓	✓	✓	✓	✓	✓	✓
N	18,355	14,957	18,355	14,957	1,707,657	3,381,091	3,769,093
R^2	0.1403	0.1292	0.1025	0.0907	0.2557	0.2205	0.2047

Standard errors in parentheses, and two-way clustered at the manager and month-year levels.

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

Notes: The table presents the relation between a CLO's decision to sell risky loans, defaulted loans, and CCC loans, and, quality and coverage covenant results. The regression specification follows a linear probability model: $\mathbb{1}_{defaulted/CCC,ct} = \alpha + \beta \times \Delta Result_{ct} + \Gamma Z_{ct} + \gamma_{my} + \delta_a + \delta_w + \epsilon_{ct}$. $\mathbb{1}_{risky,ct}$ takes on the value 1 if there is a decline in the share of defaulted loans (Columns 1-2), decline in the share of CCC loans (Columns 3-4), and decline in share of risky loans using the leave-one-out methodology, in which I iterate through each firm and recompute the covenant result in the absence of that particular firm (Columns 5-7). Z contains all control variables, including size, performance, and age, ϵ is the error, c denotes CLO, t denotes the month-year pair, m denotes CLO manager, $year$ denotes the year, a denotes the arranger, and w denotes the trustee. The columns denote different covenant results (standardized): Interest Diversion/Junior OC covenant, Senior OC covenant, Interest Diversion/Junior OC covenant, Senior OC covenant, Interest Diversion covenant, Junior OC covenant, and Senior OC covenant (Column 1-8, respectively).

Table A.4.2: Defaulted Loans and Covenant Results

Panel A: Defaulted Share_t and Covenant Result_t							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Default Share	WAS	WA Life	Interest Div.	Junior IC	Junior OC	Senior IC	Senior OC
Covenant Result	0.1063	-0.1945	-0.0446	-1.0752***	-0.3517	-0.3801	0.3501
	(0.3650)	(0.2344)	(0.1051)	(0.2672)	(0.3330)	(0.2764)	(0.3081)
Size Control	✓	✓	✓	✓	✓	✓	✓
Performance Control	✓	✓	✓	✓	✓	✓	✓
Age Control	✓	✓	✓	✓	✓	✓	✓
Manager-Year FE	✓	✓	✓	✓	✓	✓	✓
Arranger FE	✓	✓	✓	✓	✓	✓	✓
Trustee FE	✓	✓	✓	✓	✓	✓	✓
N	4,533	4,453	1,598	4,142	4,137	4,443	4,860
R^2	0.5739	0.4979	0.5051	0.6162	0.5183	0.5884	0.4772
Panel B: Δ Defaulted Share_{t+1} and Covenant Result_t							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ΔDefault Share	WAS	WA Life	Interest Div.	Junior IC	Junior OC	Senior IC	Senior OC
Covenant Result	-0.2826	-0.0989	-0.0851	-0.2821	-0.0767	-0.2408*	0.0147
	(0.2395)	(0.1237)	(0.2386)	(0.2138)	(0.1039)	(0.1288)	(0.1760)
Size Control	✓	✓	✓	✓	✓	✓	✓
Performance Control	✓	✓	✓	✓	✓	✓	✓
Age Control	✓	✓	✓	✓	✓	✓	✓
Manager-Year FE	✓	✓	✓	✓	✓	✓	✓
Arranger FE	✓	✓	✓	✓	✓	✓	✓
Trustee FE	✓	✓	✓	✓	✓	✓	✓
N	3,988	3,915	1,428	3,659	3,664	3,927	4,279
R^2	0.2066	0.1297	0.1539	0.1558	0.1379	0.1265	0.1318
Panel C: Δ Covenant Result_t and Δ Defaulted Share							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Δ Covenant Result	WAS	WA Life	Interest Div.	Junior IC	Junior OC	Senior IC	Senior OC
ΔDefault Share	0.0069	-0.0002	-0.0008	-0.0095**	-0.0015	-0.0044*	0.0037
	(0.0053)	(0.0003)	(0.0005)	(0.0045)	(0.0024)	(0.0023)	(0.0052)
Size Control	✓	✓	✓	✓	✓	✓	✓
Performance Control	✓	✓	✓	✓	✓	✓	✓
Age Control	✓	✓	✓	✓	✓	✓	✓
Manager-Year FE	✓	✓	✓	✓	✓	✓	✓
Arranger FE	✓	✓	✓	✓	✓	✓	✓
Trustee FE	✓	✓	✓	✓	✓	✓	✓
N	3,207	3,132	1,027	2,820	2,885	3,059	3,425
R^2	0.1667	0.1787	0.1990	0.1742	0.2063	0.1516	0.1786

Standard errors in parentheses, and two-way clustered at the manager and month-year levels.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between defaulted loans and quality and coverage covenant results. Panel A tests the relation between the defaulted share and standardized covenant result. The regression specification is: $Defaulted_{ct} = \alpha + \beta \times Result_{ct} + \Gamma Z_{ct} + \gamma_{my} + \delta_a + \delta_w + \epsilon_{ct}$. Panel B tests the relation between the change in defaulted share in the subsequent period and current standardized covenant result. The regression specification is: $\Delta Defaulted_{ct+1} = \alpha + \beta \times Result_{ct} + \Gamma Z_{ct} + \gamma_{my} + \delta_a + \delta_w + \epsilon_{ct}$. Panel C tests the relation between the change in defaulted share and change in standardized covenant result. The regression specification is: $\Delta Defaulted_{ct} = \alpha + \beta \times \Delta Result_{ct} + \Gamma Z_{ct} + \gamma_{my} + \delta_a + \delta_w + \epsilon_{ct}$. $Defaulted_{ct}$ is the defaulted share, $\Delta Defaulted_{ct+1}$ is the change in the defaulted share in the subsequent period, $\Delta Defaulted_{ct}$ is the change in the defaulted share in the current period, $Result$ denotes the covenant result, Z contains all control variables, including size, performance, and age, ϵ is the error, c denotes CLO, t denotes the month-year pair, m denotes CLO manager, $year$ denotes the year, a denotes the arranger, and w denotes the trustee. The columns denote different test restrictions; Weighted Average Spread covenant, Weighted Average Life covenant, Interest Diversion covenant, Junior IC covenant, Junior OC covenant, Senior IC covenant, and Senior OC covenant (Column 1-7, respectively).

Table A.4.3: CCC Loans and Covenant Results

Panel A: CCC Share_t and Covenant Result_t

CCC Share	(1) WAS	(2) WA Life	(3) Interest Div.	(4) Junior IC	(5) Junior OC	(6) Senior IC	(7) Senior OC
Covenant Result	0.2524	2.3219***	-0.2553	-0.6207***	0.1800	-0.3331	0.3350*
	(0.2312)	(0.1818)	(0.1907)	(0.1848)	(0.2046)	(0.2070)	(0.1978)
Size Control	✓	✓	✓	✓	✓	✓	✓
Performance Control	✓	✓	✓	✓	✓	✓	✓
Age Control	✓	✓	✓	✓	✓	✓	✓
Manager-Year FE	✓	✓	✓	✓	✓	✓	✓
Arranger FE	✓	✓	✓	✓	✓	✓	✓
Trustee FE	✓	✓	✓	✓	✓	✓	✓
N	4553	4781	1607	4160	4153	4460	4879
R^2	0.6501	0.7411	0.7029	0.6853	0.6650	0.6495	0.6252

Panel B: Δ CCC Share_{t+1} and Covenant Result_t

ΔCCC Share	(1) WAS	(2) WA Life	(3) Interest Div.	(4) Junior IC	(5) Junior OC	(6) Senior IC	(7) Senior OC
Covenant Result	-0.1962**	0.0752	-0.1202	-0.6676***	0.2707**	-0.2064**	0.2840***
	(0.0915)	(0.0855)	(0.0771)	(0.1454)	(0.1151)	(0.0832)	(0.0829)
Size Control	✓	✓	✓	✓	✓	✓	✓
Performance Control	✓	✓	✓	✓	✓	✓	✓
Age Control	✓	✓	✓	✓	✓	✓	✓
Manager-Year FE	✓	✓	✓	✓	✓	✓	✓
Arranger FE	✓	✓	✓	✓	✓	✓	✓
Trustee FE	✓	✓	✓	✓	✓	✓	✓
N	3765	3664	1324	3438	3459	3682	4038
R^2	0.3263	0.3251	0.5030	0.3629	0.3555	0.3299	0.3124

Panel C: Δ Covenant Result_t and Δ CCC Share

Δ Covenant Result_t	(1) WAS	(2) WA Life	(3) Interest Div.	(4) Junior IC	(5) Junior OC	(6) Senior IC	(7) Senior OC
ΔCCC Share_t	0.0221*	-0.0001	0.0055	-0.0024	-0.0022	-0.0055	-0.0051
	(0.0129)	(0.0012)	(0.0035)	(0.0029)	(0.0019)	(0.0037)	(0.0045)
Size Control	✓	✓	✓	✓	✓	✓	✓
Performance Control	✓	✓	✓	✓	✓	✓	✓
Age Control	✓	✓	✓	✓	✓	✓	✓
Manager-Year FE	✓	✓	✓	✓	✓	✓	✓
Arranger FE	✓	✓	✓	✓	✓	✓	✓
Trustee FE	✓	✓	✓	✓	✓	✓	✓
N	3222	3147	1036	2830	2894	3069	3437
R^2	0.1800	0.1763	0.1999	0.1669	0.2146	0.1713	0.1739

Standard errors in parentheses, and two-way clustered at the manager and month-year levels.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents the relation between CCC loans and quality and coverage covenant results. Panel A tests the relation between the CCC share and standardized covenant result. The regression specification is: $CCC_{ct} = \alpha + \beta \times Result_{ct} + \Gamma Z_{ct} + \gamma_{my} + \delta_a + \delta_w + \epsilon_{ct}$. Panel B tests the relation between the change in CCC share in the subsequent period and current standardized covenant result. The regression specification is: $\Delta CCC_{ct+1} = \alpha + \beta \times Result_{ct} + \Gamma Z_{ct} + \gamma_{my} + \delta_a + \delta_w + \epsilon_{ct}$. Panel C tests the relation between the change in CCC share and change in standardized covenant result. The regression specification is: $\Delta CCC_{ct} = \alpha + \beta \times \Delta Result_{ct} + \Gamma Z_{ct} + \gamma_{my} + \delta_a + \delta_w + \epsilon_{ct}$. CCC_{ct} is the CCC share, ΔCCC_{ct+1} is the change in the CCC share in the subsequent period, ΔCCC_{ct} is the change in the CCC share in the current period, *Result* denotes the covenant result, Z contains all control variables, including size, performance, and age, ϵ is the error, c denotes CLO, t denotes the month-year pair, m denotes CLO manager, *year* denotes the year, a denotes the arranger, and w denotes the trustee. The columns denote different test restrictions; Weighted Average Spread covenant, Weighted Average Life covenant, Interest Diversion covenant, Junior IC covenant, Junior OC covenant, Senior IC covenant, and Senior OC covenant (Column 1-7, respectively).

Table A.4.4: Leave-one-out Junior IC ratio

	Manager-level				CLO-level			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Risky share	Δ Risky	Default Share	CCC Share	Risky Share	Δ Risky	Default Share	CCC Share
Junior IC Test	-0.5537***	-0.5848***	-0.5897***	-0.2319	-0.3823**	-0.3282**	-0.2741***	-0.2816**
	(0.1838)	(0.1184)	(0.1174)	(0.1611)	(0.1685)	(0.1481)	(0.0992)	(0.1399)
Size Control	✓	✓	✓	✓	✓	✓	✓	✓
Performance Control	✓	✓	✓	✓	✓	✓	✓	✓
Age Control	✓	✓	✓	✓	✓	✓	✓	✓
CLO-Year FE	No	No	No	No	Yes	Yes	Yes	Yes
Manager-Year FE	Yes	Yes	Yes	Yes	No	No	No	No
Arranger FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Trustee FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	978,914	843,738	978,914	983,756	978,913	843,738	978,913	983,755
R^2	0.7237	0.5101	0.3055	0.6838	0.9018	0.7460	0.5740	0.8703

Standard errors in parentheses, and double clustered at the Manager Month-Year Level

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

Notes: This table presents the results from the "leave-one-out" methodology. I iterate through each firm and recompute the Junior IC ratio in the absence of that particular firm. The baseline regression specification (Column 1-4) is as follows: $Y_{ct} = \alpha + \beta \times Result_{ct} + \Gamma Z_{ct} + \gamma_{my} + \delta_a + \delta_w + \epsilon_{ct}$ where Y is the outcome variable: risky change (Columns 1, 5), change in risky share in the subsequent period (Columns 2, 6), default share (Columns 3, 7), CCC share (Columns 4, 8), $Result$ is the Junior IC covenant result, Z contains CLO controls including size, performance, and age, ϵ is the error, c denotes CLO, t denotes month-year pair, y denotes year, m denotes manager, a denotes arranger, and w denotes trustee. In Column 5-8, a CLO-year FE (γ_{cy}) is included in lieu of the manager-year (γ_{my}) fixed effect.

A.5 Alternative Mechanisms

A.5.1 Private Information

I assess whether managerial trades reflect new information on the financial performance of the issuer, using indirect and direct methods.

The results from Section 3.5 suggest that private information is not the main driver of preemptive sales. If distressed trades of CLOs reflect private information, large sales will lead to a downward, permanent adjustment of prices. Evidence of reversal is inconsistent with this information hypothesis and lends credence to the price pressure hypothesis, previously described. Moreover, the results from Appendix A.3, suggest that managerial consideration of private information is limited. Despite the potential for information exchange within private equity firms that are affiliated with CLO managers, it does not appear that managers affiliated with PE firms behave any differently from managers who are not, refuting presuppositions of greater sophistication (Figures A.3.10, A.3.9). Additionally, tests of the *superior information hypothesis* show that managers do not exhibit greater proclivity to hold onto "winners" who emerge from bankruptcy (Figure A.3.11). Thus, selling decisions do not appear tethered to information on firm fundamentals. Further, if trades are made based on private information, managers may attempt to reduce how conspicuous their trades are to recover the highest value. However, evidence of this is scant (Figure A.3.13). Anecdotally, a CLO manager confirmed that managers do not solicit private information on firms. They are attuned to firms' quarterly calls and assess the health of firms based on public reports. Because these reports are backwards-looking, and promulgated widely, markets react instantaneously. Thus, private information does not appear to be a driver of preemptive sales.

As an additional test of private information, I study whether there are spillovers from the loan market to other financial markets, upon revealing information through systematized trades, à la Ivashina and Sun (2011*b*). In particular, I apply an event study framework to analyze whether large sales (above the 95^{th} or 99^{th} percentile of all sales) are associated with subsequent negative, abnormal returns in the stock market. If abnormal returns after a large sale are negative, statistically significant, and persistent, it could indicate that CLO managerial sales provide a meaningful signal to other institutional players about the quality of the underlying loans. Moreover, it may also suggest that information propagates from active managers in the loan market to other participants in the stock market.

In the event study framework, I focus on large sales by CLO managers. I define an event by the issuer-date pair in one of two ways: either the size of an *individual* transaction is located in the tail of the distribution of all transaction sizes, or, the daily transaction volume of an issuer's loans is located in the tail of the distribution of all daily issuer volumes. The tail of the distribution is defined above the 95^{th} and 99^{th} percentiles. I use both the market-adjusted and Fama-French three factor model to study abnormal returns. Depending on the threshold and the specific definition of an event, the number of events ranges from 146 to 1,724. Across the specifications, the results do not substantively change. I do not find any evidence of cumulative abnormal returns. I report the most conservative results, using the Fama-French three factor model with a cutoff at the 99^{th} percentile in Figures A.5.2 and A.5.3. These figures do not exhibit any marked change around the sale date, nor, is there downward persistence in the return. Hence, I rule out that private information drives these trades.

Figure A.5.1: Cumulative Abnormal Stock Returns around Large Sale Events

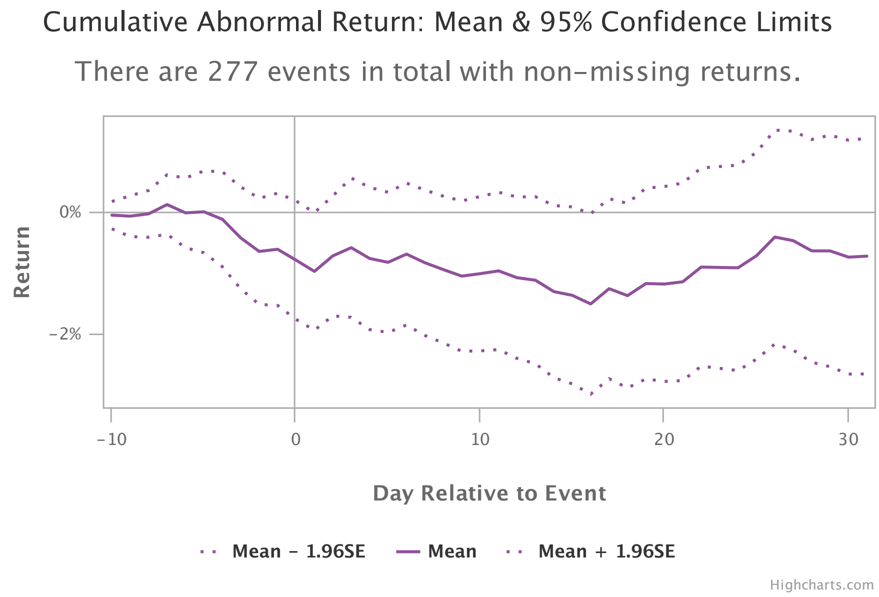


Figure A.5.2: Individual Transactions

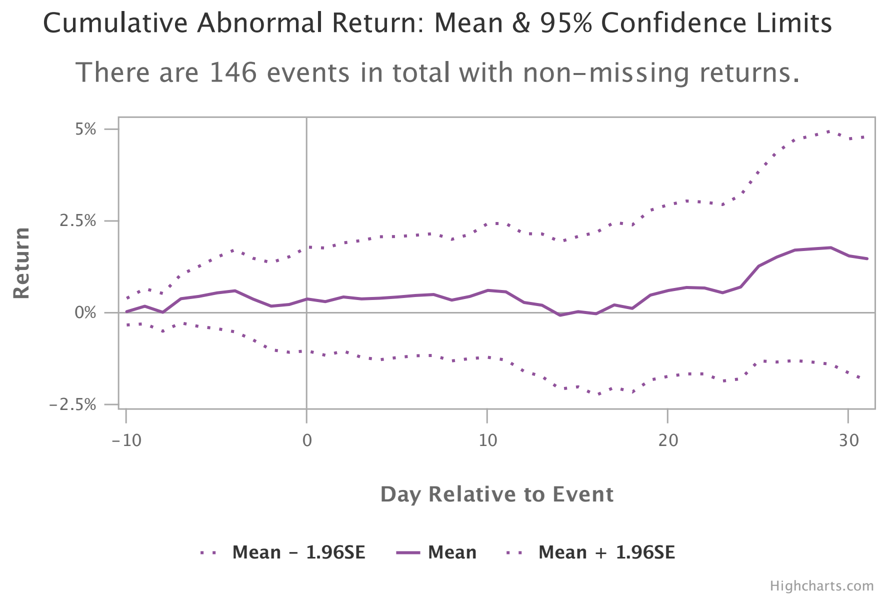


Figure A.5.3: Daily Issuer Transactions

Notes: The top figure shows the cumulative abnormal stock returns around large sale events, which is defined by an issuer-date pair, signifying that the transaction size of an issuer's loans on a given date exceeded the $>=99^{th}$ percentile of all sales across the sample period. The bottom figure shows the cumulative abnormal stock returns around large sale events, which is defined by an issuer-date pair, signifying that that the total volume of an issuer's loans on a given date exceeded the $>=99^{th}$ percentile of all daily volumes across all issuers in the sample period. The estimation window is 30 days, minimum number of valid returns is 70 days, gap is 50 days, the event window start date is 10 days before the sale, and the event window end date is 30 days after the sale.

A.5.2 Reputational concerns

A potential determinant of preemptive sales is reputational concerns. Reputational concerns may be entwined with the design of loss-averse covenants; when covenants are triggered and CLOs begin paying down liabilities, investors may lose confidence in the ability of the manager to perform. Distinct from this, I consider how reputational concerns may directly cause CLO managers to prematurely divest of risky loans as a way to signal adeptness in marketing and advertising to potential investors. In other words, investors care about default, but not recovery; "It's almost axiomatic in our market that every CLO manager's pitch book has a page showing how they outperformed the broad loan market, either on a total return basis, or on a default / loss basis" (Ashton (2019)).

Consider the following microcosm: CLOs operate in a two period world and hold a single loan with initial value v_0 at $t = 0$. Suppose that news is released right before $t = 1$ that the loan will experience default and have a recovery value of v_2 at $t = 2$. If investors know with considerable certainty that the firm will recover, given past evidence of the high incidence of recoveries, under rational expectations, the value of the loan today, v_1 should equal the recovery value at $t = 2$, v_2.[5] If the CLO attempts to sell the loan at $t = 1$, they will receive a price of v_2. Hence, investors should be indifferent between the manager selling at $t = 1$ or holding the loan until $t = 2$. The results from Appendix A.3, coupled with the price patterns from Section 3.5, suggest that $v_1 \neq v_2$. This may be explained if rational expectations do not hold.

In Figure A.5.4, I examine how the CLO default rate is related to the subsequent initial deal size of a CLO for a given manager. The top left figure indicates that over time, managers administer CLOs of larger sizes. Additionally, the percent of defaulted loans decreases over time (top right). This may suggest that managers become more skilled with time or learning on the job. In the table underlying the figure, I codify these relations and find that they are statistically significant. Additionally, I relate the percent of a manager's defaulted loans to the manager's subsequent initial deal sizes. If the percent of defaulted loans experiences an increase of 1%, the subsequent deal size is expected to decline by 0.5-1.4%.

Hence, reputational concerns may potentially influence managerial trading decisions.

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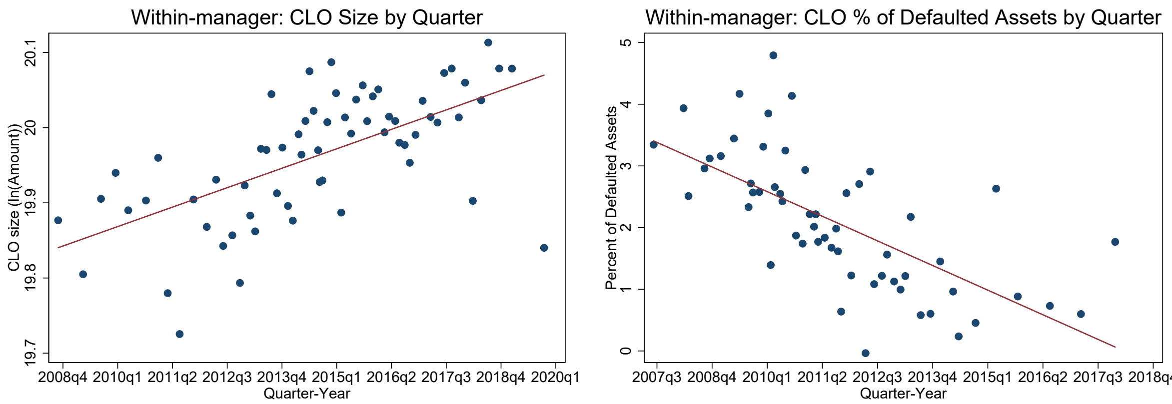
5. The argument hinges on the assumption that the cost and effort of the restructuring process is zero, i.e., the investor is a "freeloader."

Figure A.5.4: CLO Default Rate and Subsequent Size



	(1) $\ln(\text{Amount})_t$	(2) Defaulted Share_t	(3) $\ln(\text{Amount})_{t+1}$	(4) $\ln(\text{Amount})_{t+1}$	(5) $\ln(\text{Amount})_{t+1}$
Quarter-Year Trend	0.0052***	-0.0798***			
	(0.0015)	(0.0215)			
Defaulted Share			-0.0142*	-0.0060**	-0.0055*
			(0.0069)	(0.0022)	(0.0030)
CCC Share					-0.0036
					(0.0047)
Manager FE	✓	✓	✓	✓	✓
Year FE				✓	✓
N	1,634	453	413	413	406
R^2	0.2724	0.4747	0.2353	0.2937	0.2982

Standard errors in parentheses

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

Notes: The left figure shows the relation between the initial CLO deal size and time trend for a given manager. The right figure shows the relation between the percent of defaulted loans and time trend. The table codifies these relations through regressions in Columns 1-2. In Columns 3-5, the percent of a CLO's defaulted loans is related to the manager's subsequent initial CLO deal size. Manager fixed effects are included in Columns 1-5, and year fixed effects in Columns 4-5.

A.5.3 Bankruptcy

Lastly, I consider whether managers may experience pressure to preemptively sell distressed loans in consideration of bankruptcy defaults. There are several reasons for this including the inability to maneuver bankruptcy, ex-ante, and, alterations to the original claim, ex-post. While these bankruptcy-specific concerns can compound the effect of a fire sale on distressed loans, they do not appear to be *primary* factors that drive preemptive selling in the first place.

Bankruptcy is not of cardinal consideration to managers in preemptively selling distressed loans. The trading patterns surrounding other adverse credit events including missed interest and principal payments are examined in Appendix A.3. It is found that a similar quadratic pattern fits the trading pattern of these loans (Figures A.3.18 and A.3.21). This suggests that managerial trading behavior around defaults is not unique to bankruptcies nor motivated by bankruptcy-specific concerns, i.e., negotiation and restructuring.[6]

Furthermore, while managers may be concerned by the imminent and associated risks of bankruptcies, the risks often materialize along quality concentration, capital and liquidity dimensions per covenant restrictions. In other words, default is consequential to a manager, insofar, as it tangibly affects the manager's ability to supervise a CLO – the composition and cash flow of a CLO's loans, confidence of investors, and, by extension, its performance. These elements are best captured by the covenant restrictions, and in particular, the capital constraints which effectively penalize CLOs for holding distressed loans through mark-to-market accounting. Thus, the indenture a manager is bound by and the covenants therein provide a measurable framework for assessing proximate considerations of managers. This is not to say that bankruptcy plays no role in influencing managerial trading decisions. The prospect of bankruptcy default may *magnify* the quantity and price effects relative to other adverse credit events, as evinced by a comparison of selling patterns around bankruptcy default events and other adverse credit events. There are two concrete bankruptcy-specific reasons why a CLO manager may be reluctant to hold onto a distressed loan through bankruptcy default.

An ex-ante concern may be that the restructuring process can be convoluted, protracted, and require unflagging attention and active participation in deliberations with other investors who hold stake. If managers lack the sophistication to maneuver the bankruptcy process, they may preemptively sell, ceding power to more sophisticated participants who posses the capacity to arbitrate the bankruptcy process. Given the large percentage of firms emerging from bankruptcy, this conjecture is plausible. However, the counterfactual cannot be assessed – if CLO managers were to hold onto their claims, would the number of firms that emerge from bankruptcy be the same?

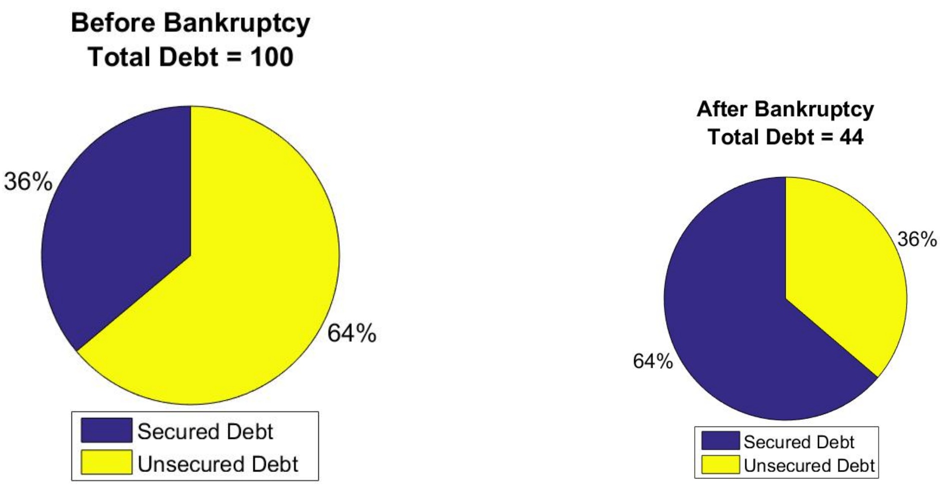
In addition to the ex-ante concern, managers may also fear that debt restructuring could result in unfavorable outcomes for leveraged loan investors, ex-post. Restructuring often results in the introduction of super-senior claims through debtor-in-possession financing and new pari-passu debt, which may dilute the value of the original senior secured loans. Ivashina and Vallee (2019) provides specific evidence of this behavior through a case-study of J.Crew in 2016. In 2016, J.Crew exploited a weak credit covenant to move loans from a restricted subsidiary to an unrestricted

6. If it were, there would be a downward, permanent adjustment after other adverse credit events – not reversion.

subsidiary, allowing J.Crew to secure new debt, while diluting the existing claims of senior secured creditors. In sample, I show that restructuring of defaulted portfolio firms leads to the fortification of the capital structure, as shown in Figures A.5.5 and A.5.6, and discussed in Section 3.5. This may occur through debt-equity swap arrangements and write-offs. Debt-equity swap arrangements are unfavorable to CLOs. As CLOs are cash flow based enterprises, holding equity can have material pernicious effects to noteholders. As cash flow dwindles, the likelihood of triggering covenants increases. Covenant breaches materialize as loss when proceeds used for junior management fees and equity distributions are diverted towards paying down liabilities or the purchase of high-quality loans (See section 3 of Kundu (2021*a*)). Thus, CLO managers may be disincentivized from holding onto distressed claims through bankruptcy. Moreover, many CLO managers may be explicitly prohibited from participating in the restructuring process or providing workouts.[7]

Hence, the prospect of bankruptcy cannot in and of itself affect CLO trading behavior, as the selling patterns are evident for other adverse credit events as well. However, bankruptcy-specific concerns can magnify the trading effects.

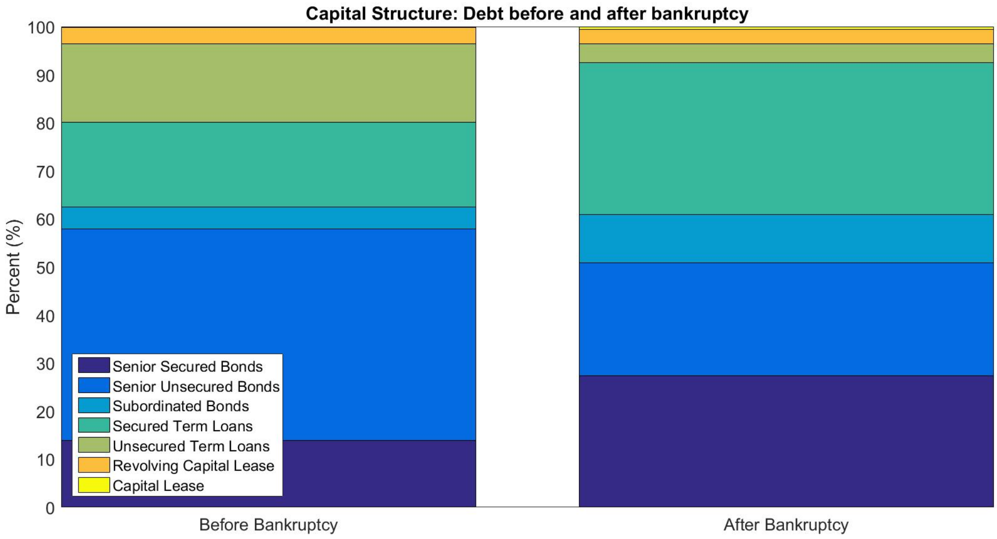
Figure A.5.5: Total Debt: A breakdown



Notes: The figure presents the change in total amount of debt before (left figure) and after (right figure) bankruptcy, and the share of secured and unsecured debt for distressed issuers in the sample. "Before" bankruptcy is defined 6-18 months before the bankruptcy date. "After" bankruptcy is defined as 6-18 months after the bankruptcy date. The share of secured debt is represented in blue. The share of unsecured debt is represented in yellow. The total amount of debt before bankruptcy is normalized to be 100.

7. See articles Cioffi (2020) and Haunss (2020).

Figure A.5.6: Debt Structure



Notes: The figure presents the debt structure before (left figure) and after (right figure) bankruptcy. "Before" bankruptcy is defined 6-18 months before the bankruptcy date. "After" bankruptcy is defined as 6-18 months after the bankruptcy date. The figures show the relative composition of debt before and after bankruptcy. From top to bottom, the figure shows the amount of capital lease, revolving capital lease, unsecured term loans, secured term loans, subordinated bonds, senior unsecured bonds, and senior secured bonds.

A.6 Model

In the model, I develop a framework that captures the problem of CLO managers, integrating modeling techniques from Vayanos and Vila (2019) and Bolton, Chen and Wang (2011). The model has three main objectives. First, I explain the origin of covenants, referring to DeMarzo (2005). Second, I show that covenants can generate price pressure and trigger fire sales in the leveraged loan market. Lastly, I connect price pressure of loans to the affected issuers' default policy.

A.6.1 Model in a nutshell

I begin by referring to the model of DeMarzo (2005) to explain the origin of covenants. It has been shown that intermediaries can raise additional capital when securitization is possible. However, I argue that covenants are necessary to ensure that senior claims are managed appropriately and carry little risk, while the CLO is in operation – not just at conception. The presence of covenants allows the intermediary to raise additional capital (Predictions 1, 2, 3). Moreover, CLO-specific covenants make CLO managers preferred-habitat investors, subject to unique demand shocks – in contrast to risk-averse arbitrageurs, per Vayanos and Vila (2019). If preferred-habitat investors experience shocks that alter their demand, the shocks will transmit to asset prices via a market clearing condition (Predictions 4, 5). Further, by assuming that banks are pass-through intermediaries, and, that CLO managers do not differentiate between primary and secondary issuance, I show that the endogenous spread can affect issuing firms' optimal investment and financing decisions using the set-up of Bolton, Chen and Wang (2011), in which the firm's optimal policy is contingent on a "double-barrier policy" using the firm's cash-capital ratio. Experiencing pressure price can affect an issuer's default policy, and the decision to file for bankruptcy (Prediction 6).

A.6.2 Description of the Model

A.6.3 Origin of covenants

It has been shown that the size of an informed intermediary (CLO) will be larger when pooling and tranching of securities is possible than when assets are sold as purchased – the amount of cash that is raised increases in the quality of the asset pool. DeMarzo (2005) shows that with pooling and tranching, when residual risk is fully diversifiable, senior tranches are virtually riskless, making them attractive investments. However, in the absence of supervision over the life of a securitization, I posit that there may be deterioration in the quality of the asset pool and risk may no longer be diversifiable post-acquisition.[8] Hence, supervisory-linked covenants provide a mechanism of ensuring that after acquisition, senior tranches remain riskless. There are two key insights I extrapolate to the CLO setting from DeMarzo (2005). First, the intermediary

8. Managers may also deliberately risk-shift. Given that managers are residual claimants of the equity tranche, it is in their personal interest to maximize the equity value. In this case, the intermediary may risk-shift. To investors, trades according to effort provision and assessing critical values is indistinguishable from risk-shifting trades. Hence, with risk-shifting trades, the assumption that residual risk is fully diversifiable may not be plausible even in large pools, and, consequently, the issued debt tranches may not be risk-free. More details of this are provided in Kundu (2021*a*).

can raise more capital by pooling and tranching than outright reselling of the assets. Second, the presence of covenants allow the intermediary to raise additional capital by mitigating agency frictions (1, 2).

Covenants provide a mechanism for ensuring that the associated portfolio satisfies quality and coverage restrictions. Covenants are associated with triggers to supervisory actions and thresholds, thereby ensuring that managers appropriately manage risk with options for recourse. With many covenants, a consequence of triggering a threshold is early amortization. This can accelerate repayment to investors, cut off manager fees and equity distribution, and hurt the reputation of the CLO manager. The presence of these covenants can also provide investors with protection from prolonged exposure to a risky pool of assets[9]. Covenants are significant in facilitating the provision of credit. In the absence of covenants, if defaults are realized and senior tranches bear losses, demand for the putative riskless tranches will shrink, reducing the aggregate amount of credit extended by the intermediary. The presence of covenants ensure that senior claims are virtually riskless, thereby, allowing the intermediary to raise more capital.

These covenants are an important component of the investors' problem, described below. Covenants are supervisory instruments unique to the liability structure of CLOs. Given these features, CLOs behave as *preferred-habitat* investors with demand for leveraged loans of specific characteristics, as stipulated by the covenants they are bound by – unlike the arbitrageurs which are other prospective purchasers of leveraged loans.

A.6.4 Investors' Problem

Suppose that are two types of agents in an economy, preferred-habitat investors (CLOs) and arbitrageurs (e.g., hedge funds, pension funds, etc.). Preferred-habitat investors are investors with very limited risk-taking capacity. They have demand for leveraged loans of specific characteristics. In this model, *Safe* captures the quality of the loan. In this model, how safe a loan is, is denoted by s. Arbitrageurs, on the other hand, are risk-averse mean-variance optimizers in the economy who are relatively unconstrained and have greater risk-taking capacity in comparison to preferred-habitat investors. r_t denotes an exogenous short rate in an economy.

The wealth position of an arbitrageur at time t is denoted by W_t. The dollar position of an arbitrageur in a representative leveraged loan of safety s is $X_t^s ds$ where $s \in (0, S)$. The budget constraint of an arbitrageur is:

$$dW_t = (W_t - \int_0^S X_t^s ds) r_t dt + \int_0^S X_t^s \frac{dP_t^s}{P_t^s} \tag{A.6.1}$$

where P represents the price of the leveraged loan

9. Covenant restrictions are a general equilibrium outcome that is determined jointly by CLOs and investors. Covenants are imposed ex-ante by investors, and may partially reflect their own risk-taking capacity. In the absence of any covenant that forces divestiture, a manager may hold onto risky loans, increasing the total amount of risk-based capital, lowering banks' capital ratios under Section 939A of Dodd-Frank and Basel regulatory frameworks, as discussed in Sections 4.2-4.4 of Kundu (2021*a*). If banks are pushed closer to their capital constraints, it may have pernicious effects on loan origination and securitization, and by extension, credit in the economy. Hence, this provides another explanation for how covenants serve to protect investors and their claims.

Arbitrageurs' optimization problem maximizes a mean-variance objective over dW_t:

$$\max_{\{X_t^s\}_{s\in(0,\infty)}} [\mathbb{E}_t(dW_t) - \frac{a}{2}Var(dW_t)] \tag{A.6.2}$$

where $a \geq 0$ is the risk-aversion coefficient.

Preferred-habitat investors have demand of the following form:

$$Z_t^s = -\alpha(s)\log(P_t^s) - \beta_t^s \tag{A.6.3}$$

where $\alpha(s) \geq 0$ is dependent on the safety of the loan, but time-invariant and represents the *demand slope*. β_t^s is time-varying and represents the *demand intercept*. The demand intercept is defined as follows:

$$\beta_t^s = \theta_0(s) + \sum_{k=1}^{K} \theta_k(s)\beta_{k,t} \tag{A.6.4}$$

where $\{\beta_{k,t}\}_{k=1,...,K}$ are time-varying demand risk factors that preferred-habitat investors care about. Note that $\{\beta_{k,t}\}_{k=1,...,K}$ is independent of s. $\{\theta_k(s)\}_{k=1,...,K}$ are functions that specify the safety levels from which demand changes originate.

Covenants limit the actions CLO managers can take, ensure appropriate supervision, and stipulate actions in event of triggers. The covenants directly affect demand risk-factors $\{\beta_{k,t}\}_{k=1,...,K}$, which in turn, affect managers' demand and capacity to take on riskier loans, and may induce price pressure. Each covenant is intended to capture a different dimension of risk in a CLO's portfolio. Hence, this is modeled as K demand risk-factors.

Let $q_t \equiv (r_t, \beta_{1,t}, \ldots, \beta_{K,t})$, a K+1 vector that evolves as follows:

$$dq_t = -\Gamma(q_t - \bar{r}\mathbb{E})dt + \Sigma dB_t \tag{A.6.5}$$

where $\bar{r}$ is a constant, $\mathbb{E} = [1, 0, 0, \ldots, 0]^T$, and (Γ, Σ) are constant square matrices of dimension $K+1 \times K+1$. dB_t is the K+1 vector consisting of independent Brownian motions, i.e., $B_t = (dB_{r,t}, dB_{\beta,1,t}, \ldots, dB_{\beta,K,t})^T$. Note that if Σ and Γ are non-diagonal, shocks to factors are correlated, and the the expected change in instantaneous drift of each factor depends on other factors.

A.6.4.1 Equilibrium

Following Vayanos and Vila (2019)'s conjecture that there exists K+2 functions

$$(A_r(s), \{A_{\beta,k}(s)\}, C(s)),$$

the price of a loan of safety s can be written as:

$$P_t^s = e^{-[A(s)^T q_t + C(s)]} \tag{A.6.6}$$

where $A(s)$ is a vector of dimension K+1, i.e., $(A_r(s), A_{\beta,1}(s), \ldots, A_{\beta,K}(s))^T$, and $A_r(s)$ is the risk factor associated with the short rate, r_t The dynamics of the price process is given by Ito's Lemma and Equation A.6.5:

$$\frac{dP_t}{P_t} = \mu_t dt - A^t \Sigma dB_t \tag{A.6.7}$$

where the instantaneous expected return, μ_t takes the following form:

$$\mu_t^s = A'(s)^T q_t + C'(s) + A(s)^T \Gamma(q_t - \bar{r}\mathbb{E}) + \frac{1}{2} A(s)^T \Sigma\Sigma^T A(s) \tag{A.6.8}$$

By substituting the price dynamics into Equation A.6.1, the arbitrageurs' optimization problem in Equation A.6.2 can be written as follows:

$$\max_{\{X_t^s\}_{s\in(0,\infty)}} \left\{ \int_0^\infty X_t^s(\mu_t^s - r_t)ds - \frac{a}{2}\Big[\int_0^\infty X_t^s A(s) ds\Big]^T \Sigma\Sigma^T \Big[\int_0^\infty X_t^s A(s) ds\Big] \right\} \tag{A.6.9}$$

The FOC with respect to X_t is:

$$\mu_t^s - r_t = aA(s)^T \Sigma\Sigma^T \Big[\int_0^\infty X_t^s A(s) ds\Big] \tag{A.6.10}$$

The LHS represents the increase in portfolio expected return if the arbitrageurs invest an additional dollar in the leveraged loan with safety s over investing at the short rate. The RHS represents the increase in portfolio risk, adjusted for risk-aversion a. This can equivalently be written as:

$$\mu_t^s - r_t = aA(s)^T \lambda_t \tag{A.6.11}$$

where λ_t represents factor prices, $\lambda_t = \Sigma\Sigma^T \Big[\int_0^\infty X_t^s A(s) ds\Big]$. Given that there are only two types of agents in the economy, for the market to clear, the position of arbitrageurs and preferred-habitat investors in the leveraged loan with safety s must be 0.

$$X_t^s + Z_t^s = 0 \tag{A.6.12}$$

Hence, by the market clearing condition, and Equations A.6.3 and A.6.6,

$$\lambda_t = (-\alpha(s)(A(s)^T q_t + C(s)) + \theta_0(s) + \Theta(s) q_t) A(s) ds\Big] \tag{A.6.13}$$

where Θ is a vector of dimension K+1, i.e., $(0, \theta_1(s), \ldots, \theta_K(s))$.

Substitution of the expressions for μ_t^s and λ_t from Equations A.6.8 and A.6.13 into A.6.11 yields the following price condition

$$A'(s)^T q_t + C'(s) + A(s)^T \Gamma(q_t - \bar{r}\mathbb{E}) + \frac{1}{2} A(s)^T \Sigma\Sigma^T A(s) - r_t \tag{A.6.14}$$

$$= aA(s)^T \Sigma\Sigma^T \Big[\int_0^\infty (\theta_0(s) + \Theta(s) q_t - \alpha(s)(A(s)^T q_t + C(s))) A(s) ds\Big] \tag{A.6.15}$$

Let P^* denote the equilibrium price from.

A.6.5 Firm's Problem

In this section, I describe the firm's optimal value-capital ratio, optimal dynamic investment and financing policies using the framework of Bolton, Chen and Wang (2011).

The firm uses physical capital for production. The price of capital is unity. Let K and I denote the level of capital stock and gross investment respectively.

Capital stock follows a dynamic process:

$$dK_t = (I_t - \delta K_t)dt. \tag{A.6.16}$$

where δ is the rate of depreciation. A firm's operating revenue at time t is given by $K_t dA_t$ where dA_t is a risk-adjusted productivity shock that evolves according to:

$$dA_t = \mu_A dt + \sigma_A dZ_t. \tag{A.6.17}$$

The firm's cash flow from operations over time increment dt evolves according to:

$$dY_t = K_t dA_t - I_t dt - G(I_t, K_t)dt. \tag{A.6.18}$$

$G(I_t, K_t)$ denotes the firm's adjustment cost incurred during investment. $G(I_t, K_t)$ is homogenous of degree 1 in I and K, so that $G(I, K) = g(i)K$ where $g(i)$ is a convex and increasing function in i. the firm's investment capital ratio, $i = \frac{I}{K}$. For simplicity, the following functional form is adopted:

$$g(i) = \frac{\theta i^2}{2}. \tag{A.6.19}$$

where θ is the degree of the adjustment cost.

It is assumed that a firm's investment opportunities are constant across time. This allows the model to highlight the dynamic implications of financing frictions in the absence of any changes in the investment opportunity set.

Let H_t denote the firm's cumulative external financing until time t, dH_t – the firm's incremental external financing over time increment dt, X_t – the cumulative cost of external financing up to time t, and dX_t – the incremental cost of raising incremental external funds H_t.

Let W_t denote a firm's cash inventory at time t. If $W_t > 0$, the probability of the firm's survival is 1. If $W = 0$, the firm will either have to raise external funds to continue operating, i.e., pay financing costs, or, file for bankruptcy if financing costs are too high. τ denotes the firm's bankruptcy time. If $\tau = \infty$, the firm will never file for bankruptcy.

In addition to the risk-free rate, r, assume that there is a carry cost γ, which captures agency costs or tax distortions associated with free cash in the firm. Assume that both the risk-free and carry cost are time invariant. $\gamma > 0$ is needed for the firm to pay out cash, otherwise the firm will keep cash in the firm, incurring no costs, while generating slack in the financial constraints. A positive carry cost implies that shareholders can invest at rate r which is higher than the net rate of return $(r - \gamma)$. The payout of cash reduces the firm's cash balance, and exposes the firm to current and future underinvestment as well as future external financing costs. If there are positive costs associated with raising external funds, the firm can reduce future costs by retaining earnings to finance future investments. This generates a tradeoff.

Let U_t denote the firm's cumulative payout to shareholders up until time t, and dU_t – the incremental payout over time interval dt. Then, the firm's cash inventory will evolve according to the following process:

$$dW_t = dY_t + (r - \gamma)W_t dt + dH_t - dU_t. \tag{A.6.20}$$

In words, the incremental change in cash flow is equal to the sum of cash flow from operations, net interest income over time interval dt, and the net cash flow from financing.

A.6.5.1 Firm's Optimization Problem

$$\max_{I,U,H,\tau} E\Big[\int_0^{\tau} e^{-rt}(dU_t - dH_t - dX_t) + e^{-r\tau}(bK_t + W_t)\Big] \tag{A.6.21}$$

where b denotes the value of the firm if the firm files for Chapter 11 bankruptcy.

Let $P(K, W)$ denote the firm value. The firm's maximization problem in the interior region of W where $dU_t = 0$, $dH_t = 0$, and $dX_t = 0$ is:

$$rP(K,W) = \max_I \Big\{(I - \delta K)P_K + [(r-\gamma)W + \mu_A K - I - G(I,K)]P_W + \frac{\sigma_A^2 K^2}{2} P_{WW}. \tag{A.6.22}$$

The two-state optimization problem can be reduced to a one-state problem in ω where $\omega = \frac{W}{K}$, the cash-capital ratio. By exploiting homogeneity of degree 1, and substituting partial derivatives for Equation A.6.22, the following ODE can be obtained.

$$rp(\omega) = (i(\omega) - \delta)(p(\omega) - \omega p'(\omega)) + ((r-\gamma)\omega + \mu_A - i(\omega) - g(i(\omega)))p'(\omega) + \frac{\sigma_A^2}{2}p''(\omega)$$

A.6.5.2 Firm is financially constrained

If the firm's cash-capital ratio, ω, is below a threshold $\underline{\omega}$, the firm will incur financing costs to raise new funds or file for bankruptcy.

In the absence of any financing costs, in a Modigliani-Miller world, the firm will not want to prematurely file for bankruptcy as production is efficient and cash can be stored internally without bearing any cost while loosening financial constraints. With financing costs, as internal cash earns below-market return, there is value to externally financing.

Next, I will define $\underline{\omega}$. Investment is smooth because of convex adjustment costs, hence, the firm can pay for any level of investment as long as $\omega > 0$. For this reason, it is always better to defer external financing as long as possible. Therefore, a firm will always prefer using cash and then seeking external options only when cash runs out. Hence, the optimal bankruptcy boundary is $\underline{\omega} = 0$

The firm value upon filing for bankruptcy is:

$$p(0)K = bK \Rightarrow p(0) = b. \tag{A.6.23}$$

To raise external financing, there is a fixed issuance cost S, and variable cost $s(P^*)$. The variable cost $s(P^*)$ is the spread associated with each loan – an inverse function of the price of the loan.

Because firm value is continuous pre and post obtaining external financing, the following condition must hold at the boundary:

$$\max_{m} p(0) = p(m) - S - (1 + s(P^*)). \quad \text{(A.6.24)}$$

m is optimally chosen, so that the last dollar raised is equivalent to the marginal cost of external financing, i.e.,

$$p'(m^*) = 1 + s(P^*) \quad \text{(A.6.25)}$$

When $\omega = 0$, the firm's value is:

$$V = \max\Big\{bK, (p(m^*) - S - (1 + s(P^*))m^*)K\Big\}. \quad \text{(A.6.26)}$$

The firm will decide to either seek external financing or file for bankruptcy to maximize the value of the firm.

$$Decision = \begin{cases} \text{Externally finance if } V = (p(m^*) - S - (1 + s(P^*))m^*)K \\ \text{File for bankruptcy if } V = bK \end{cases} \quad \text{(A.6.27)}$$

Coupling this with our results from the investors' problem, I now consider the dynamic implications of this.

A.6.6 Dynamic Implications

Consider the following sequence of events. The price of a representative loan issued by a firm is P^*. The issuer misses an interest payment on the loan and is in distress. The CLO manager who is holding on to the loan will be closer to her covenant constraints Given this shock to the CLO manager, who has limited risk-taking capacity, her demand for the affected loans will decrease, if the shock is significant. Consequently, the price of a firm's debt will fall from P^* to P^{**}, and the corresponding spread will increase, i.e., $s(P^{**}) > s(P^*)$. The CLO manager's trading actions occur in the secondary market, and financing occurs in the primary market. The CLO manager, however, is a large, active purchaser in both markets and therefore has undifferentiated demand between an issuer's primary and secondary issuance. Suppose the firm was an ex-ante marginal firm, indifferent between filing for bankruptcy and raising external financing. That is,

$$p(m^*) - S - (1 + s(P^*))m^*)K = bK. \quad \text{(A.6.28)}$$

A marginal firm indifferent between seeking external financing and filing for bankruptcy will file for bankruptcy if the spread increases.

Proof. Let m^{**} represent the optimal amount of external financing per Equation A.6.24. The value of the firm if the firm seeks external financing is given by Equation A.6.27. For the firm to file for bankruptcy, the following inequality must be satisfied:

$$p(m^{**}) - S - (1 + s(p^{**}))m^{**})K <= p(m^*) - S - (1 + s(P^*))m^*)K. \quad \text{(A.6.29)}$$

According to Equation A.6.25,

$$p'(m^*) =< p'(m^{**}). \tag{A.6.30}$$

By concavity, $m^{**} < m^*$

The line tangent to the point $p(m^*)$, $p^T(m)$ for any m is of the form:

$$p^T(m) = p(m^*) + p'(m^*)(m - m^*) \tag{A.6.31}$$

Because $m^{**} < m^*$ and $p(m)$ is a concave function, the following holds:

$$p(m^{**}) <= p(m^*) + p'(m^*)(m^{**} - m^*) \tag{A.6.32}$$

$$p(m^{**}) - p(m^*) <= p'(m^*)m^{**} - p'(m^*)m^*). \tag{A.6.33}$$

Appealing to Equation A.6.30, and substituting for the marginal cost of financing from Equation A.6.25 yields:

$$p(m^{**}) - p(m^*) <= p'(m^{**})m^{**} - p'(m^*)m^*) \tag{A.6.34}$$

$$p(m^{**}) - S - (1 + s(p^{**}))m^{**})K <= p(m^*) - S - (1 + s(P^*))m^*)K. \tag{A.6.35}$$

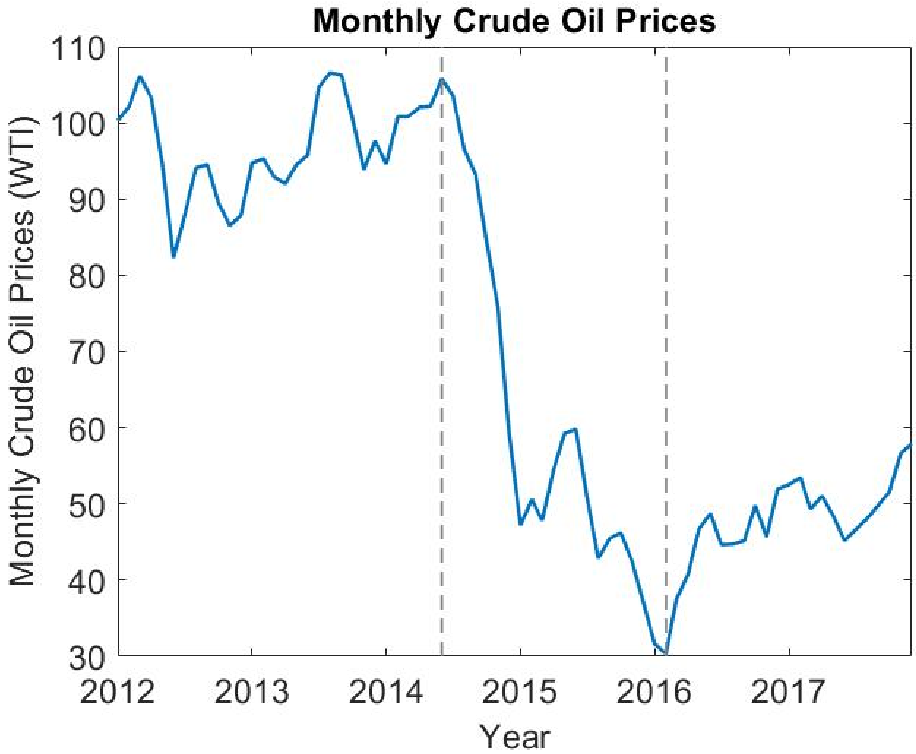
If there is price pressure in the secondary loan market due to unanticipated demand shocks experienced by CLO managers, the spread will increase. This will induce marginal firms to file for bankruptcy.

APPENDIX B
APPENDIX FOR CHAPTER 4: THE EXTERNALITIES OF FIRE SALES: EVIDENCE FROM COLLATERALIZED LOAN OBLIGATIONS

B.1 Figures and Tables

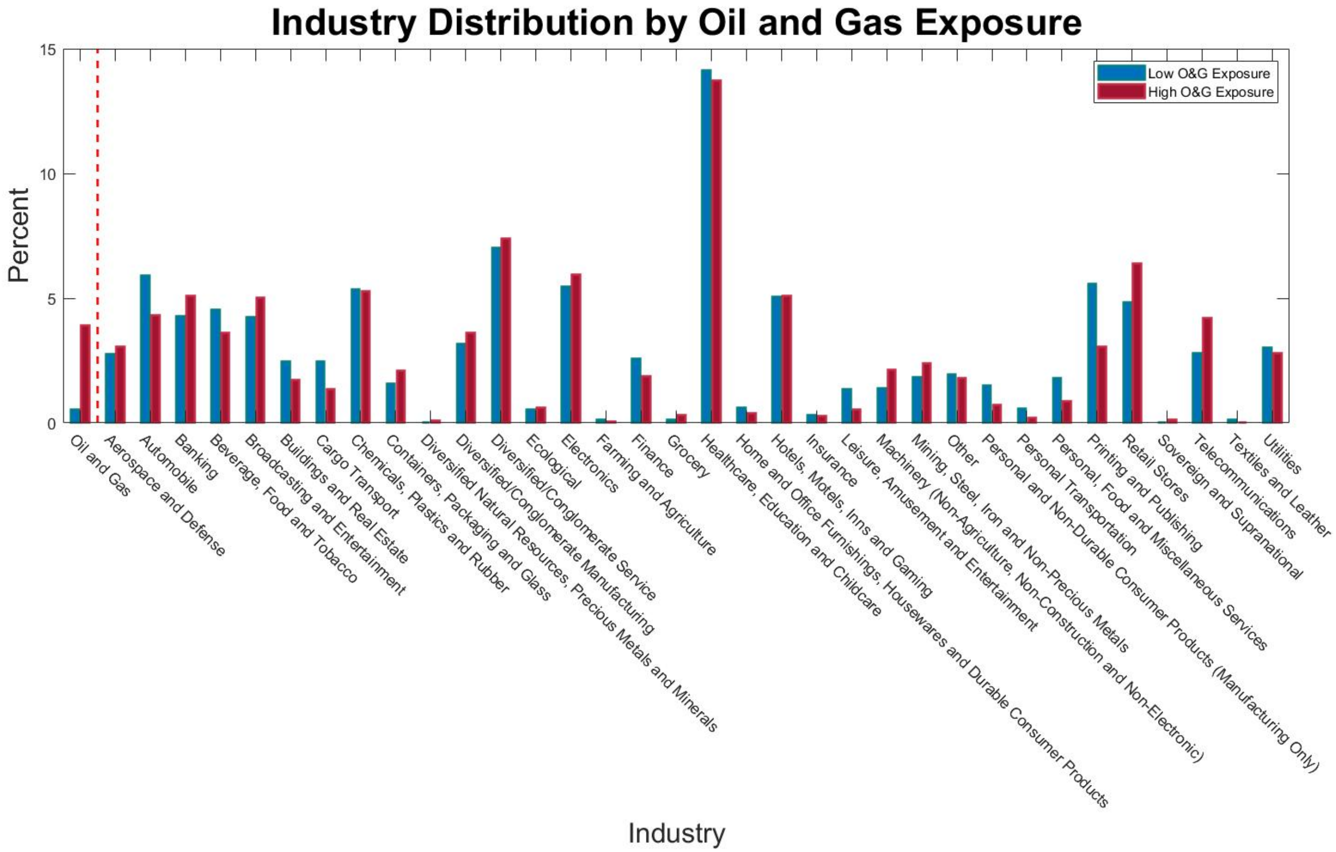
B.1.1 Figures

Figure B.1.1: 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 B.1.2: Industry Composition by CLO O&G Exposure



Notes: In this figure, I compare 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-Hischman 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). Industries are listed across the y-axis. The y-axis denotes the percent of a CLO portfolio in a given industry.

Figure B.1.3: Geographic Composition by CLO O&G Exposure

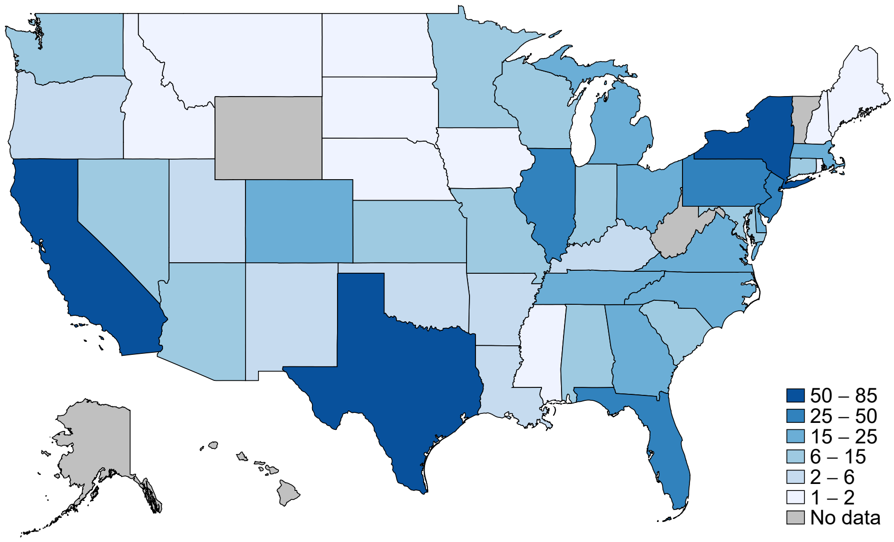


Figure B.1.4: Low O&G Exposure

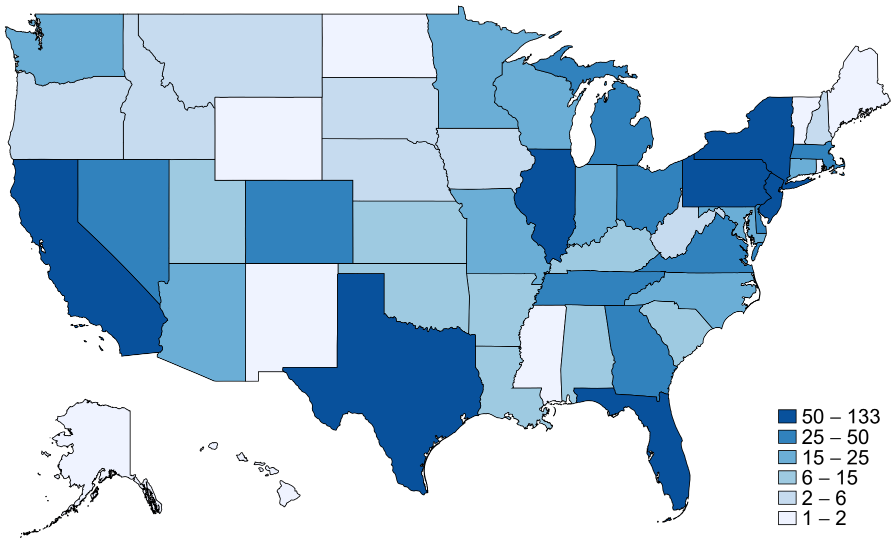


Figure B.1.5: High O&G Exposure

Notes: In this figure, I compare 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 number of firms headquartered in each state. Gray shading signifies that data is unavailable for that state. Darker blue shading reflects a greater number 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 is 0.0501, while it is 0.0493 for CLOs with high O&G exposure.

Figure B.1.6: Placebo Tests

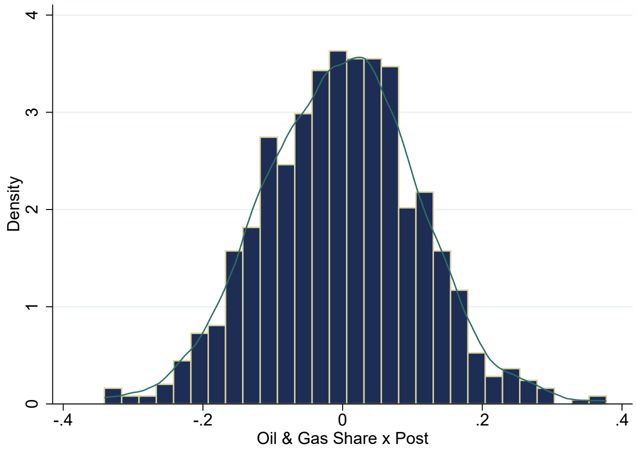


Figure B.1.7: Secondary Loan Price

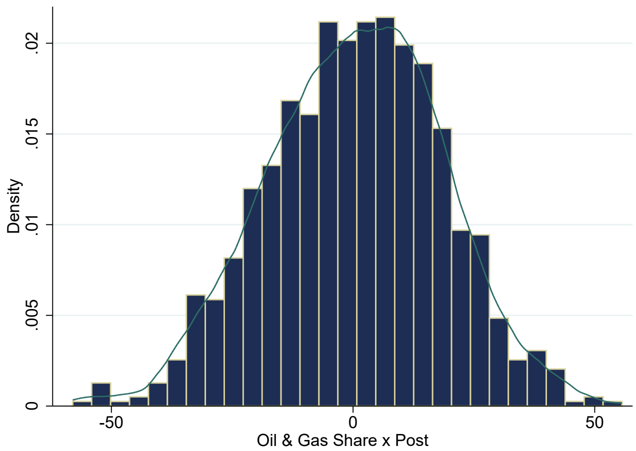


Figure B.1.8: All-In-Drawn Spread

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 price, f denotes the portfolio firm ($f \in$ CLO c), t indexes the time, m denotes the month, and y denotes the year, and $Y_{i,t} = \beta_0 + \beta_1(\text{Placebo O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Placebo O\&G Exposure}_f \times \text{Oil Shock}_t) + \beta_4\text{Maturity} + \gamma_0 X_i + \alpha_{m,y} + \alpha_f + \epsilon_{i,t}$ where $Y_{i,t}$ is the All-In-Drawn 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. 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 Figure B.1.7 and B.1.8 are -0.7503 and 0.7690, respectively, hence, the null hypothesis that the average difference is equal to zero cannot be rejected in either case.

Figure B.1.9: Alternative Empirical Specification

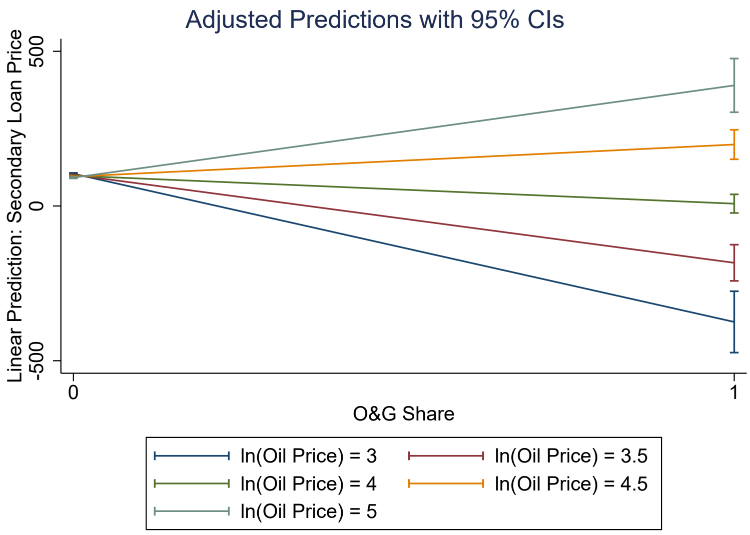


Figure B.1.10: Secondary Loan Price

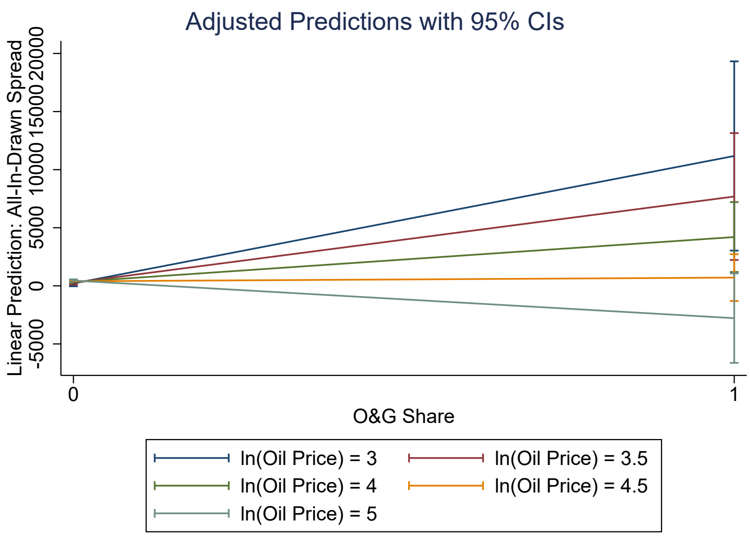


Figure B.1.11: All-In-Drawn Spread

Notes: In this figure, I plot the marginal effects – the slope of the secondary loan price (top) and All-In-Drawn spread (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 price 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-Drawn loan spread 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.

Figure B.1.12: Dynamic Effects of Firm O&G Exposure on Bond Credit Spreads and Equity Returns

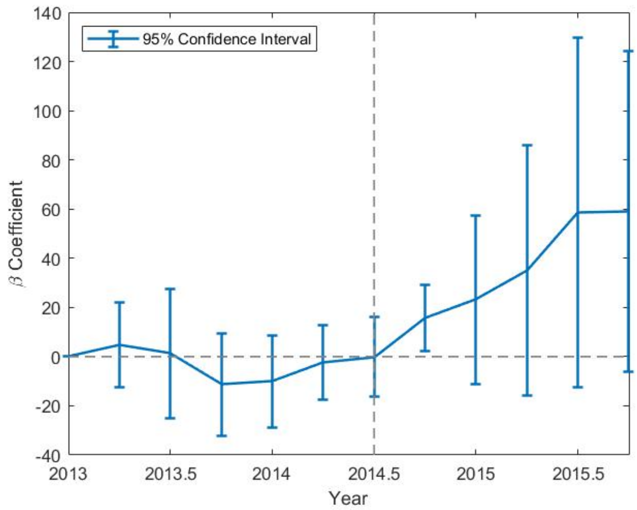


Figure B.1.13: Bond Credit Spreads

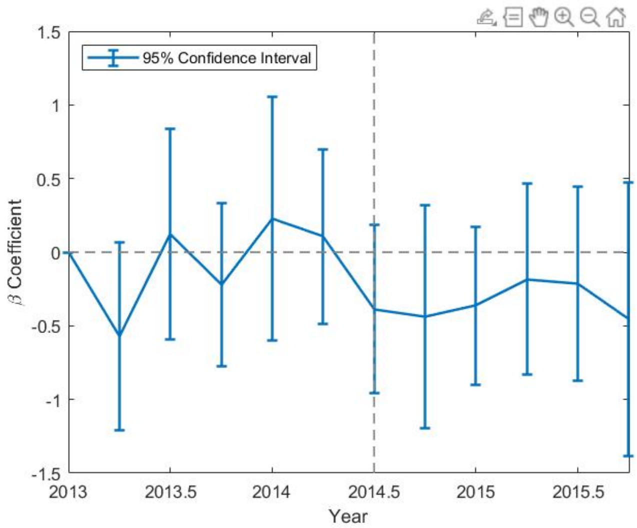
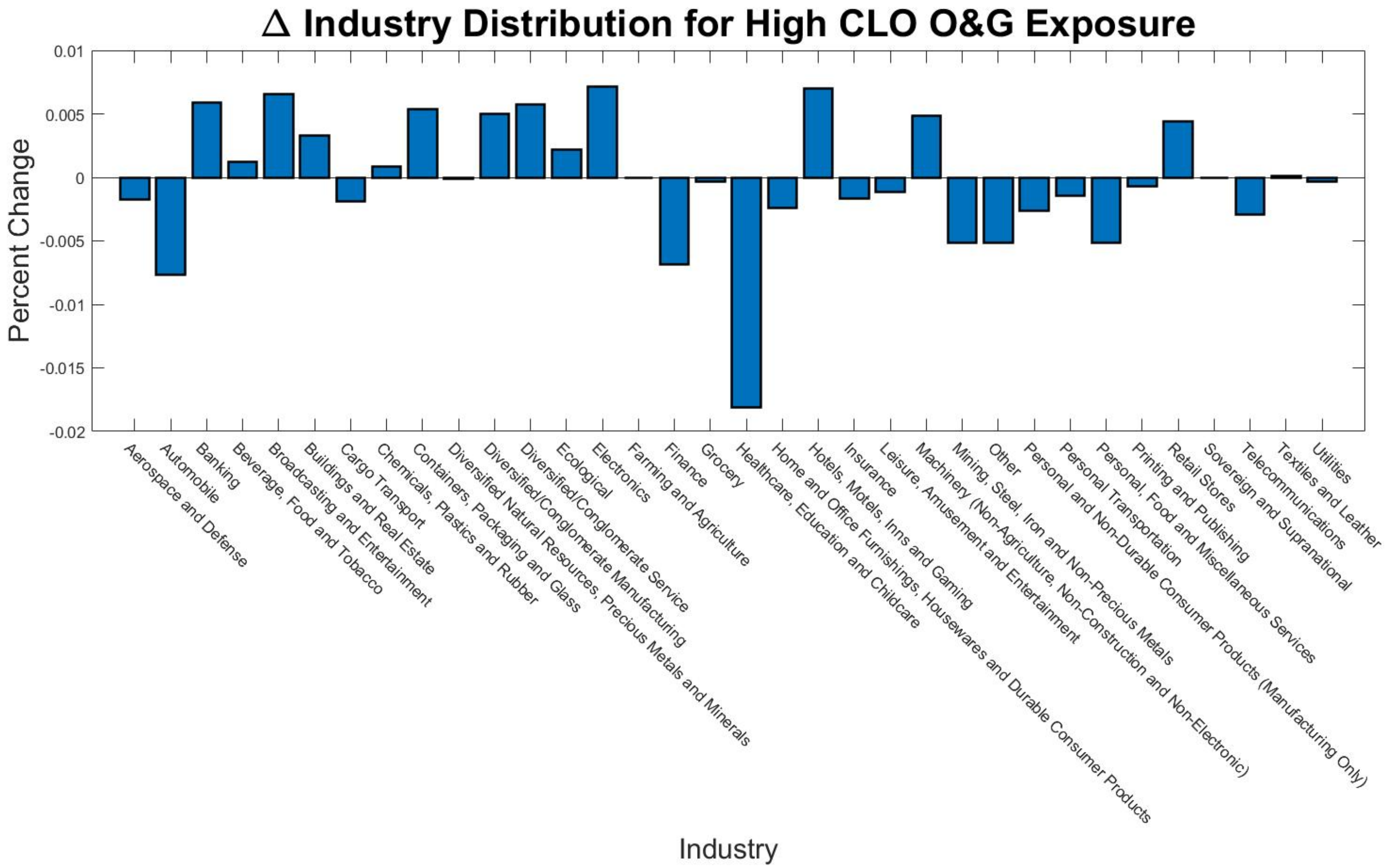


Figure B.1.14: Equity Returns

Notes: The figure plots the coefficients and the associated 95% confidence intervals of the interaction term from the following regression at the firm level (quarterly-frequency): $Y_{f,t} = \beta_0 + \sum_{k=2013}^{2015} \sum_{q=1}^{4} \beta_{4*(k-2013)+q}(\text{Firm O\&G Exposure}_f \times \mathbb{1}_{t \in kqt}) + \beta_{13}\text{Firm O\&G Exposure}_f + \gamma_0' X_{f,t} + \alpha_f + \alpha_y + \epsilon_{f,t}$ where $Y_{f,t}$ is the monthly bond credit spread (top figure) or equity return (bottom figure), f denotes the portfolio firm ($f \in$ CLO c), t indexes the month, q denotes the quarter, 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, while $\mathbb{1}_{t \in Quarter-Year}$ is an indicator variable that takes a value of 1 if the time period corresponds to quarter-year kq. I include the bond type – convertible, debenture, medium term note, medium term note zero – in Figure B.1.13, and risk-free rate, small-minus-big, high-minus-low, and market return factors in Figure B.1.14. The x-axis indicates the year. The y-axis indicates the point estimate of the interaction term. Standard errors are clustered by issuer.

Figure B.1.15: 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.

B.1.2 *Tables*

Table B.1.1: Extensive Margin: Risky Loans and Covenant Results (Table 2 of Kundu (2021*b*))

	Risky Sale and Covenant Result						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\mathbb{1}_{\text{Risky Sale, ct}}$	WAS	WA Life	Interest Div.	Junior IC	Junior OC	Senior IC	Senior OC
Covenant Result	0.0065	-0.0189***	-0.0300***	0.0328***	-0.0380***	-0.0122	-0.0318***
	(0.0097)	(0.0048)	(0.0095)	(0.0119)	(0.0053)	(0.0105)	(0.0057)
Manager-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Arranger FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Trustee FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	13,933	14,820	5,209	12,388	13,072	13,656	14,959
R^2	0.0957	0.0942	0.1393	0.1068	0.1069	0.1030	0.0990

Standard errors in parentheses, and double clustered at the Manager Month-Year Level

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

Notes: The table presents the relation between a CLO's decision to sell risky assets and quality and coverage covenant results. The baseline regression specification follows a linear probability model: $\mathbb{1}_{risky,ct} = \alpha + \beta \times \Delta Result_{ct} + \gamma_{my} + \delta_a + \delta_w + \epsilon_{ct}$. $\mathbb{1}_{risky,ct}$ takes on the value 1 if there is a decline in the share of risky assets (sum of defaulted and CCC-rated loans) between consecutive months, ϵ is the error, c denotes CLO, t denotes the month-year pair, m denotes CLO manager, y denotes the year, a denotes the arranger, and w denotes the trustee. The columns denote different covenant results (standardized); Weighted Average Spread covenant, Weighted Average Life covenant, Interest Diversion covenant, Junior IC covenant, Junior OC covenant, Senior IC covenant, and Senior OC covenant (Column 1-7, respectively).

Table B.1.2: Interest Diversion Threshold and O&G Exposure

ln(ID Threshold)	(1)	(2)	(3)	(4)	(5)
O&G Share	4.7835	-13.3219	6.4127	-12.5161	-22.5949
	(7.0591)	(14.2926)	(7.3806)	(16.5032)	(27.8942)
Constant	-0.2888				
	(0.2588)				
CLO Controls		✓	✓	✓	✓
Manager FE		✓		✓	✓
Arranger FE					✓
Trustee FE					✓
Year FE			✓	✓	
Month-Year FE					✓
N	111	87	111	85	66
R^2	0.0076	0.6094	0.1663	0.6351	0.9278

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 (standardized) Interest Diversion covenant threshold of CLO c, and X denotes the vector of controls, consisting of current CLO age and CLO size. 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 B.1.3: 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: In this table, I compare 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 B.1.4: Firm Profitability and O&G Exposure

Profitability	(1)	(2)	(3)	(4)	(5)	(6)	(7)
High O&G Share × ln(Oil Price)	-0.2819	-0.0175	-0.1830	-0.0897	-0.1814	-0.2101	-0.1245
	(0.2076)	(0.2441)	(0.1975)	(0.2492)	(0.1980)	(0.2735)	(0.2451)
High O&G Share	1.2262	0.1315		0.3187		0.8548	
	(0.9175)	(1.0860)		(1.1164)		(1.2445)	
ln(Oil Price)	0.5968***	0.2661	0.3979**	0.4030	0.4278**	0.4750*	0.2660
	(0.1715)	(0.2244)	(0.1685)	(0.2442)	(0.2130)	(0.2671)	(0.2540)
Issuer Controls						✓	✓
Rating FE		✓					
Industry FE		✓					
Rating-Industry FE				✓		✓	
Issuer FE			✓		✓		✓
Year FE				✓	✓	✓	✓
N	6,486	4,456	6,470	4,451	6,470	2,951	4,385
R^2	0.0059	0.1360	0.4075	0.2299	0.4079	0.3229	0.4911

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 profitability. The baseline regression specification takes the form $RoA_{f,t} = \beta_0 + \beta_1(\text{High O\&G Exposure})_f + \beta_2(\ln(\text{Oil Price}))_t + \beta_3(\text{High O\&G Exposure}_f \times \ln(\text{Oil Price})_t) + \gamma_0' X_{f,t} + \epsilon_{f,t}$ where $RoA_{f,t}$ is the (standardized) profitability of firm f at time t, and X denotes the vector of issuer controls, consisting of size, tangibility, leverage, net worth, and market-to-book ratio. Firms with above-median CLO O&G exposure have *High* O&G exposure. ln(Oil Price)$_t$ is a continuous variable, indicating the oil price. Standard errors are clustered by issuer.

Table B.1.5: CLO Selection by Covariance of Oil Price and Firm Profitability

$\mathbb{1}_{\text{High CLO O\&G Share}}$	(1)	(2)	(3)	(4)	(5)	(6)
Covariance(Oil Price, Firm Profitability)	-1.7779	-2.0157	-1.3314	-3.4276	0.5745	-0.6339
	(5.4906)	(2.5317)	(2.8732)	(5.4548)	(0.3715)	(1.2001)
CLO Age			-0.0033***	-0.0033***		-0.0033***
			(0.0005)	(0.0005)		(0.0011)
Defaulted Share			-0.0192***	-0.0235***		-0.0182*
			(0.0060)	(0.0065)		(0.0094)
Risky Share			0.0035	0.0064**		0.0052
			(0.0021)	(0.0029)		(0.0064)
Firm Size					-0.0039***	-0.0011
					(0.0011)	(0.0007)
Firm Tangibility					0.0104***	-0.0026*
					(0.0036)	(0.0015)
Firm Leverage					0.0129	-0.0009
					(0.0105)	(0.0057)
Firm Net Worth					0.0175**	0.0009
					(0.0089)	(0.0052)
Firm Market-to-Book Ratio					-0.0001	-0.0000
					(0.0001)	(0.0000)
Constant	0.7510***					
	(0.0226)					
Manager-Arranger-Trustee FE					✓	✓
Rating-Industry FE				✓		✓
Rating FE			✓			
Industry FE			✓			
Manager FE		✓				
CLO Type FE						✓
Year FE				✓	✓	
Month-Year FE						✓
N	9,201	9,200	9,073	8,053	7,110	6,023
R^2	0.0000	0.3283	0.1238	0.1658	0.8504	0.9011

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 (Column 2-6), age (Columns 3, 4, 6), defaulted share (Columns 3, 4, 6), and risky share (Columns, 3, 4, 6). Issuer controls include size, tangibility, leverage, net worth, and market-to-book ratio in Columns 5 and 6. Standard errors are two-way clustered by CLO and issuer.

Table B.1.6: CLO-Level Trading Effects

Transaction Amount	(1)	(2)	(3)	(4)	(5)	(6)
O&G Share × Post	-10.6608***	-10.5710***	-10.7245***	-15.1090***	-13.8098***	-23.7717***
	(2.8455)	(2.8312)	(2.8491)	(3.0963)	(3.1822)	(6.9345)
O&G Share	9.3300***	9.2784***	9.3794***	16.3223***		
	(2.3471)	(2.3175)	(2.4150)	(2.9078)		
Post	0.1315	0.1715*			0.2070*	
	(0.0860)	(0.0915)			(0.1088)	
Manager FE			✓			
Rating-Industry FE				✓		
CLO-Issuer FE						✓
Year FE		✓			✓	
Month-Year FE			✓	✓		✓
N	86,082	86,082	86,077	77,970	85,977	55,203
R^2	0.0053	0.0057	0.0469	0.0343	0.0650	0.4329

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 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 and month-year.

Table B.1.7: Issuer-Level Trading Effects

Transaction Amount	(1)	(2)	(3)	(4)	(5)
O&G Share × Post	-1.6833*	-1.6738*	-2.9533**	-2.3576*	-2.5800*
	(0.9391)	(0.9367)	(1.0861)	(1.3210)	(1.3358)
O&G Share	0.8848	0.8813	2.3788**		
	(0.7162)	(0.7126)	(0.9532)		
Post	0.0331	0.0212		0.0356	
	(0.0294)	(0.0308)		(0.0419)	
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 B.1.8: Issuer-Level Effects by Transaction Type

	Purchases			**Sales**		
Total Transaction Amount	(1)	(2)	(3)	(4)	(5)	(6)
O&G Share × Post	0.2243	1.1255	0.5331	8.1515***	10.9487***	9.6185***
	(1.6497)	(1.9370)	(1.8573)	(2.6452)	(3.1875)	(2.9268)
O&G Share	-3.4125**			-14.0377***		
	(1.5670)			(3.1174)		
Post		-0.0781			-0.3705***	
		(0.0655)			(0.1189)	
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 B.1.9: Primary Institutional Loan Maturity and O&G Exposure

Maturity (Months)	(1)	(2)	(3)	(4)	(5)	(6)
O&G Share × Post	-297.0095*	-395.4002**	-395.2332**	-408.0260**	-409.4155*	-460.2031**
	(157.4307)	(184.6172)	(184.9694)	(187.8888)	(228.5919)	(222.3893)
Post	8.2354	11.0521*	13.2475*	14.3619*	13.6066	
	(4.8912)	(5.8000)	(7.4260)	(7.5606)	(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	620	592	592	589	582	582
R^2	0.6289	0.5970	0.5981	0.6368	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 B.1.10: Primary Institutional Loan Amount and O&G Exposure

ln(Loan Amount)	(1)	(2)	(3)	(4)	(5)	(6)
O&G Share × Post	-0.9048	-5.0442	-4.7797	-6.7672	-4.6737	-5.8864
	(6.3562)	(7.1042)	(7.0378)	(7.4648)	(6.5940)	(7.9274)
Post	-0.1627	-0.0502	0.1435	0.1900	0.1400	
	(0.2146)	(0.2411)	(0.2920)	(0.3176)	(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	633	604	604	601	582	582
R^2	0.6268	0.6180	0.6206	0.6627	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 $Y_{i,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \beta_4\text{Maturity} + \gamma_0 X_i + \alpha_{m,y} + \alpha_f + \epsilon_{i,t}$ where $Y_{i,t}$ is the (standardized) 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 issuer and month-year.

Table B.1.11: Bond Liquidity and O&G Exposure

Bond Liquidity	(1)	(2)	(3)	(4)	(5)
O&G Share × Post	2.6539*	2.6237*	2.6952*	2.6098*	2.6049*
	(1.5525)	(1.5427)	(1.5816)	(1.3025)	(1.3013)
Post	-0.0158	-0.0298	-0.0307	-0.0473	
	(0.0198)	(0.0319)	(0.0326)	(0.0296)	
Time to Maturity				0.0173***	0.0174***
				(0.0025)	(0.0026)
Issuer FE	✓	✓	✓	✓	✓
Bond Type FE	✓	✓	✓	✓	✓
Security Level FE			✓	✓	✓
Rating FE				✓	✓
IG FE				✓	✓
Defaulted FE				✓	✓
Year FE		✓	✓	✓	
Month-Year FE					✓
N	16,209	16,209	16,209	9,955	9,955
R^2	0.0950	0.0958	0.0981	0.3025	0.3083

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 $Y_{i,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \beta_4\text{Time to Maturity} + \gamma_0 X_{i,t} + \alpha_{m,y} + \alpha_f + \epsilon_{i,t}$ where $Y_{i,t}$ is the (standardized) 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 B.1.12: Firm Liquidity and O&G Exposure (Wild Cluster Bootstrap)

	(1) ΔUndrawn	(2) ΔUndrawn	(3) ΔUndrawn	(4) ΔDrawn	(5) ΔDrawn	(6) ΔDrawn
O&G Share × Post	-2.7562	-2.7586	-2.7848	3.4348	3.4228	3.4349
	(0.0232)	(0.0241)	(0.0172)	(0.0681)	(0.0611)	(0.0752)
Post	0.0395	0.0335		-0.0699*	-0.1524	
	(0.2767)	(0.744)		(0.0964)	(0.124)	
Issuer FE	✓	✓	✓	✓	✓	✓
Year FE		✓			✓	
Quarter-Year FE			✓			✓
N	2,111	2,111	2,111	2,111	2,111	2,111
R^2	0.0278	0.0279	0.0335	0.0240	0.0252	0.0284

p-values from wild two-way cluster bootstrap by issuer and quarter-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 $Y_{f,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \alpha_{q,y} + \alpha_f + \epsilon_{f,t}$ where $Y_{f,t}$ are various measures of liquidity for firm f at time t ($f \in$ CLO c), 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 $\Delta(\frac{\text{Unused}}{\text{Total Firm Liquidity}})$ in Columns 1-3, and $\Delta(\frac{\text{Drawn}}{\text{Total Firm Liquidity}})$ in Columns 4-6, where *Total Firm Liquidity* is defined as the sum of the total line of credit and cash and cash equivalents. The p-values from wild two-way cluster bootstrapping by issuer and quarter-year are in parentheses.

Table B.1.13: Investment by Size and Age

	Large Firms Firms		Small Firms	
Investment	Old	Young	Old	Young
O&G Share × Post	-2.6067	-1.9838	-3.6740	-13.8896**
	(2.9691)	(3.5640)	(5.0767)	(5.2621)
Issuer FE	✓	✓	✓	✓
Industry FE	✓	✓	✓	✓
Quarter-Year FE	✓	✓	✓	✓
N	591	448	446	509
R^2	0.1880	0.1856	0.1497	0.1858

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 size and age. The baseline regression specification takes the form $I_{ft} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \alpha_{q,y} + \alpha_f + \epsilon_{f,t}$ where I_{ft} denotes investment of firm f at time t ($f \in$ CLO c), 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 present the results for large firms, while in Columns 3 and 4, I present the results for small firms. Columns 1 and 3 consist of old firms, while Columns 2 and 4 consist of young firms. Standard errors are clustered by issuer.

Table B.1.14: Investment by Bank Dependence and Timing of Refinancing

	Last Refinancing After Shock		**Last Refinancing Before Shock**	
Investment	Bond Access	No Bond Access	Access	No Bond Access
O&G Share × Post	3.6552	-6.8414	-0.7585	-10.8335**
	(2.9749)	(8.3901)	(1.4469)	(4.6397)
Issuer FE	✓	✓	✓	✓
Industry FE	✓	✓	✓	✓
Quarter-Year FE	✓	✓	✓	✓
N	769	441	636	708
R^2	0.1853	0.2920	0.1317	0.1924

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 timing of loan refinancing. The baseline regression specification takes the form $I_{ft} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \alpha_{q,y} + \alpha_f + \epsilon_{f,t}$ where I_{ft} denotes investment of firm f at time t ($f \in$ CLO c), 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 present the results for firms which had last refinanced after the shock in the sample period, while in Columns 3 and 4, I present the results for firms which had last refinanced before the shock in the sample period. In Columns 1 and 3, firms have access to the bond market, while in Columns 2 and 4, firms do not have access to the bond market. Standard errors are clustered by issuer.

Table B.1.15: Triple-Difference: Constrained Firms and Investment

Investment	(1)	(2)
No Access × O&G Share × Post	-10.8285**	
	(4.2396)	
Small × O&G Share × Post		-7.2847*
		(4.4064)
No Access × Post	0.2040	
	(0.1245)	
Small × Post		0.1940
		(0.1350)
O&G Share × Post	0.6152	-1.0657
	(1.8073)	(2.1684)
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 (standardized) 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.

Table B.1.16: Falsification Test: Primary Non-Institutional Loan Spread and O&G Exposure

All-In-Drawn Spread	(1)	(2)	(3)	(4)	(5)	(6)
O&G Share × Post	-40.3666	161.3654	135.2760	250.2754	197.1342	-142.2520
	(248.2369)	(262.9362)	(268.0703)	(259.5060)	(194.2592)	(223.3746)
Post	-17.6838*	-27.0345**	-15.4694	-18.6264	-14.3602	
	(9.6592)	(11.1942)	(18.8218)	(16.9834)	(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	610	440	440	438	432	432
R^2	0.8716	0.8518	0.8528	0.8769	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 $Y_{i,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \beta_4\text{Maturity} + \gamma_0 X_i + \alpha_{m,y} + \alpha_f + \epsilon_{i,t}$ where $Y_{i,t}$ is the All-In-Drawn 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 B.1.17: Alternative Measures of Issuer Exposure to CLOs

	CLO Health (ID Cov.)		**Equal Weights**		**Equal Weighting (Loan Frequency)**		**Value Weighting (Loan Frequency)**		**Value Weighting (Loan Amount)**	
	Secondary Price	All-In-Drawn	Secondary Price	All-In-Drawn	Secondary Price	All-In-Drawn	Secondary Price	All-In-Drawn	Secondary Price	All-In-Drawn
Issuer Exposure × Post	0.4248***	-12.4521*	-44.9946*	2051.6695***	-82.5273***	2102.7887***	-80.1203***	2024.8176***	-82.6503***	2102.7887***
	(0.1111)	(6.8618)	(24.9657)	(703.6106)	(31.3736)	(719.7521)	(30.8555)	(712.6827)	(31.3846)	(719.7521)
Post	-0.1237	8.9954	1.0911	-51.7958*	2.0636**	-53.4040*	2.0054*	-51.4677*	2.0668**	-53.4040*
	(0.3315)	(14.9394)	(0.8473)	(28.4214)	(1.0430)	(28.9912)	(1.0336)	(28.5252)	(1.0434)	(28.9912)
Issuer-Loan Type FE	✓		✓		✓		✓		✓	
Issuer FE		✓		✓		✓		✓		✓
Maturity Control		✓		✓		✓		✓		✓
Secured FE		✓		✓		✓		✓		✓
Purpose FE		✓		✓		✓		✓		✓
Country of Syndication FE		✓		✓		✓		✓		✓
Distribution FE		✓		✓		✓		✓		✓
Seniority FE		✓		✓		✓		✓		✓
Loan Type FE		✓		✓		✓		✓		✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
N	55,994	517	107,922	567	57,593	567	57,593	567	57,593	567
R^2	0.5782	0.9160	0.5887	0.9215	0.5963	0.9217	0.5963	0.9215	0.5963	0.9217

Standard errors are clustered by CLO (Col. 1, 3, 5, 7, 9) and Issuer (Col. 2, 4, 6, 8) 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 (Columns 1, 3, 5, 7, 9) and All-In-Drawn Spread (Columns 2, 4, 6, 8, 10) for non-O&G firms. The regression specification takes the form $Y_{i,t} = \beta_0 + \beta_1(\text{Firm Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm Exposure}_f \times \text{Oil Shock}_t) + \alpha_{f,l} + \alpha_y + \epsilon_{i,t}$ 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 y denotes the year in Columns 1, 3, 5, 7, and 9. The regression specification takes the form $Y_{i,t} = \beta_0 + \beta_1(\text{Firm Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm Exposure}_f \times \text{Oil Shock}_t) + \beta_4\text{Maturity} + \gamma_0 X_i + \alpha_y + \alpha_f + \epsilon_{i,t}$ where $Y_{i,t}$ is the All-In-Drawn 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 y denotes the year respectively in Columns 2, 4, 6, 8, and 10. In Columns 1-2, Firm Exposure$_f$ measures the weighted average of distance to the Interest Diversion constraint ($ln(\frac{\text{Current Performance}}{\text{Current Threshold}})$ of a firm f across all CLOs before the shock occurs. In Columns 3-4, Firm 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 5-6, Firm 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 7-8, Firm 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 9-10, Firm 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 in Columns 1, 3, 5, 7, 9, and by issuer in Columns 2, 4, 6, 8, 10.

Table B.1.18: Selling Propensity by Secondary Loan Price Relative to Par and CLO O&G Exposure

Panel A					
$1_{(\text{loan price}>100)}$	(1)	(2)	(3)	(4)	(5)
O&G Share × Post	-1.6731**	-1.7769***	-1.4571**	-2.0619***	-1.7187***
	(0.6254)	(0.6168)	(0.5515)	(0.5987)	(0.5366)
O&G Share	2.4821***	2.4962***	1.7836***	1.3470***	1.1687***
	(0.4672)	(0.4637)	(0.4589)	(0.3925)	(0.3993)
Post	-0.0600	-0.0941**		-0.1170**	
	(0.0370)	(0.0413)		(0.0432)	
Rating-Industry FE			✓		
Issuer-Loan Type FE				✓	✓
Year FE		✓		✓	
Month-Year FE			✓		✓
N	35,279	35,279	31,829	34,985	34,985
R^2	0.0204	0.0223	0.1578	0.2827	0.3203
Panel B					
$1_{(\text{loan price}<90)_i,t}$	(1)	(2)	(3)	(4)	(5)
O&G Share × Post	0.7432*	0.7510**	0.4323*	0.4425**	0.3902**
	(0.3681)	(0.3653)	(0.2415)	(0.2045)	(0.1922)
O&G Share	-1.5565***	-1.5564***	-0.3653**	-0.3948**	-0.3655**
	(0.3049)	(0.3014)	(0.1499)	(0.1506)	(0.1477)
Post	-0.0039	-0.0003		-0.0222*	
	(0.0178)	(0.0210)		(0.0126)	
	(0.0130)				
Rating-Industry FE			✓		
Issuer-Loan Type FE				✓	✓
Year FE		✓		✓	
Month-Year FE			✓		✓
N	35,279	35,279	31,829	34,985	34,985
R^2	0.0098	0.0099	0.3628	0.5752	0.5819

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 propensity to sell loans issued by non-O&G firms by price categorization. The baseline regression specification takes the form $\mathbb{1}_{(price \leqslant p)_{i,t}} = \beta_0 + \beta_1(\text{CLO O\&G Exposure})_c + \beta_2(\text{Oil Shock})_t + \beta_3(\text{CLO O\&G Exposure}_c \times \text{Oil Shock}_t) + \alpha_f + \alpha_l + \alpha_{m,y} + \epsilon_{i,t}$ where $\mathbb{1}_{(price \leqslant p)_{i},t}$ 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 p =\$100 in Panel A, and below p =\$90 in Panel B per \$100 of notional par, Z is a vector of firm controls including rating and industry, m, y denote the month and year respectively, and l denotes the loan-type. CLO O&G Exposure$_f$ measures the O&G share of a given 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 B.1.19: Interest Rate of Loans and O&G Exposure

Interest Rate	(1)	(2)	(3)	(4)	(5)
O&G Share × Post	-1.9507***	-2.1007***	-1.5329**	-1.7283***	-1.8714***
	(0.5977)	(0.5511)	(0.5703)	(0.5737)	(0.5710)
O&G Share	3.0023***	3.9032***			
	(0.5690)	(0.6270)			
Post	0.0382	0.0312	0.0055	0.0102	
	(0.0240)	(0.0239)	(0.0263)	(0.0257)	
Manager FE		✓			
CLO FE			✓	✓	✓
Issue Type FE				✓	✓
Issuer FE	✓	✓	✓	✓	✓
Index FE	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	
Month-Year FE					✓
N	1,967,665	1,967,665	1,967,664	1,963,614	1,963,614
R^2	0.7689	0.7709	0.7739	0.8358	0.8370

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 loan interest rate for non-O&G firms. The baseline regression specification takes the form $\text{Interest Rate}_{i,c,t} = \beta_0 + \beta_1(\text{CLO O\&G Exposure})_c + \beta_2(\text{Oil Shock})_t + \beta_3(\text{CLO O\&G Exposure}_c \times \text{Oil Shock}_t) + \gamma_0 X_c + \alpha_f + \alpha_l + \alpha_{m,y} + \alpha_r + \epsilon_{i,c,t}$ 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, and X is a vector of CLO controls including manager and CLO indicators. 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 B.1.20: CLO CCC Loans and O&G Exposure

$\mathbb{1}_{\text{CCC loan}}$	(1)	(2)	(3)	(4)	(5)
O&G Share × Post	-0.9022***	-0.8593***	-0.8172***	-0.9962***	-0.9971***
	(0.2857)	(0.2769)	(0.2734)	(0.2925)	(0.2920)
Post	0.0223***	0.0212***	0.0228***	0.0284***	
	(0.0074)	(0.0071)	(0.0073)	(0.0078)	
Manager FE		✓			
CLO FE			✓	✓	✓
Issuer FE	✓	✓	✓	✓	✓
Loan Type FE				✓	✓
Year FE	✓	✓	✓	✓	
Month-Year FE					✓
N	3,416,878	3,416,878	3,416,874	3,411,591	3,411,591
R^2	0.5287	0.5331	0.5429	0.5530	0.5534

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 firm O&G exposure and likelihood of CCC and below rated loans. The baseline regression specification takes the form $\mathbb{1}_{(\text{CCC loan})i,c,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \gamma_0 Z_i + \gamma_0 X_c + \alpha_{l,f,c} + \alpha_{m,y} + \epsilon_{i,c,t}$ where $\mathbb{1}_{(\text{CCC loan})i,c,t}$ denotes whether loan i issued by firm f and held by CLO c at time t has a rating of CCC or below ($f \in$ CLO c), l denotes the loan type, m, y denote the month and year respectively, Z is a vector of loan controls including loan type and issuer, and X is a vector of CLO controls including manager and CLO indicators. 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 and month-year.

Table B.1.21: Triple-Difference: Risky Firms and Firm Outcomes

	(1) Secondary Loan Price	(2) All-In-Drawn Spread	(3) Investment
Risky × O&G Share × Post	-270.7383***	1494.2151	-10.0547*
	(86.1335)	(2159.2770)	(5.2123)
Risky × Post	6.6826***	-31.0497	0.2241
	(2.3895)	(61.7280)	(0.1526)
O&G Share × Post 36.3184	1631.8741*	-2.1114	
	(32.6817)	(923.1815)	(2.0887)
Maturity Control		✓	
Issuer-Loan Type FE	✓		
Issuer FE		✓	✓
Secured FE		✓	
Purpose FE		✓	
Distribution FE		✓	
Seniority FE		✓	
Loan Type FE		✓	
Country of Syndication FE		✓	
Industry FE			✓
Rating FE			✓
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 $Y_{i,f,t} = \beta_0 + \beta_1(\text{Firm O\&G Exposure})_f + \beta_2(\text{Oil Shock})_t + \beta_3(\text{Firm O\&G Exposure}_f \times \text{Oil Shock}_t) + \beta_4(\text{Constrained}_f \times \text{Oil Shock}_t) + \beta_5(\text{Constrained}_f \times \text{Oil Shock}_t \times \text{Firm O\&G Exposure}_f) + \beta_6\text{Constrained}_f + \beta_7(\text{Constrained}_f \times \text{Firm O\&G Exposure}_f) + \alpha_{q,y} + \alpha_f + \alpha_I + \epsilon_{f,t}$ where $Y_{i,f,t}$) denotes the secondary loan price in Column 1, All-In-Drawn Spread in Column 2, and (standardized) 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. 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.

Table B.1.22: Distance to Interest Diversion Covenant and COVID-19 Exposure

Distance to ID Threshold	(1)	(2)	(3)	(4)	(5)
COVID-19 Share × Post	-3.8025***	-3.9675***	-3.9104***	-4.6904***	-4.5172***
	(1.1159)	(1.0992)	(1.1022)	(1.0007)	(1.0437)
COVID-19 Share	-9.0717***	-4.2903	-3.9119		
	(2.4115)	(2.3778)	(2.3942)		
Post	-0.3228**	-0.2494*		-0.2197*	
	(0.1286)	(0.1237)		(0.1120)	
CLO Controls		✓	✓		
CLO FE				✓	✓
Manager FE	✓	✓	✓		✓
Arranger FE					✓
Trustee FE					✓
Year FE		✓		✓	
Month-Year FE			✓		✓
N	4,986	4,986	4,986	4,984	4,955
R^2	0.6001	0.6546	0.7221	0.8180	0.8885

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 $Y_{c,t} = \beta_0 + \beta_1(\text{CLO COVID-19 Exposure})_c + \beta_2(\text{COVID-19 Shock})_t + \beta_3(\text{CLO COVID-19 Exposure}_c \times \text{COVID-19 Shock}_t) + \gamma_0' X_{c,t} + \epsilon_{c,t}$ 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, 3) and CLO size (Column 3). 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.

B.2 Data Construction of Firm-Level Variables

In this section, I describe the definition of variables.

B.2.1 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 Stock Growth)* is defined as the log difference of 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 total assets (`atq`).

6. *Cash Flow* is the ratio of the operating income before depreciation (`ebitda`) to cash adjusted, total assets (`atq-cheq`).

7. *Employment Growth* is defined as the log difference in employment ($\Delta ln(\texttt{emp})$)

8. *Tobin's Q* is the ratio of market value of assets to book value of assets. First, I compute the market value of equity – the product of price close at quarter and common shares outstanding ($\texttt{prccq} \times \texttt{cshoq}$). Then, I compute the market value

of assets as the sum of the market value of equity, total assets (atq), and deferred taxes and investment tax credit (txditcq), minus the book value of common stock (ceqq). Lastly, I take the ratio of the market value of assets to the book value of assets (atq).

9. *Investment Growth* is the difference in the log of capital expenditures (Δ ln(capxy)).

10. *Market-to-Equity* is the ratio of the cash-adjusted market value of equity (prccq $\times$ cshoq - cheq) to cash-adjusted stockholders equity (teqq - cheq)

11. *Tangibility* is the ratio of capital stock (k_{it}) to the cash-adjusted total assets (atq-cheq). The capital stock is defined as described in *Investment*.

12. *Leverage* is the ratio of total debt (dlcq+dltttq) to total assets (atq).

13. *Profitability* is the return on assets, defined as the ratio of net income (niq) to total assets (atq).