CLO Performance*

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Abstract

We study the performance of collateralized loan obligations (CLOs) to understand the market imperfections giving rise to these vehicles and the corresponding costs. CLO equity tranches earn positive abnormal returns from the risk-adjusted price differential between leveraged loans and CLO debt tranches, rather than managerial skill in selecting and trading loans. Debt tranches offer higher returns than similarly rated corporate bonds, making them attractive to regulated intermediaries demanding safe assets. Temporal variation in equity performance and management fees highlights the resilience of CLOs to market volatility due to their long-term funding structure and a reduction in surplus over time as the market has grown.

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Collateralized loan obligations (CLOs) have received a great deal of attention in recent years because of their rapid growth and broad reach. Standard & Poor's (2020b) reports that two-thirds, or $2.1 trillion, of leveraged loan issuance since the 2008 financial crisis has been funded by CLOs. A broad array of financial institutions invest in CLOs, including banks, insurers, pension funds, mutual funds, and hedge funds. As a result, U.S. and European regulators have expressed concerns about the growth of the CLO market and the financial system's exposure to these vehicles (MarketWatch (2019), Standard & Poor's (2020a)).

In this paper, we address two questions arising from the growth of CLOs. What market imperfections are CLOs designed to address, and how large are the economic costs of these imperfections? With perfect capital markets, there is no role for CLOs, or securitization more broadly, because economic agents can costlessly transform cash flows. Thus, CLOs exist to mitigate market imperfections. We test the implications of different imperfections for the performance of CLO assets and liabilities. In doing so, we provide large-sample evidence on CLO performance, shedding light on the risks and rewards of these vehicles.

We begin by constructing a novel data set that offers a near-comprehensive view of the CLO market. The data include the full history of cash distributions to every CLO tranche, as well as information on contract terms, collateral holdings, and trading activity. The sample period, August 1997 to March 2021, encompasses three distinct business cycles including the first nine months of the Covid-19 crisis.

Our central finding is that CLO equity tranches provide statistically and economically significant abnormal returns, or "alpha," against a variety of public benchmarks. Using the generalized public market equivalent (GPME) framework of Korteweg and Nagel (2016), we find that the average completed CLO equity investment offers a net present value (NPV) of 66 cents per dollar invested, gross of fees. This equates to approximately $33 million, or 6.6% of total assets, for the typical deal. The magnitudes of the NPV estimates depend on the choice of factors in the stochastic discount factor (SDF), but they are economically large and statistically significant across a range of specifications. After-fee GPME estimates imply that managers capture approximately 47% of the before-fee surplus. Because many managers fund a portion of the equity tranche in the CLOs they manage, this fraction is likely a conservative estimate of the compensation of CLO managers.

Since equity investors receive the residual cash flow from the collateral pool after debt tranches are paid, these abnormal returns must be due to risk-adjusted price differentials between the leveraged loans in the collateral pool and the secured notes issued to finance the vehicle. We confirm this intuition by applying the GPME framework to the cash flows produced by CLO collateral and debt tranches. Although the conclusions regarding abnormal performance depend on the choice of SDF, in each specification we observe that debt tranches offer lower risk-adjusted returns than loan collateral.

We explore several explanations for this differential, beginning with collateral selection by CLO managers. The pool of leveraged loans comprising CLO assets generates gross returns that are economically indistinguishable from a broad-based index of leveraged loans. Net of fee returns are similar to those generated by a diversified portfolio of loan mutual funds. These similarities show that CLO managers, in aggregate, have neither an informational advantage nor superior skill in selecting leveraged loans when compared to other market participants. Put differently, the average CLO does not appear to exploit relative price inefficiencies within the leveraged loan market.

We then examine the performance of CLO debt to understand its appeal to investors. Like CLO equity, debt tranches offer higher returns than public benchmarks. Discounting cash flows using the returns of corporate bonds with the same credit rating and duration, we find public market equivalent (Kaplan and Schoar (2005)), or PME, estimates for debt tranches that are statistically and economically significantly larger than one. Our estimates imply annualized return differences ranging from 0.5% for AAA-rated tranches to 2.2% for B-rated tranches. Unlike CLO equity, these differences in performance are more likely indicative of unmeasured differences in risk, as opposed to abnormal risk-adjusted returns. CLO debt tranches are less liquid, are more likely to be prepaid, and have higher systematic risk exposure than corporate bonds (Coval, Jurek, and Stafford (2009), Elkamhi, Li, and Nozawa (2020)).

Regardless of whether these higher returns reflect additional risk, these results shed light on why CLO debt tranches command a high price (or earn low risk-adjusted returns). The majority of funding for CLOs is composed of AAA and AA-rated senior tranches. These tranches are primarily held by banks and insurance companies (DeMarco, Liu, and Schmidt-Eisenlohr (2020), Foley-Fisher, Heinrich, and Verani (2020)) whose demand for these instruments is motivated by several market imperfections. As regulated entities, risk-based capital requirements create a preference for highly rated assets when external equity financing is costly. Investing in senior CLO tranches instead of non-investment-grade loans can relax balance sheet constraints and expand the supply of credit to firms (Ivashina and Sun (2011), Shivdasani and Wang (2011), Nadauld and Weisbach (2012)). Indeed, Irani et al. (2020) show that bank capitalization plays an important role in the retention of risky syndicated loans that face high capital charges. The high yields on CLO tranches relative to similarly rated debt also cater to reach-for-yield incentives induced by rating-based capital requirements (Brennan, Hein, and Poon (2009), Becker and Ivashina (2015), Merrill, Nadauld, and Strahan (2019)).[1] Independent of regulatory considerations, senior debt tranches cater to the demand for safe assets (Gorton, Lewellen, and Metrick (2012)) that stems from a desire to smooth consumption intertemporally and across states of nature (Gorton and Ordonez (2013)), and to acquire informationally insensitive collateral (Dang, Gorton, and Holmstrom (2019)).

Taken together, our results suggest that equity investors earn economic rents for providing risk-bearing capital that supports lending to risky borrowers and the issuance of highly rated tranches. These rents are derived from either borrowers willing to pay high risk-adjusted

[1]Regulatory arbitrage by banks and insurers has the potential to undermine financial stability by weakening capital buffers (Acharya and Richardson (2009)). While an examination of this issue is beyond the scope of this study, our results on CLO equity performance highlight an underappreciated benefit of this equilibrium. CLOs' long-term financing insulates them from rollover risk, which makes them better suited than banks, which are susceptible to runs, to hold risky loans during tumultuous periods.

spreads for loans due to an inadequate supply of intermediated credit (Schwert (2020)), intermediaries willing to earn low risk-adjusted spreads on CLO tranches to satisfy their demand for safe assets and reduced capital charges, or both.

Time variation in equity performance sheds further light on this phenomenon. CLOs originated before 2009, so-called "CLO 1.0" transactions, performed significantly better than "CLO 2.0" deals issued after 2009. Moreover, CLOs issued since 2017 have lower equity payouts than previous transactions in the CLO 2.0 era. This declining equity performance along with the growth of the market suggests that capital flows have begun to mitigate pricing distortions and the ability to earn rents from exploiting them.

Performance by vintage reveals a particularly striking, almost counterintuitive, pattern that highlights the mechanisms facilitating abnormal equity returns. Equity tranches of CLOs issued in 2006 and 2007, just before the onset of the financial crisis, have the best performance among all of the vintages in our sample. These vehicles locked in low-cost financing prior to the crisis and reinvested in high-yielding loans during and after the crisis. The result was a windfall of excess interest and principal for CLO equity investors as the economy recovered. This resilience to market volatility is also observed during the first nine months of the Covid-19 crisis. Equity distributions modestly decline in the second and third quarters of 2020 before returning to pre-crisis levels in the fourth quarter. However, it is too early to draw conclusions on the ultimate performance of outstanding CLOs, especially as the Covid-19 crisis continues to unfold.

This resilience is attributable to several structural features of CLOs. First, CLOs are closed-end vehicles in which capital inflows and outflows are limited. Second, coverage tests are based on par values and credit ratings instead of market prices. Consequently, market volatility does not cause the diversion of cash flows to pay down debt tranches unless the volatility coincides with rating downgrades and defaults. Third, embedded options to reinvest collateral and reissue debt after a non-call period enable opportunistic trading and refinancing by CLO managers. Finally, CLOs employ a long-term funding structure known as "term leverage" that insulates the vehicle from rollover risk. Unlike most levered investment vehicles that use short-term debt (e.g., hedge funds), CLOs issue long-term debt with maturities in excess of seven years and fixed credit spreads. With this funding structure, CLO equity can be viewed as mitigating market incompleteness by augmenting the span of tradeable claims.

While not a direct implication of our empirical results, it is important to note that traditional explanations of securitization predicated on information asymmetry are unlikely rationales for CLO issuance. Theories by Glaeser and Kallal (1997), Riddiough (1997), DeMarzo and Duffie (1999), and DeMarzo (2005) show that tranching mitigates the lemons problem that arises when informationally advantaged intermediaries sell their assets to investors. However, in the vast majority of CLOs, referred to as "open-market" deals, the manager acquires collateral by participating in loan syndicates or buying loans in the secondary market. Importantly, open-market CLO managers do not arrange the loans in their collateral pools. Indeed, CLO managers are often at an informational *dis*advantage to the loan arrangers, many of whom are investors in CLO debt.[2]

Existing research on CLOs has focused on their implications for financial contracting (Shivdasani and Wang (2011)), lender behavior (Benmelech, Dlugosz, and Ivashina (2012), Wang and Xia (2014), Bord and Santos (2015), Peristiani and Santos (2019)), and fire-sale risk in the loan market (Elkamhi and Nozawa (2020), Kundu (2020)). We extend this body of work by identifying the market frictions behind the issuance of CLOs and measuring the corresponding costs. In the process, we provide the first large-sample empirical evidence on the risk-adjusted investment performance of CLO assets and liabilities.

Our findings on risk-adjusted performance build on prior research examining the pricing of collateralized debt obligations (CDOs). Most papers in this literature focus on tranches of

[2]This distinction was central to the success of a lawsuit filed by the Loan Syndications and Trading Association against the Securities and Exchange Commission and the Federal Reserve Board arguing that CLO managers should be exempt from the risk retention rule imposed by the Dodd-Frank Act. The D.C. Circuit court ruled in February 2018 that open-market CLO managers are not "securitizers" as defined in the rule because these managers neither own nor control the asset that is transferred to the securitization vehicle. See *Loan Syndications & Trading Ass'n v. SEC*, 223 F. Supp. 3d 37 (D.D.C. 2016).

broad credit default swap indices (CDX) due to data availability.[3] CLOs differ from CDX in their function, channeling capital to firms rather than solely providing a venue for hedging and speculation by investors, as well as their form, including coverage tests to bolster senior tranches and incentives for managerial performance. The empirical evidence on CDX pricing is mixed. Applying a structural model to pre-crisis data on tranche spreads, Coval, Jurek, and Stafford (2009) find that senior tranches are overpriced (equivalently, offer negative risk-adjusted returns) and equity tranches are underpriced. Collin-Dufresne, Goldstein, and Yang (2012) dispute these claims, arguing that CDX tranches are properly priced when the model is adjusted to allow for near-term default by firms. Longstaff and Myers (2014) focus on the realized returns of CDX equity tranches, finding that they earn alpha that is close to zero and statistically insignificant. Based on this literature, the pricing of CLO tranches is an empirical question that we address using novel data on realized performance.

Our results also shed light on the conclusions of Liebscher and Mahlmann (2017) and Fabozzi et al. (2020), who argue that active trading by CLO managers reveals differential skill. We also find significant cross-sectional heterogeneity in manager style and performance. However, in aggregate, CLO managers do not exhibit superior skill in selecting or trading collateral relative to other participants in the leveraged loan market. Rather, the economic rents captured by managers appear to be driven by their access to institutional capital, especially that deployed in equity tranches.

Finally, we offer a different perspective on contemporaneous work by Griffin and Nickerson (2020), who identify discrepancies between the credit ratings of CLO tranches and leveraged loans during the Covid-19 crisis. Although collateral pools have become riskier in recent years, we show that CLO debt tranches are secured by significantly more collateral (i.e., lower leverage) than they were before the financial crisis due to post-crisis tightening of

[3]Exceptions include Ospina and Uhlig (2018) and Cordell, Feldberg, and Sass (2019), who investigate the performance of residential mortgage-backed securities and CDOs that invested in asset-backed securities (ABS CDOs), respectively, during the financial crisis. In related work, Chernenko (2017) studies the incentives and performance of CDO managers and Erel, Nadauld, and Stulz (2014) examine bank performance in the financial crisis as a function of AAA-rated securitization tranche holdings.

rating agencies' criteria for structured products. Therefore, any risk assessment of the CLO market should account for this countervailing force.

The remainder of the paper is organized as follows. Section 1 discusses our data sources and sample construction. Section 2 describes the relevant institutional details and the mechanisms governing payments to investors. Section 3 examines the risk-adjusted performance of CLO equity, assets, and debt. Section 4 presents supporting evidence to help interpret the performance results. Section 5 concludes.

1 Data

1.1 CLO Information

We use CLO data from Intex Solutions, a leading provider of information on structured finance products. Intex obtains data directly from trustees, third-party financial institutions responsible for enforcing the indenture that governs the structure, and packages it for use by both buy- and sell-side market participants. The data include information on deal structures, the histories of collateral holdings and transactions, cash distributions to each tranche, and fee payments. Our sample period begins in August 1997 and ends in March 2021.

Figure 1 compares the coverage of the Intex CLO data to the total size of the U.S. CLO market as reported by the Securities Industry and Financial Markets Association (SIFMA). Since 2007, Intex's coverage has exceeded 90% of the entire CLO market, with near-complete coverage since the financial crisis. This difference is due to the inclusion of a small number of "balance-sheet" CLOs, collateralized bond obligations (CBOs), and more recently, commercial real estate CLOs in the aggregate market data. We exclude these vehicles from our analysis to maintain focus on a homogeneous set of deals. We also exclude resecurizations, which differ from standard CLOs because their collateral consists of CLO tranches instead of leveraged loans. Thus, our data offer near-comprehensive coverage of the universe of standard "open-market" CLOs.

Table 1 summarizes the Intex data by annual vintage. CLO issuance grew rapidly in the early 2000s before the financial crisis all but eliminated new deals. Beginning in 2011, issuance increased rapidly again, with aggregate dollar issuance in 2014 exceeding the pre-2008 crisis peak. The delineation created by the financial crisis has led market participants to denote CLOs originated before and after the financial crisis as CLO 1.0 and CLO 2.0, respectively. More than just a temporal distinction, CLOs originated before and after the crisis differ in other ways that we explore below.[4]

The typical deal size is around $500 million with a leverage (debt-to-value) ratio of approximately 90%. Outside of a small number of deals issued during the financial crisis, there is a remarkable degree of uniformity across deals in terms of size and leverage, consistent with the findings in Benmelech and Dlugosz (2009). Further detail on the distributions of these variables may be found in the Internet Appendix.

1.2 Sample Selection

For our analysis, we require the identity of the collateral manager, information on distributions to each tranche, the presence of an equity tranche in each deal, leverage of at least 50%, and U.S. dollar denominated tranches. We focus on CLOs that invest in institutional term loans, as opposed to lines of credit. In total, these requirements reduce our sample size from 2,280 to 2,234 deals.

An additional requirement is a complete history of payments to each tranche, which reduces the sample to the 2,149 deals reported in the bottom row of Table 1. Missing data on distributions arise for two reasons. The first reason is the growth of Intex as a data provider over the last two decades. Older CLOs are less populated than more recent

[4]Another delineation is between broadly syndicated loan deals and middle-market deals. The former invest in loans to large firms that are originated by a bank and syndicated widely to bank and nonbank investors. The Intex data contain 2,091 broadly syndicated loan deals with a collateral value of $1.1 trillion, accounting for the bulk of our sample. In middle-market deals, the CLO manager plays a dual role, originating loans to small- and medium-size companies and purchasing them in a CLO that they manage. In aggregate, there are 189 middle-market deals worth $91 billion in the Intex data. We pool these deal types in our analysis because the findings in each segment of the market are qualitatively similar.

deals. The second reason is the relaxation of reporting requirements for CLO trustees after all secured tranches have been repaid. This relaxation can result in missing liquidation payments to equity tranches, a small number of which we fill with the aid of Bloomberg data and trustee reports. See the Internet Appendix for further details on the imputation of missing cash flows and our sample selection procedure.

A potential concern with this data requirement is selection bias if reporting is correlated with performance. However, our sample is only modestly affected, with most of the 5.7% reduction in observations coming from the CLO 1.0 period. Our sample contains 82% of deals issued before 2010 and 99% of deals issued since 2010. Further, consistent with our sample's representativeness, we find CLO tranche default rates that are similar to those reported by Standard & Poor's (2014) for rated CLOs issued between 1994 and 2013.[5] Ultimately, our sample offers the most comprehensive coverage of the CLO universe available in the academic literature and includes more than twice as many deals as prior papers studying the performance of CLOs (e.g., Liebscher and Mahlmann (2017), Fabozzi et al. (2020)).

The last column of Table 1 reports the number of deals that were fully paid down (i.e., completed) by March 2021. Because CLOs have a typical maturity of eight years, the number of completed deals mechanically declines as we approach the end of our sample horizon. CLOs also have a minimum life of two years but may be "called" by the equity investors before maturity to execute a refinancing or liquidate the deal, resulting in some completed deals from more recent vintages. This optionality is also a source of value for equity investors and a risk to debt investors. As such, we track each deal from origination through any refinancing events in our analysis of tranche performance.

[5]Standard & Poor's (2014) reports that default rates among publicly rated U.S. CLO tranches issued from 1994 to 2013 were 0.15% for investment-grade tranches and 1.05% for non-investment-grade tranches. The default rates in our sample are 0.22% for investment-grade tranches and 1.45% for non-investment-grade tranches issued over the same period. At this time, neither Moody's (2020) nor Standard & Poor's have noted any defaults from the CLO 2.0 vintages.

1.3 Supplementary Data

We supplement the Intex CLO information with data from several other sources, which are detailed in the Internet Appendix. IHS Markit provides information on loans in the collateral pool since 2002. Specifically, the Markit data contain loan characteristics and price quotes sourced from dealers in the over-the-counter secondary market for leveraged loans. These quotes are used by loan mutual funds to mark their portfolios to market.

Loan mutual fund data for 312 funds come from Morningstar Direct. These data are merged with return information from the Center for Research in Securities Pricing (CRSP), resulting in a final sample of 290 loan mutual funds for which we have return information. The S&P/LSTA U.S. Leveraged Loan 100 Index total return is sourced from Bloomberg.

To construct our benchmark indices for CLO debt tranches, we use daily bond-level quote data from Bank of America Merrill Lynch and interest rate swap data from Bloomberg. Finally, we obtain equity and bond index returns from Bloomberg and factor returns from Ken French and Zhiguo He's websites.

2 Institutional Details and Investor Distributions

2.1 CLO Life Cycle

Figure 2 illustrates the life cycle of a typical CLO. An asset manager begins the process by securing a line of credit with a bank to purchase the loans that will comprise the collateral pool. This pool consists primarily of floating-rate, senior secured term loans with maturities between five and seven years. Most loans are rated BB or B, below investment-grade, and are referred to as "leveraged loans" because of their high risk. The typical CLO holds loans issued by 150 to 250 distinct borrowers. Standard contract terms limit exposure to any industry at 15% of the loan pool and to any company at 2% of the loan pool. Contracts also limit the portfolio share of loans paying fixed or semi-annual (as opposed to quarterly) coupons, loans rated CCC+ or below, and loans that mature after CLO debt securities. The warehousing process of acquiring loans with the proceeds of the credit line takes six to nine months, after which the CLO is marketed to investors to raise long-term financing.

In return for their capital, investors receive claims on the cash flows generated by the collateral pool. These claims fall into two broad categories: secured and unsecured, which we refer to as debt and equity, respectively. Debt investors receive floating-rate claims secured by the loans in the collateral pool. The floating-rate nature of these claims matches that of the collateral, thereby insulating investors from interest rate risk. Debt claims are differentiated by their priority in the CLO capital structure – senior, mezzanine, and junior – and consequently the credit rating they are assigned and the interest rate spread they are promised. Equity investors receive unsecured, unrated claims.

Investors vary across the priority structure of claims based on their preferences and regulatory constraints. Banks invest primarily in AAA-rated senior tranches. Insurance companies and pension funds invest across the capital structure, while hedge funds and other alternative asset managers concentrate in mezzanine and junior debt. The equity tranche is usually funded in part by a private credit fund raised by the CLO manager's parent company, with outside investors contributing as well.

CLO managers pay down the line of credit with the issuance proceeds and continue purchasing loans from the market. This "ramp-up" period spans several months, but typically no more than six, until the collateral pool reaches the target principal amount specified in the CLO indenture. At this point, the CLO becomes "effective," and the manager shifts roles from building to managing the loan portfolio. The distribution of interest and principal payments received from the collateral pool begins at quarterly intervals. Covenants, such as coverage tests, become effective.[6]

Once effective, the CLO enters two overlapping but distinct phases, detailed in Figure

[6]Coverage tests ensure that the collateral is sufficient to repay secured noteholders. Three common tests include overcollateralization, interest coverage, and interest diversion. See Standard & Poor's (2018) for more details.

2. The first is the non-call period, which lasts two years. During this period, investors are protected from refinancing and early liquidation. The second is the reinvestment phase, which lasts four to five years. During this phase, the CLO manager actively trades loans to manage the credit risk and principal balance of the collateral pool, subject to the collateral quality requirements and coverage tests spelled out in the CLO indenture.

The amortization period is the last phase and occurs after the reinvestment phase ends. All principal generated by the loans is used to retire the outstanding CLO tranches and unwind the structure. At this stage, the manager's ability to buy and sell collateral is limited to the reinvestment of unscheduled principal payments. Thus, CLOs are actively managed investment vehicles for most of their lives.

2.2 Distributions to Debt

Cash flows from the collateral pool are distributed to investors according to a "waterfall," or priority structure set forth in the CLO indenture. Interest received from the collateral pool is first used to pay administrative expenses and senior management fees. The remainder is used to pay interest on the secured notes beginning with the senior noteholders, followed by the mezzanine noteholders, and then the junior noteholders. The priority of subordinated management fees varies from deal to deal, but the typical structure involves a fixed fee before equity is paid and an incentive fee conditional on the cumulative equity internal rate of return (IRR) exceeding a prespecified threshold.

Principal payments received during the reinvestment period are used to invest in new loans. After the reinvestment period, principal payments follow a similar waterfall. Those received after the reinvestment period, during the amortization phase, are used to pay down the principal of the secured noteholders according to the same priority structure as interest payments.

An exception to this distribution scheme occurs when a coverage test is failed. This failure occurs when the quality of the collateral pool deteriorates because of defaults or a large fraction of downgrades to CCC+ or lower. The consequence of failure is the repurposing of loan interest payments to pay down the principal of senior noteholders until the coverage test is passed. Any remaining interest is then used to pay interest according to the priority structure. Thus, coverage tests act as automatic stabilizers that deleverage the capital structure of the CLO and protect senior investors against the loss of principal.

2.3 Distributions to Equity

Distributions to equity come from excess interest and principal payments generated by the collateral pool. This excess cash flow arises from two credit enhancements present in all CLOs: overcollateralization and excess spread.

Overcollateralization refers to the aggregate par amount of the collateral pool being greater than that of the debt tranches. This excess collateral is purchased with the proceeds from the equity investors, though they have no contractual claim to it; equity is unsecured. As with interest payments, this excess collateral can be distributed to equity investors only after all of the debt tranches have been made whole. The average collateral value is approximately 112% of the face value of the secured notes. In other words, there is $1.12 in the collateral pool for each dollar of debt issued. In the median deal, AAA-rated tranches are secured with 161% of their value in collateral. The AA, A, BBB, and BB rated tranches have overcollateralization ratios of 139%, 128%, 120%, and 115%, respectively. Because leverage and overcollateralization are inversely related, Table 1 shows that overcollateralization has been increasing over time.

Excess spread refers to the difference in the value-weighted average interest spread on the collateral and that of the CLO debt. As long as the loans in the collateral pool perform by making interest payments, they produce cash flows that are greater than the required interest payments to debtholders. The excess is distributed to equityholders.

Panels A and B of Figure 3 illustrate the excess spread in our sample. Panel A presents the principal value-weighted average spread over LIBOR of loans in the collateral pool. Panel

B presents the same for CLO debt tranches. We compute these coupon rates by summing the interest rate spread and base rate, typically three-month LIBOR. We also account for the presence of some fixed-rate CLO debt tranches, as well as any pricing features included in the loan contracts (e.g., interest rate floors). The shorter series of collateral coupon rates for earlier vintages reflects our reduced ability to link their collateral to the IHS Markit data.

We note three aspects of these plots. First, the time-series pattern in both figures is similar, reflecting the evolution of LIBOR and credit risk premia over the sample period. Second, the level of the collateral coupon is higher than that of the CLO tranche coupon at each point in time, reflecting the excess spread. Third, the coupon rates differ across vintages at the same point in time, with particularly striking differences between the debt tranche coupon rates of pre- and post-crisis vintages.

Panels C and D in Figure 3 present the after-fee distributions to CLO equity tranches. In addition to reporting the time-series median by vintage group (Panel C), we also report the median in event time relative to each CLO's closing date (Panel D) to ease comparisons across vintage groups. Payout yields to equity investors are sensitive to changes in the macroeconomic environment. We see a V-shaped fall and rise in equity payout yields surrounding the financial crisis, when equity distributions fell to zero for the majority of CLOs. The steep fall in distributions was driven by the failure of coverage tests due to loan defaults and rating downgrades, which resulted in the diversion of cash flows to pay down senior note principal. However, as we will see, these temporary cash flow disruptions had a negligible effect on the overall performance of equity tranches issued before the 2008 crisis.

Focusing on the CLO 2.0 vintages, we notice a steadily declining life cycle of payout yields. This pattern results from the accumulation of defaults over a deal's life, which gradually reduce the principal value of the collateral pool and the interest stream it generates. Although the post-crisis period is not known for having a high level of corporate defaults, Moody's (2018) reports that global loan defaults by rated firms amounted to \$155.2 billion from 2011 to 2017, equivalent to about 10% of the leveraged loan market. Most of these defaults were by the non-investment-grade firms that populate the collateral pools of CLOs. Given the high leverage of the typical CLO, this level of default is sufficient to significantly reduce the excess cash flow available for CLO equityholders.

Comparing the pre- and post-financial crisis eras, CLOs issued immediately after the crisis have initial payout yields that are similar to the initial level observed in pre-crisis deals. However, at the same point in time after the financial crisis, the pre-crisis CLO vintages have noticeably higher payout yields than the newly issued post-crisis deals. This difference stems from the long-term liability structure of the CLO and the manager's ability to reinvest the collateral pool.

Pre-crisis CLOs issued debt and purchased loans at relatively low spreads. When the crisis hit in 2008, leveraged loan spreads increased, as did the spreads promised to debt investors in newly issued CLOs. As the economy recovered, spreads remained at relatively high levels in the persistently low interest rate environment (Roberts and Schwert (2020)). These high spreads entered the CLO collateral pools as loans turned over because of maturities, prepayments, and amendments. Thus, as spreads in the collateral pool increased, spreads on the liability side remained fixed at low, pre-crisis levels due to the long-term nature of CLO debt financing. The net effect is that pre-crisis CLOs earned higher excess spreads after the crisis, despite losing some collateral value to defaults during the Great Recession.

To shed light on the increasing cost of CLO debt over our sample period, Figure 4 presents the value-weighted average liability structure for CLOs issued in the 1.0 and 2.0 eras. Two changes in liability structure stand out. First, the leverage ratio of a typical CLO fell from 91% in CLO 1.0 to 89% in CLO 2.0. Second, and more importantly, the portion of the capital structure rated AAA fell from 72% in CLO 1.0 to 61% in CLO 2.0. These changes are attributable, at least in part, to changes in rating agency criteria that include increases in default probability assumptions by a factor of 30% (Moody's (2010)) and a tripling of default correlation assumptions (Nickerson and Griffin (2017)) in response to the severe losses of ABS CDO – not CLO – tranches in the financial crisis.

3 Risk-Adjusted Performance

This section presents our main empirical results on the investment performance of CLOs. We begin by documenting the historical returns of CLO equity tranches with descriptive performance metrics that can be estimated at the deal level but do not effectively adjust for risk exposures. We compute the performance metrics using after-fee tranche distributions and before-fee distributions that we construct with observed fee payments. To evaluate the risk-adjusted performance of CLO equity, we estimate the generalized public market equivalent (GPME) of Korteweg and Nagel (2016). We use the same technique to assess the performance of CLO collateral and debt tranches after showing that their respective cash flow streams must be priced differently for equity to exhibit abnormal performance.

3.1 Initial Evidence on Equity Performance

Table 2 presents results on the after-fee performance of CLO equity tranches by annual vintage and era, as well as for the entire sample period.[7] Panel A reports internal rates of return (IRRs), computed as the discount rate equating the present value of the cash distributions to the value of the original investment. The average IRR was 9.2% for CLOs issued between 1997 and 2016. As a point of reference, Harris, Jenkinson, and Kaplan (2014) find an average IRR of 10.1% for private equity buyout funds raised between 2000 and 2008, which is lower than the average IRR of 13.1% for CLOs issued during the same period.

Equity IRRs exhibit significant variation in the cross-section and time series. Somewhat surprising is the robust performance of CLOs issued between 2005 and 2007, just before the financial crisis. Median IRRs for these three years are all above 13%, despite an average lifetime that encompasses the Great Recession. Panels C and D of Figure 3 offered a preview of these results. Recall that CLO managers of these pre-crisis vintages were able to

[7]The performance metrics computed are based on an initial investment equal to the par value of equity from trustee reports. To the extent that equity investors purchase their stakes at a discount to par, which conversations with market participants indicate is not unusual, then our analysis understates the true performance of CLO equity.

reinvest principal payments during the crisis to take advantage of (1) discounted loans in the secondary market and (2) increasing interest rate spreads on newly issued loans. Because CLO funding spreads were fixed at low, pre-crisis levels, equity investors were the beneficiary of even more excess interest as a result of (2). Further, the additional overcollateralization resulting from (1) led to larger liquidating payments to equityholders.[8]

What amplified the effects of this increased cash flow is a unique feature of CLO equity that practitioners refer to as "term leverage." Because a CLO is a closed-end vehicle funded with long-term debt, the equity tranche is able to maintain a levered position over the life of the vehicle – up to ten years. This is in stark contrast to most other levered investors (e.g., banks, hedge funds) whose funding is typically short term. This feature became particularly valuable during the financial crisis when many institutional investors taking levered positions were forced to reduce leverage or liquidate their positions (Mitchell and Pulvino (2012)). In addition, credit risk premia increased in the post-crisis period (Berndt et al. (2018)), resulting in a higher cost of debt capital for borrowers. In contrast, CLO managers were able to maintain a highly levered position through the crisis without any increase in their debt servicing costs due to the long maturity of CLO securities. When markets recovered, this levered position paid off handsomely.

Panels B and C of Table 2 present public market equivalent (Kaplan and Schoar (2005)), or PME, estimates that reinforce these findings. For each CLO, we discount the cash flow stream using the realized returns of a benchmark portfolio and sum the present values. We then compute the ratio of this sum to the size of the initial investment. The result is a profitability index that measures the present value of distributions for each dollar invested. A PME greater than one indicates that investors earned more in present value terms than what they paid, while a PME less than one suggests the opposite.

We use two benchmarks for our calculations. The first is the S&P 500 Index, which is motivated by two observations. Many alternative asset managers compare their performance

[8]Of course, these benefits are constrained by the potential for loan defaults or sales at discounted prices. The overall performance of CLO equity reflects the net effect of these opposing forces.

to broad market indices (Kaplan and Schoar (2005)), suggesting that the S&P 500 Index is a practically relevant benchmark. We refer to the PME measured relative to the S&P 500 Index as "PME Market."

The second benchmark is the S&P 500 Banks sub-index, a portfolio of the largest bank stocks. As a type of shadow bank, CLOs are similar to commercial banks in several ways. Both have highly levered capital structures and assets comprised primarily of loans. Like banks, CLOs generate profits by borrowing at a market rate and lending to firms at a higher rate. Although they pursue different forms of financing, with banks relying on short-term deposits and wholesale funding while CLOs issue long-term floating-rate notes, their financing costs are similarly exposed to short-term interest rates. Longstaff and Myers (2014) find that the equity tranche returns of investment-grade and high-yield CDX, widely traded synthetic CDOs of the most liquid corporate credit default swaps, behave similarly to the returns of financial stocks. Of course, there are also important differences, such as banks' activities other than commercial lending and the influence of deposit insurance. We refer to the PME measured relative to the S&P 500 Banks sub-index as "PME Bank."

Panel B reports an average PME Market of 1.31, implying that CLO equity earned higher returns than an index of public equities. Once again this compares favorably against the PMEs of buyout funds, which Harris, Jenkinson, and Kaplan (2014) estimate as 1.27 for vintages from 2000 to 2008. Looking across vintages reveals that this outperformance comes almost entirely from the pre-crisis vintages, 2005 to 2007, much like what we saw in Panel A. We also note a decrease in the dispersion of PMEs in the CLO 2.0 era, as evidenced by their shrinking standard deviation and interquartile range. CLO equity performance has become more homogeneous over time.

Panel C presents results for the PME Bank metric. The relatively poor performance of banks during and after the financial crisis leads to PMEs that are substantially larger when compared to their counterparts in Panel B. The overall average PME of 2.38 is impressive, but as with prior panels, there are significant differences between pre-financial crisis and post-financial crisis CLOs. Buying CLO equity prior to 2009 earned investors 3.44 times what they would have earned investing in bank equities. The analogous multiplier is only 0.80 for vintages from 2009 onward, implying that bank stocks have offered higher returns than CLO equity since the financial crisis.

The three panels of Table 2 paint a consistent picture of CLO equity performance and identify a strength of the CLO structure. Term leverage provides resilience in the face of market volatility, as seen in the performance of deals issued immediately prior to the financial crisis. This unique feature of CLO equity enables managers to attract capital to the bottom of the vehicle's capital structure. In light of the contrast with other levered investment vehicles, CLO equity mitigates market incompleteness by providing a levered equity claim that is largely immune to rollover risk. We provide further evidence on the resilience of CLOs to market volatility in Section 4.3.

3.2 Management Fees

CLO managers often retain equity to provide a signal of quality to investors or, for a brief time during our sample, to comply with regulations.[9] To evaluate the performance of "inside" equity held by CLO managers, we add the management fees described above to the after-fee equity distributions to form a panel of before-fee equity payouts.

Intex provides a complete history of fee payments for 69% of the completed deals in our sample. For deals without historical fee data, we estimate fees using the contractual fee rates specified in the offering memorandum, available for an additional 3% of completed deals. Specifically, we calculate the senior fee as a percentage of the collateral balance each quarter, as well as a subordinated fee that is paid conditional on a non-zero distribution to

[9]Requirements of CLO managers to take positions in the CLOs that they manage have varied over time. Throughout our sample period, retention of equity is dictated by market participants' desire to invest in CLOs whose managers have skin in the game. In addition, the Credit Risk Retention Rule of the Dodd-Frank Act legally required CLO managers to take positions in their CLOs as of December 24, 2016. Specifically, managers were required to retain 5% exposure to the CLO assets, through either a "horizontal" investment in equity or a "vertical" investment in each tranche. However, open-market CLO managers were exempted from this requirement as the result of a D.C. Circuit court ruling in February 2018. See *Loan Syndications & Trading Ass'n v. SEC*, 223 F. Supp. 3d 37 (D.D.C. 2016).

equity. Incentive fees are often structured in a complex manner, so we omit them from the estimation to avoid overstating the before-fee cash flows. Finally, we use the sample median senior and subordinated fees of 15 and 30 basis points (bps), respectively, for the remaining 28% of deals with neither historical nor contractual fee data.

Figure 5 shows that the typical fee is about 50 bps of the collateral balance before the incentive fees are triggered. The increase in fee payments near the maturity of the CLO 1.0 vintages demonstrates the impact of incentive compensation on successful deals. The slight reduction in fees since 2017 is consistent with managers competing for capital flows.[10]

Table 3 shows that all of the equity performance metrics are higher before fees. Although this improvement is not surprising, its magnitude is striking due to substantial fees earned by CLO managers. With the typical CLO having a leverage ratio of 90%, senior and subordinated management fees totaling 0.5% of the collateral balance are equivalent to approximately 5% of the equity balance per year. This fee stream is even richer for the CLO 1.0 transactions that cleared the IRR threshold for incentive compensation.

As a result, the average IRR increases by more than 50% when fees are included, rising from 9.2% to 15.9%. The PMEs increase by approximately 25%. While the time-series patterns are similar to those found in Table 2, a notable difference is that the PMEs for CLO 2.0 deals are much closer to one.

3.3 Risk-Adjusted Performance

The PME analysis provides descriptive evidence on the performance of CLOs, but it cannot tell us whether CLO equity offers abnormal performance because it implicitly assumes that the market beta is equal to one. To address this issue, we implement the generalized public market equivalent (GPME) of Korteweg and Nagel (2016).[11] This framework adjusts for the beta exposure of test assets and allows for statistical inference that accounts for correla-

[10] One limitation of our fee data is that we cannot observe side agreements between investors and managers. According to several CLO managers with whom we spoke, "back-end rebates" and other transfers between managers and investors occur outside of the indenture and are not made available to the CLO trustee.

[11] We thank Arthur Korteweg and Stefan Nagel for providing the GPME code on their websites.

tion across deals. Specifically, the GPME discounts cash flows with an exponentially affine stochastic discount factor (SDF),

$$M_{t+h}^{h} = \exp\left(ah - br_{m,t+h}^{h}\right),$$

summing each CLO's discounted cash flows and averaging across all deals. Distributions are normalized to an initial investment of \$1 so the baseline GPME estimate is relative to zero, in contrast to PMEs, which have a baseline of one. The SDF parameters are chosen to correctly price the risk-free asset and factor returns, which ensures that the valuation properly benchmarks against contemporaneous factor performance. A limitation of this approach is its reliance on a sufficiently long time series, which requires use of the entire sample as opposed to the subsamples defined by CLO 1.0 and 2.0.

We focus on CLO equity performance because the balance-sheet identity implies that abnormal equity performance is associated with a difference in the pricing of the collateral and the debt tranches. Specifically, if the equity payoff E per dollar invested P_E is abnormally high based on an SDF M,

$$\frac{E\left[ME\right]}{P_E} > 1, \tag{1}$$

then the difference between the present values of the collateral C minus the present value of debt D, weighted by their respective par values, must also be abnormally high:

$$\left(\frac{P_C}{P_E}\right)\frac{E\left[MC\right]}{P_C} - \left(\frac{P_D}{P_E}\right)\frac{E\left[MD\right]}{P_D} > 1. \tag{2}$$

To shed further light on the drivers of any abnormal performance, we apply the same SDF to the collateral and debt tranches. However, we should note that the GPME framework is not well equipped to match changes in the term structure of interest rates, so its ability to price fixed-income claims is limited. Thus, these estimates should be interpreted with caution.

Table 4 presents the GPME estimates. For robustness, we consider several SDF specifications, beginning with the capital asset pricing model (CAPM). To account for the option-like payoffs of CLO tranches and potential segmentation between the corporate equity and debt markets, we include the returns on the S&P/LSTA U.S. Leveraged Loan 100 Index, the Bloomberg-Barclays U.S. Corporate High Yield Bond Index, and the CBOE S&P 500 Put-Write Index with the equity market return in alternative two-factor models. We apply the intermediary asset pricing model from He, Kelly, and Manela (2017), which has been shown to successfully price risky fixed-income assets including corporate bonds and credit default swaps. Finally, we consider the Fama and French (1993) three-factor model. In the Internet Appendix, we show that our results are robust to alternative pricing models.

The top section of Table 4 reports after-fee GPME estimates. All of the specifications reveal a positive equity GPME that is statistically significant at the 1% level. The estimates imply that in present value terms, outside equity investors earn between 35 cents and 65 cents per dollar invested above what they could earn by investing in public market factors.[12] Consistent with the balance-sheet intuition discussed above, the GPME is higher for collateral than for debt tranches in each specification, though the choice of SDF affects whether the GPME is positive or negative. The weighted averages of the collateral and debt tranche GPMEs, reported as "implied equity," are slightly lower but in line with the equity GPMEs.

The middle section reports analogous estimates for "inside" equity investments by CLO managers, inclusive of estimated fees. In line with the after-fee results, the GPMEs are positive and statistically significant across the board. Economically, the point estimates imply that in present value terms, CLO managers earn between 66 cents and 109 cents per dollar invested above what they could earn by investing in public market factors. The difference between the after-fee and before-fee GPME estimates implies that the present value of manager compensation amounts to between 30 cents and 44 cents per dollar of equity raised, or between 40% and 50% of the surplus created by CLO issuance. Because

[12]It is possible that the outperformance of CLO equity reflects compensation for illiquidity. Although we cannot rule out this possibility, we should note that illiquidity does not necessarily imply a large effect on returns. Following Constantinides (1986), investors in equity tranches are likely to have a long horizon, while impatient investors stay away in anticipation of high secondary market transaction costs. In this equilibrium, the marginal equity investor would require little compensation for illiquidity. The Internet Appendix shows that the GPMEs are unaffected by including the Pastor and Stambaugh (2003) liquidity factor in the SDF.

managers often hold a portion of the equity tranche, these shares are likely conservative estimates of the surplus extracted by managers.[13] As expected, collateral performance is stronger on a risk-adjusted basis when fees are included, and the weighted average with debt tranches is again consistent with the balance-sheet identity.

Overall, these results imply that CLO managers are able to earn "alpha" over public benchmarks that is shared between themselves and outside equity investors. Since equity investors receive the residual cash flow from the collateral pool after debt tranches are paid, we observe that this outperformance comes from differences between the pricing of leveraged loans and CLO debt tranches. Although the evidence does not allow us to take a strong stand on whether loans trade at a discount or debt tranches trade at a premium, previously discussed evidence on the impact of CLOs on loan spreads (e.g., Ivashina and Sun (2011), Nadauld and Weisbach (2012)) and investor behavior (e.g., Becker and Ivashina (2015), Merrill, Nadauld, and Strahan (2019)) suggests that both may be at work.

4 Interpretation of Equity Performance

This section presents auxiliary results that help shed light on the abnormal performance of CLO equity and the market imperfections underlying the rise in CLO issuance. First, we examine whether the high returns of CLO collateral relative to debt tranches are attributable to informed trading by CLO managers. Second, we compare the performance of debt tranches to similarly rated corporate bonds to understand why investors are willing to pay relatively high prices for CLO debt. Third, we present evidence from the financial and the Covid-19 crises to show how the long-term structure of CLOs provides resilience to market volatility and facilitates outperformance. Finally, we discuss time variation in performance and the market forces behind the decline in equity payoffs over our sample period.

[13] Management fees are compensation for the labor input of CLO managers. We do not take a stand on whether this compensation is too high or low and focus instead on the ability of managers to generate outperformance relative to public benchmarks.

4.1 Collateral Performance

How are CLO managers able to generate abnormal equity returns? One possibility is that managers have skill in selecting and trading loans. To assess this hypothesis, we require information on collateral cash flows and fees. Because data on the cash flows generated by CLO collateral are sparsely populated in Intex, we exploit the balance sheet identity to compute the after-fee cash flows of CLO collateral as the sum of distributions to all CLO debt and equity tranches. Before-fee cash flows are computed as the sum of after-fee cash flows and management fees.[14]

We assess the performance of CLO collateral using PME estimates against two benchmarks for the leveraged loan market. The first is the S&P/LSTA U.S. Leveraged Loan 100 Index, which has a correlation of 0.99 with a value-weighted portfolio of all leveraged loans in the IHS Markit Loan Pricing database. The second is a value-weighted return of loan mutual funds in the intersection of the Morningstar Direct and CRSP databases. The first provides a benchmark for before-fee cash flows, the second an investable benchmark for after-fee cash flows. We emphasize that these benchmarks are chosen to test whether CLO collateral earns high returns relative to other leveraged loans and not to make statements concerning abnormal risk-adjusted performance, which is covered in Section **??**.

Table 5 reports the PME estimates for CLO collateral distributions by vintage, era, and for the entire sample. Panel A shows that gross of management fees, CLO collateral pools generate cash flows that are slightly lower than the return of the leveraged loan market. The overall average PME of 0.98 implies that one dollar invested in CLO collateral would generate the same cash flows as 98 cents invested in the leveraged loan index over our sample

[14] Our estimates of collateral cash flows may be biased downward for several reasons, including unobserved payments (taxes, administrative fees, petition fees, hedge payments), the use of collateral interest to purchase additional collateral in the event of coverage test or tranche rating impairment during the reinvestment period, or the use of collection and supplemental reserve accounts. Importantly, any downward bias in collateral cash flows implies that the true difference in pricing relative to debt tranches is even larger than estimated in Table 4. In the Internet Appendix, we use Intex data on collateral cash flows for a subset of our sample to quantify the bias. We also provide alternative tests of informed trading by CLO managers, which we discuss below.

period. To test whether the PME is statistically different from one, we construct a J-test using the spatial GMM covariance matrix from Korteweg and Nagel (2016), which accounts for correlated performance across deals by assuming that correlation declines with the degree of overlap in their time windows. We find that the PME is statistically significant at the 1% level, indicating that CLO collateral has statistically underperformed the loan index.

The pre- and post-crisis eras – CLO 1.0 and CLO 2.0 – lead to a similar conclusion. Though the CLO 1.0 vehicles exhibit statistically significant underperformance relative to the LSTA Index (0.97), the difference is economically small and insignificantly different from both the CLO 2.0 and overall averages (0.98). One explanation for this slight underperformance could be an underestimation of the fees, which leads to an underestimation of the gross cash flows from the collateral pool.

Panel B presents analogous results for after-fee collateral distributions relative to a value-weighted index of loan mutual funds. For context, the average mutual fund in our sample has an annual fee of 62 bps, slightly higher than the typical CLO. The average PMEs for the whole sample and across CLO 1.0 and 2.0 eras show no statistically or economically significant difference from one.

In sum, the results in Table 5 show that, in aggregate, CLO collateral offers similar returns to a value-weighted index of leveraged loans. This is unsurprising, as CLOs fund a majority of leveraged loan issuance, approximately two-thirds by the end of our sample period. Further, CLOs are contractually obligated to hold highly diversified pools of loans, as previously discussed. Thus, any surplus generated by the average CLO is not due to managerial skill at selecting loan collateral.

To provide additional evidence on this front, in the Internet Appendix we analyze the excess returns after collateral transactions. If CLO managers trade on private information, we should expect collateral purchases to have higher returns than collateral sales. However, we observe no economically or statistically significant difference between the post-trade returns of purchases and sales, which suggests that the average trade is not motivated by an informational advantage.

It is worth mentioning a distinguishing feature of CLOs versus other securitization vehicles. Open-market CLOs, which comprise 94% of the completed deals in our sample, do not originate any of the loans in their collateral pools. Rather, CLOs participate in the syndication process or purchase loans in the secondary market. In fact, many of the banks originating the leveraged loans that wind up in collateral pools are themselves investors in CLO tranches. Thus, the traditional lemons problem used to justify tranching (e.g., DeMarzo (2005)) is less relevant here than in other securitization markets. The evidence in Table 5 supports this conclusion by showing that CLO managers do not have an informational advantage relative to other market participants.[15]

4.2 Debt Performance

The GPME estimates in Table 4 suggest that CLO debt tranches earn low risk-adjusted returns, or command high prices, relative to leveraged loans. Why do CLO debt tranches appeal to investors and in particular the banks and insurance companies that provide the majority of funding for senior tranches? To shed light on this question, Table 6 presents two measures of economic returns for debt tranches grouped by credit rating at issuance over the CLO 1.0 and 2.0 eras, and the full sample.[16]

Panel A presents internal rates of return (IRRs). Average IRRs are monotonically related to their initial ratings, reflecting compensation for credit risk, and range from 2.37% for AAA-rated tranches to 6.55% for B-rated tranches over the full sample. IRR volatilities follow a similar pattern and are inversely related to credit rating. These patterns hold across the

[15] This claim refers to the aggregate CLO market, but it is possible that individual managers have access to superior information. The Internet Appendix provides evidence on the determinants of relative performance across managers and shows that some managers are able to generate persistent outperformance through collateral selection and trading, consistent with the findings of previous studies by Liebscher and Mahlmann (2017) and Fabozzi et al. (2020).

[16] In the Internet Appendix, we present evidence on debt tranche performance in terms of credit rating changes. All classes of debt experienced sharp downgrades in the financial crisis, but most tranches recovered to their original rating, and some mezzanine tranches were even upgraded above their original ratings. Outside of the financial crisis, CLO tranche ratings were stable over our sample period.

CLO 1.0 and 2.0 eras, though the latter period exhibits average IRRs that are more than 0.8% higher for tranches rated between AA and BBB.

Panel B presents PMEs in the same manner as IRRs. For CLO debt tranches, corporate bonds with the same credit rating are a natural benchmark, but they suffer from a duration mismatch that creates different exposures to interest rate changes. Recall that CLO tranches are floating-rate instruments with an effective duration of less than one year. In contrast, corporate bonds are fixed-rate instruments with an average maturity of 10 years, or approximate duration of seven years.

To address this mismatch, we construct synthetic floating-rate corporate bond returns by swapping the fixed coupon payments into floating payments using interest rate swaps. This calculation assumes an investor buys the corporate bond at issuance and enters into a payer swap. We use changes in the interest rate swap curve to mark the swap to market, which allows for the calculation of daily returns on the synthetic floating-rate bond. We compute benchmark indices for each rating category by value-weighting the synthetic floating-rate returns of individual bonds.[17]

Unlike IRRs, the average PMEs do not vary monotonically with credit rating, nor should they if the benchmark is accurately capturing risk, though the PMEs tend to be higher for lower-rated tranches. The PMEs also exhibit relatively little temporal or cross-sectional variation. The standard deviations for the full sample range from 0.08 for AAA-rated tranches to 0.23 for B-rated tranches. Comparing PMEs across the two subperiods, we see similar distributions, except for the B-rated CLO 1.0 tranches, of which there are only six observations, including one that defaulted during the Great Recession.

One distinguishing feature of the estimated PMEs is that every average is greater than one. In the full sample and both subperiods, nearly all of these estimates are statistically different from one at the 1% level using the spatial GMM framework from Korteweg and

[17]For the AAA benchmark, we include both AAA and AA rated corporate bonds because very few corporate issuers are rated AAA. Our results are robust to including only AAA-rated bonds in the benchmark. Details on the synthetic floating-rate corporate bond returns are provided in the Internet Appendix.

Nagel (2016). Furthermore, the 25th percentile is greater than or equal to one for all but AAA tranches in the CLO 2.0 period. Overall, the PME estimates suggest that CLO tranches have earned higher returns than similarly rated, synthetic floating-rate corporate bonds.

To put the PMEs in the context of returns, we compute the difference between the IRR and the benchmark return over the same period. Senior tranches, rated AAA, earn about 0.5% more per year than similarly rated floating-rate corporate bonds. This return differential increases for lower-rated tranches, with mezzanine tranches, rated AA to BBB, earning 0.9% to 1.4%, and junior tranches, rated BB and B, earning 1.8% to 2.2% more than their respective benchmarks.[18]

Although the results in Table 6 are suggestive of outperformance, the GPME analysis in Table 4 suggests that debt tranches earn normal or even abnormally low risk-adjusted returns. It is likely that the high returns relative to corporate bonds are due to differential risk factors not captured by the PME adjustment. CLO tranches are more exposed to systematic risk than corporate bonds issued by individual firms because a widespread economic downturn, involving defaults by firms in several industries, is necessary for CLO debt to become impaired. Coval, Jurek, and Stafford (2009) describe these as "economic catastrophe bonds" and note that credit ratings only account for the probability of default, rather than the states of the economy in which default occurs. Therefore, the high returns of CLO tranches could be explained by compensation for systematic risk exposure (Elkamhi, Li, and Nozawa (2020)).Consistent with this interpretation, the realized default rate of CLO tranches is significantly lower than the default rate on corporate bonds over our sample period (Standard & Poor's (2014), Moody's (2020)), which suggests that the "catastrophe" necessary to cause CLO defaults has not yet occurred.

[18]After the financial crisis, some researchers (e.g., Griffin and Tang (2012)) argued that the credit ratings on structured products were inflated. This is irrelevant to our analysis of regulated investors' incentives, which depend on actual ratings rather than correctly calibrated ratings. It also highlights a benefit of the GPME analysis in Section 3.3, which does not rely on credit ratings. Nevertheless, we address this possibility in the Internet Appendix by presenting PME estimates relative to corporate bonds rated lower than the CLO tranches. This analysis reveals that AAA-rated tranches have similar returns to A-rated corporate bonds, while mezzanine and junior tranches earn significantly higher returns than lower-rated bonds because they pay similarly high coupon rates but have defaulted at much lower rates.

Illiquidity and prepayment risk are additional differences that could be responsible for the relatively higher returns of CLO debt tranches. The secondary market for CLO tranches is opaque, but Hendershott et al. (2020) provide evidence on its liquidity using regulatory data. Although CLOs have lower bid-ask spreads than corporate bonds, they trade much less frequently and have higher costs of failed trades. Finally, CLO debt is almost always callable, with a standard non-call period of between six months and two years (Standard & Poor's (2018)). In contrast, Becker et al. (2018) show that only one-fifth of investment-grade corporate bonds have a call feature, while three-quarters of non-investment-grade corporate bonds are callable. As noted above, we track each tranche from origination through any refinancing events, so all else equal, a debt tranche that is refinanced to reduce its spread will have lower returns than a tranche that is not.

In sum, CLO debt tranches offer high returns relative to similarly rated corporate bonds, which helps to explain their low risk-adjusted returns relative to CLO collateral. Banks and insurance companies, which are responsible for purchasing the majority of senior CLO debt (DeMarco, Liu, and Schmidt-Eisenlohr (2020), Foley-Fisher, Heinrich, and Verani (2020)), face capital requirements that are directly tied to credit ratings. This regulation creates two distinct incentives. First, banks prefer safer assets to riskier assets, which face higher capital charges, to relax their capital constraints. Indeed, Irani et al. (2020) show that banks' incentives to sell risky loans are directly linked to their capitalization ratios. Second, banks and insurers "reach for yield" (Becker and Ivashina (2015), Merrill, Nadauld, and Strahan (2019)) by selecting the highest-yielding debt instruments in a rating category. Outside of regulatory considerations, senior debt tranches cater to the demand for safe assets (Gorton, Lewellen, and Metrick (2012)) stemming from a desire to smooth consumption (Gorton and Ordonez (2013)), and to acquire informationally insensitive collateral (Dang, Gorton, and Holmstrom (2019)). All of these forces shift demand from leveraged loans toward CLO debt tranches, creating a pricing differential that allows CLO equity to earn abnormal returns.

4.3 Equity Performance in Crises

One of the striking patterns in Table 2 is the outstanding performance of CLOs that were issued on the eve of the financial crisis. Earlier in the paper, we explain how these deals locked in low spreads on debt tranches and reinvested into loans with high spreads after the crisis. To shed further light on this phenomenon and the reasons why CLOs were able to survive through the crisis period, in this section we focus in on the balance sheet condition and cash distributions of CLOs during the financial crisis of 2008 and the more recent Covid-19 crisis of 2020.

Figure 6 presents several measures of interim performance for CLOs outstanding in the financial and Covid-19 crises. The left side of each panel is based on data from December 2007 to June 2010, while the right side covers March 2019 to December 2020. The scale of the y-axes in each row of plots is the same, allowing for direct comparisons across the two periods. The x-axes have the same scale within each column to ease comparisons across the different performance metrics. We emphasize that these measures represent only performance to date and should not be compared to previous measures of completed deal performance such as IRRs, PMEs, or GPMEs.

Panel A of Figure 6 presents median market value coverage ratios for CLO debt tranches by rating category. These ratios are computed by dividing the market value of the collateral portfolio by the principal balance of that tranche and all tranches senior to it. To illustrate, consider a CLO with just two tranches: a AAA-rated tranche with principal of \$100, and a BBB-rated tranche with principal of \$20. If the market value of collateral is \$140, then the AAA coverage ratio is 1.4 (140/100), and the BBB coverage ratio is 1.17 (140/120). Ratios greater than one correspond to a full expected recovery, while values below one correspond to an expected loss of principal.

Several features of Panel A are worth noting. First, coverage ratios respond to fundamental shocks quickly, as indicated by the steep drops following the Lehman Brothers bankruptcy and the imposition of economic shutdowns to fight Covid-19. Second, during the financial crisis, all debt tranches were undercollateralized, with the median deal being nearly 30% underwater in early 2009 and even AAA-rated tranches experiencing collateralization ratios below 0.90. Finally, coverage ratios are significantly higher today than they were a decade ago, a result of lower leverage in CLO 2.0 transactions.

Panel B shows that equity distributions respond gradually to these market value shocks, despite the insolvent condition of CLO balance sheets in late 2008 and early 2009. In the second and third quarters of 2009, the median deal paid nothing to equity investors due to coverage test failures that diverted cash flows to repay senior tranches. However, distributions rebounded to their pre-crisis level by mid-2010 and only improved from that point, as we saw in Figure 3. Due to the less severe shock to fundamentals in the Covid-19 crisis, we see only a small dip in equity payouts in the third quarter of 2020.

The evidence presented here and the strong performance of pre-crisis CLOs highlight the resilience of the CLO structure, which is due to several features. First, CLOs are closed-end vehicles in which capital inflows and outflows are limited. Second, coverage tests are based on par values and credit ratings instead of market prices. Consequently, market volatility does not cause the diversion of cash flows to pay down debt tranches unless the volatility coincides with rating downgrades and defaults. Third, CLOs employ a long-term funding structure known as "term leverage" that insulates the vehicle from rollover risk. Unlike most levered investment vehicles that use short-term debt (e.g., hedge funds), CLOs issue long-term debt with maturities in excess of seven years and fixed credit spreads. Finally, embedded options to reinvest collateral and reissue debt after a non-call period enable opportunistic trading and refinancing by CLO managers.

Indeed, the relatively strong performance of CLO 1.0 deals, which benefited from higher loan spreads induced by the crisis, suggests that CLO equity could be viewed as an option on a crisis. Consistent with this notion, we provide evidence in the Internet Appendix that deals with a longer time remaining in the reinvestment period, more distance from coverage ratio thresholds, and higher leverage at the start of the financial crisis had better equity performance. Since CLO 2.0 deals that paid down by the end of our sample period did not have such an opportunity, this could explain their relatively weak performance.

4.4 Temporal Variation in Equity Performance

Table 2 reveals a clear temporal pattern in equity performance. IRRs and PMEs are declining over time, with both the mean and standard deviation falling from the CLO 1.0 to CLO 2.0 eras. There are several forces responsible for these changes.

First of all, CLO 2.0 deals have materially higher debt servicing costs due to an increase in the credit spreads on newly issued CLO securities. CLO 2.0 transactions also have a significantly smaller fraction of AAA-rated debt. These changes are attributable to changes in credit rating agency criteria after the financial crisis, which we discuss above, as well as changes in the pricing of credit risk in securitization markets. The net effect is that post-crisis CLO managers face less attractive financing terms, which reduces the excess spread they earn relative to the managers of pre-crisis CLOs.

Second, the "arbitrage" opportunity that CLOs exploit is disappearing as more capital flows toward into the market. Expanded issuance of CLOs increases the supply of CLO tranches and the demand for leveraged loans (Ivashina and Sun (2011), Nadauld and Weisbach (2012)). Both of these forces have a negative effect on the excess spread earned by CLO equity. As a result, we observe that the most recently issued vintages (2017 to 2019) have lower initial distributions than earlier post-crisis vintages (see Figure 3).

The growth of the market has also resulted in greater competition among managers. There are 144 managers in our sample for CLOs issued prior to 2010 while there are 195 managers after that time, an increase of 35%. There are 140 new entrants in the market since 2010. The effects of increasing competition can be seen in management fees, which we present in Figure 5. There is a noticeable reduction in fees since 2017, consistent with managers competing to attract investors.

Finally, it is important to note that right-censoring in the sample of complete deals may lead to selection bias. Only a fraction of post-crisis deals have finished making cash distributions, and many of these deals were completed as a result of manager decisions (e.g., early liquidation) rather than the expiration of the vehicle. However, the interim evidence on active CLOs suggests that this is not a significant concern. Figure 3 shows that recently issued CLOs, regardless of completed status, have higher financing costs and lower initial equity distributions than pre-crisis transactions. Given the declining life cycle of CLO equity payouts, it is reasonable to expect that outstanding deals will provide lower returns than earlier vintages. Ultimately, this depends on the future path of defaults and credit spreads.

5 Conclusion

This paper provides novel evidence on the market imperfections responsible for the widespread securitization of corporate loans by examining the performance of CLO assets and liabilities. We show that CLO equity earns abnormal positive returns by exploiting risk-adjusted price differentials between the market for leveraged loans and the market for CLO debt securities. This surplus does not come from managerial skill in selecting leveraged loans, though there is heterogeneity in performance across managers. The average CLO asset pool offers similar returns to a broad index of leveraged loans and a portfolio of loan mutual funds. Rather, what distinguishes CLO managers appears to be their access to risk-bearing capital, particularly that supporting the equity tranche.

We also find that CLO equity exhibits a great deal of resilience to market volatility, with the best-performing vintages issued just prior to the financial crisis. Similar resilience is observed during the first nine months of the Covid-19 crisis. This resilience is due to the long-term, closed-end financing structure of CLOs, which provides equity investors with a levered position insulated from capital outflows and rollover risk.

CLO debt outperforms similarly rated and duration-matched corporate bonds but underperforms CLO collateral on a risk-adjusted basis. This distinction is due to the failure of credit ratings to capture systematic, liquidity, and prepayment risks. Nonetheless, high-yielding assets within a credit rating are particularly attractive to the banks and insurers that provide the bulk of funding for most CLOs. Senior CLO tranches satisfy these intermediaries' reach-for-yield incentives and demand for safe assets.

Despite the progress made here, important questions remain. How will outstanding CLOs perform through the remainder of the Covid-19 crisis and beyond? Will the CLO market continue its rapid growth after the resumption of issuance in mid-2020? What are the implications of this growth, or lack thereof, for corporate borrowers, CLO investors, and financial stability? Finally, what are the broader welfare effects of CLOs? Our analysis focuses on the gains to CLO managers and investors, but the equilibrium effects on corporate borrowing costs and the potential risks of regulatory arbitrage by intermediaries remain open issues. We look forward to future research that addresses these and other related questions.

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Figure 1: Intex Coverage of the CLO Market

This figure plots the total amount of CLOs outstanding in the Intex sample by year and compares it to the aggregate size of the U.S. CLO market. Aggregate market data are from the Securities Industry and Financial Markets Association (SIFMA).

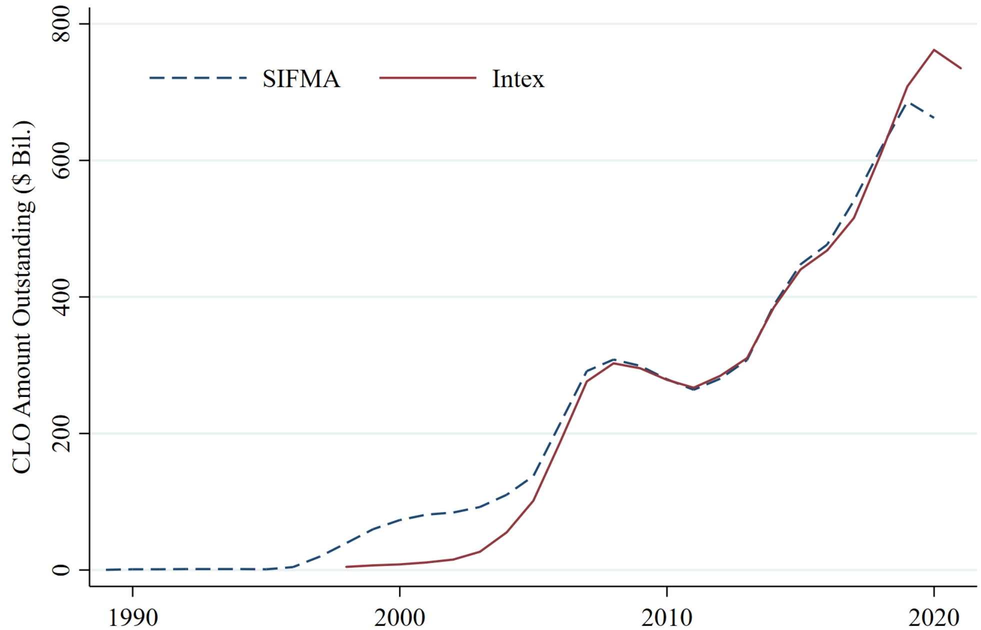


Figure 2: CLO Life Cycle

This figure illustrates the timing and duration of different periods in the life cycle of a typical CLO.

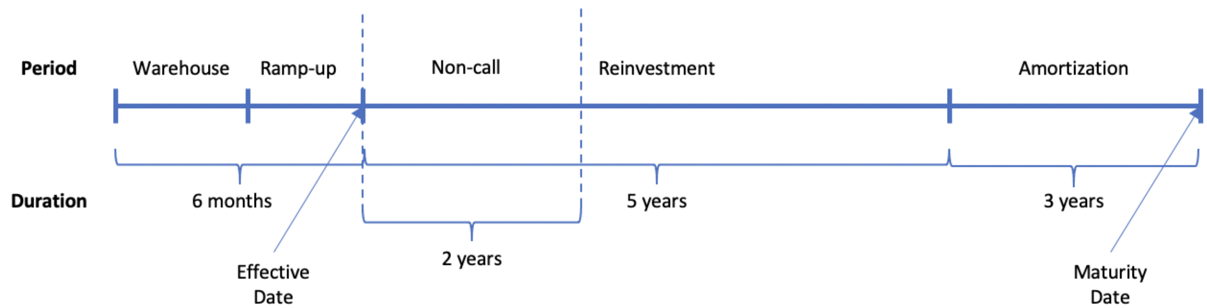
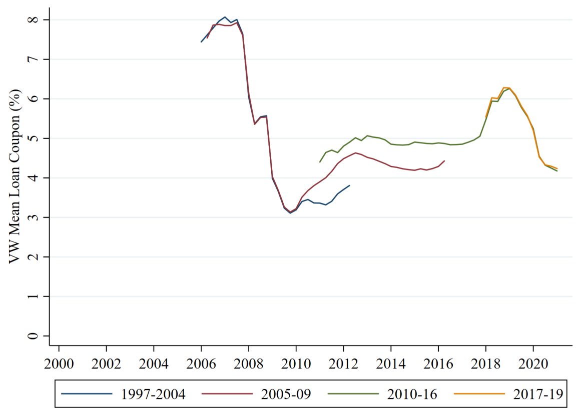


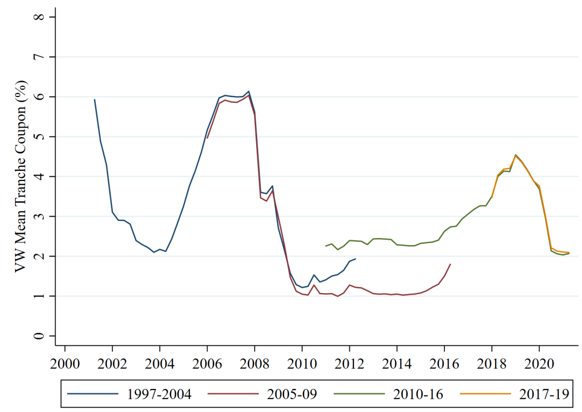
Figure 3: History of CLO Interest Rates and Cash Distributions

This figure presents the history of debt and equity tranche distributions by vintage. For ease of exposition, we sort vintages into four groups: 1997-2004, 2005-2009, 2010-2016, and 2017-2019. The first row reports the value-weighted mean coupon rate on loans in the collateral pool and debt tranches. The second row reports the median annualized distributions to equity tranches in calendar time and in event time relative to the deal's closing date. The sample is restricted to vintage-quarter observations with at least five deals and at least 25% of the initial debt outstanding. Distributions and tranche information are from Intex and loan coupon rates are from IHS Markit.

Panel A: Collateral Coupon Rate



Panel B: Debt Tranche Coupon Rate



Panel C: Equity Payout in Calendar Time

Panel D: Equity Payout in Event Time

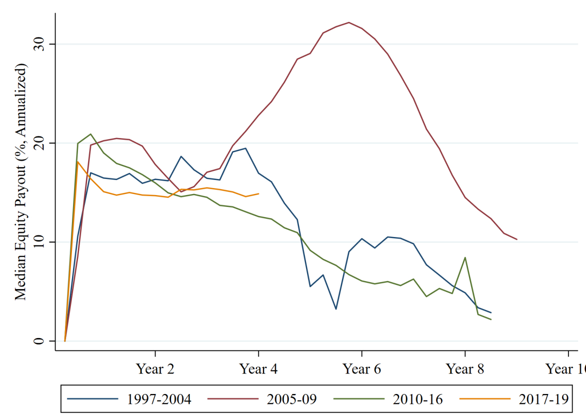


Figure 4: CLO Liability Structure

This figure presents the typical liability structure of CLOs in our sample. We split the sample into CLO 1.0, deals issued before 2010, and CLO 2.0, deals issued from 2010 onward, to highlight changes in the composition of CLO liabilities over time. We report the principal value-weighted share of liabilities by rating category in the two sub-periods. We pool the BB and B categories because they have relatively low shares. Information on liability structure is from Intex.

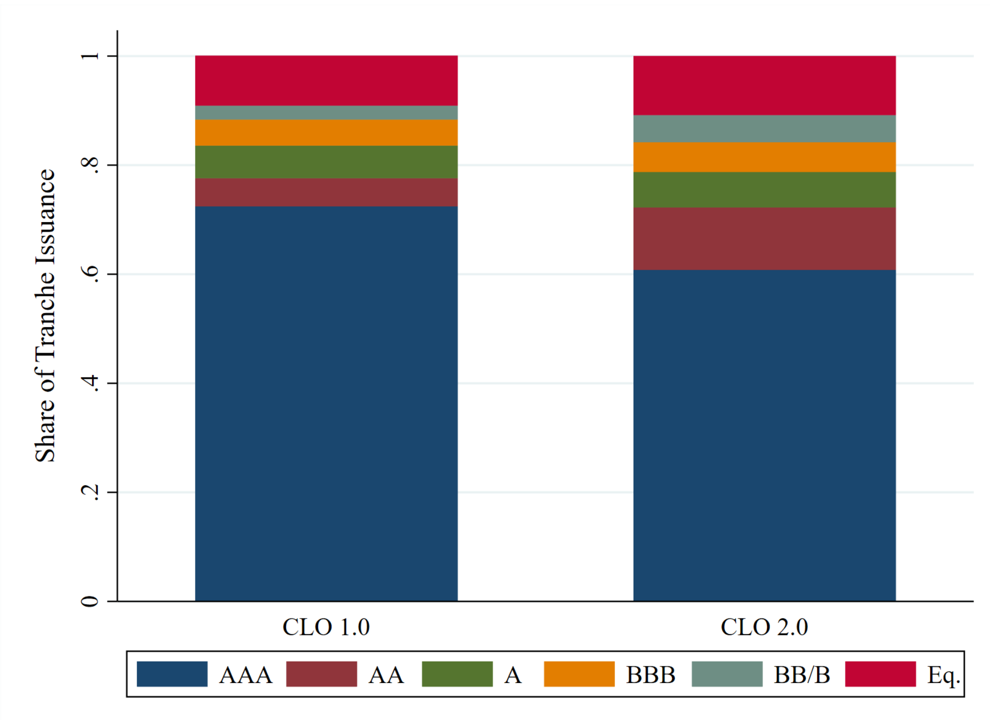


Figure 5: History of Management Fees

This figure presents the history of realized management fee payments by vintage. For ease of exposition, we sort vintages into three groups: 2005-2009, 2010-2016, and 2017-2019. We do not have data on realized fees for deals issued before 2005. For each vintage group, we plot the median fee on an annual basis. Fees are reported as a fraction of the deal's collateral balance, in basis points. The sample is restricted to vintage-year observations with at least ten deals. Data on management fees are from Intex.

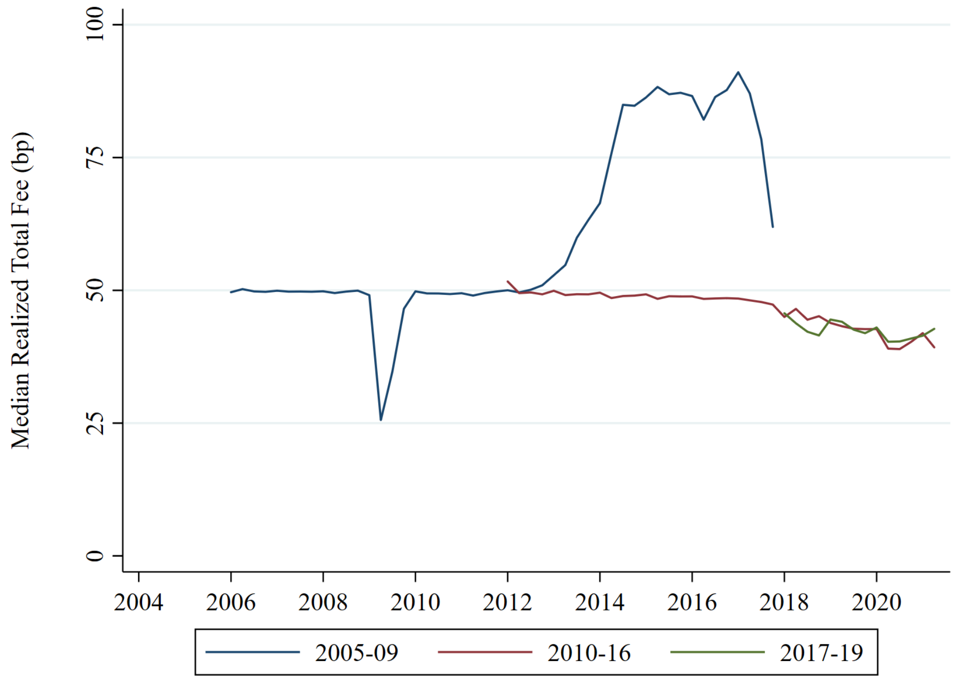
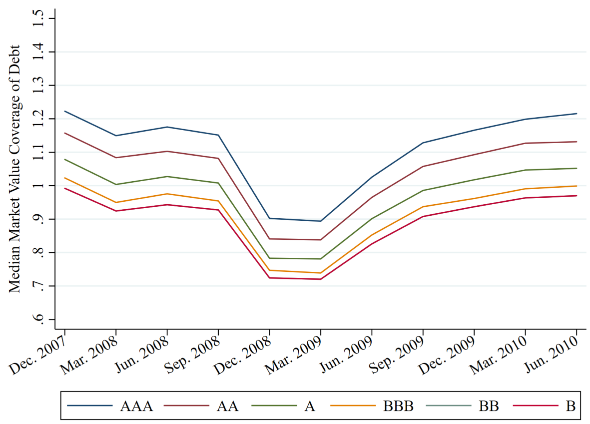
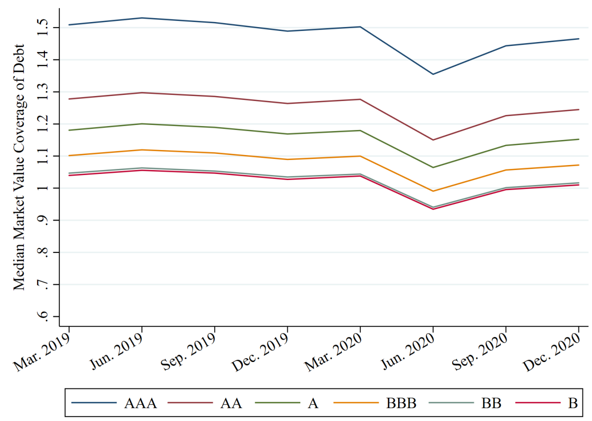


Figure 6: CLO Performance during the Financial and Covid-19 Crises

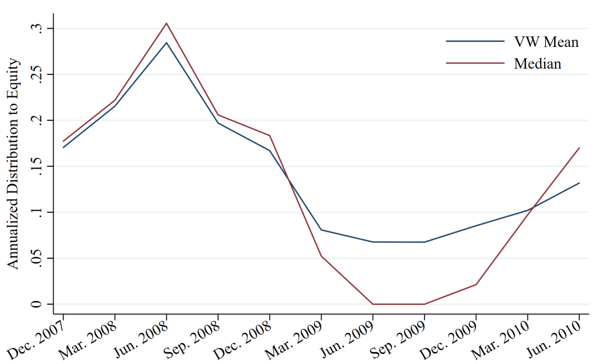
This figure plots the equity distributions and market value coverage ratios for CLOs outstanding around the financial crisis of 2008 (left column) and the Covid-19 crisis of 2020 (right column). Panel A reports median coverage ratios for CLO debt tranches by credit rating, where the coverage ratio equals the market value of collateral divided by the face value of that tranche and all tranches senior to it. Panel B reports value-weighted average and median annualized distributions for CLO equity tranches. Distributions and tranche information are from Intex and collateral prices are from IHS Markit.

Panel A: Market Value Coverage of Debt Tranches





Panel B: Annualized Distributions to Equity Investors



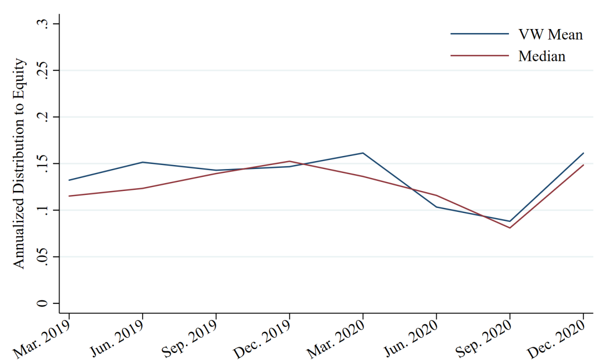


Table 1: Summary Statistics

This table summarizes the CLO sample from Intex by deal vintage. Deal Count is the number of CLOs issued in a year. Issuance Amount measures the aggregate dollar amount of CLOs issued. Both of these measures exclude refinancing and reset transactions. Mean Deal Size is the average initial deal balance. Mean Leverage Ratio is the average ratio of initial debt to deal balance. The last two columns report the number of deals with nonmissing data on equity and debt distributions and the number of such deals that have fully repaid the debt tranches, respectively. CLO 1.0 refers to issuance from 1997 to 2009, while CLO 2.0 refers to issuance from 2010 onward.

Vintage	Deal Count	Issuance Amount ($ Bil.)	Mean Deal Size ($ Mil.)	Mean Leverage Ratio	Deals with Nonmissing Distributions	Completed Deals
1997-2002	30	14.8	436.5	0.922	21	20
2003	31	13.2	424.6	0.916	25	25
2004	65	30.5	469.2	0.909	49	49
2005	99	48.6	490.6	0.906	80	79
2006	175	90.0	514.3	0.907	153	153
2007	169	95.7	566.3	0.908	149	148
2008	41	30.6	745.8	0.909	28	27
2009	5	4.7	944.6	0.905	2	2
2010	12	4.5	372.5	0.903	11	10
2011	30	14.6	487.6	0.901	27	27
2012	114	53.0	465.3	0.898	113	94
2013	171	85.1	497.7	0.896	167	66
2014	239	128.4	537.3	0.893	237	77
2015	192	103.1	536.8	0.893	190	31
2016	172	83.0	482.6	0.894	170	18
2017	206	114.3	554.8	0.893	202	7
2018	277	143.7	518.8	0.893	274	4
2019	252	121.8	483.5	0.893	251	1
CLO 1.0	615	328.1	533.4	0.903	507	503
CLO 2.0	1,665	851.6	511.5	0.888	1,642	335
Full Sample	2,280	1,179.7	517.4	0.892	2,149	838

Table 2: Equity Performance of Completed Deals

This table reports statistics on the performance of CLO equity by vintage. The sample contains completed deals that paid down 99% of their senior debt by March 2021. CLO 1.0 refers to issuance from 1997 to 2009, while CLO 2.0 refers to issuance from 2010 onward. Panel A reports internal rates of return, Panel B reports the public market equivalent (PME) versus the S&P 500 Index, and Panel C reports the PME versus the S&P 500 Banks sub-index. For the full sample PME estimates in Panels B and C, we construct a J-test of the null hypothesis that the PME equals one using the spatial GMM covariance matrix from Korteweg and Nagel (2016), which accounts for correlated performance across deals by assuming that correlation declines with the degree of overlap in their time windows. *, **, and *** denote p-values less than 0.10, 0.05, and 0.01, respectively.

Panel A: Internal Rate of Return (%)

Vintage	Mean	StDev	p10	p25	p50	p75	p90	Obs.
1997-2002	13.31	13.76	0.28	2.63	6.57	21.91	33.88	19
2003	3.32	7.92	-4.12	-1.72	3.42	8.06	12.44	25
2004	6.80	7.45	-5.95	3.52	6.98	11.30	15.18	49
2005	11.99	11.54	5.78	8.94	13.25	17.16	21.00	79
2006	15.63	8.56	8.95	12.30	16.47	19.95	22.41	153
2007	16.75	12.04	7.30	15.47	18.44	21.96	26.19	148
2008	1.03	20.81	-30.72	-5.60	7.37	14.02	19.51	27
2009	-11.28	30.04	-32.52	-32.52	-11.28	9.96	9.96	2
2010	1.46	17.15	-25.72	-0.50	4.92	12.11	16.55	10
2011	12.54	11.61	3.16	8.38	14.12	19.70	22.60	27
2012	7.09	9.40	-2.35	4.71	7.79	12.12	15.93	94
2013	5.19	11.36	-5.76	2.02	5.68	9.63	17.99	66
2014	0.02	10.07	-15.25	-7.22	1.33	7.35	10.88	77
2015	0.91	12.09	-14.13	-6.31	3.48	9.73	12.44	31
2016	-2.82	26.90	-25.94	-1.85	3.70	11.40	15.01	18
CLO 1.0	12.93	12.24	1.72	8.72	15.00	19.74	23.48	502
CLO 2.0	3.58	13.51	-10.24	-0.95	6.03	10.60	16.10	335
Full Sample	9.19	13.55	-5.61	3.78	10.92	17.58	21.58	837

Panel B: Public Market Equivalent versus S&P 500

Vintage	Mean	StDev	p10	p25	p50	p75	p90	Obs.
1997-2002	1.50	0.69	0.74	0.88	1.40	1.84	2.37	19
2003	0.91	0.31	0.61	0.75	0.85	1.06	1.28	25
2004	1.11	0.38	0.61	0.90	1.03	1.26	1.58	49
2005	1.48	0.45	1.04	1.22	1.47	1.77	2.04	79
2006	1.76	0.55	1.22	1.44	1.74	2.03	2.27	153
2007	2.03	0.60	1.32	1.79	2.06	2.35	2.69	148
2008	1.11	0.55	0.34	0.70	1.15	1.53	1.75	27
2009	0.59	0.32	0.36	0.36	0.59	0.81	0.81	2
2010	0.78	0.28	0.38	0.58	0.86	1.01	1.05	10
2011	0.95	0.24	0.72	0.79	1.00	1.11	1.25	27
2012	0.81	0.16	0.62	0.73	0.81	0.90	1.01	94
2013	0.84	0.21	0.62	0.73	0.82	0.95	1.13	66
2014	0.80	0.18	0.59	0.67	0.81	0.94	1.00	77
2015	0.80	0.20	0.49	0.65	0.84	0.93	1.08	31
2016	0.74	0.25	0.43	0.63	0.82	0.92	0.98	18
CLO 1.0	1.64***	0.64	0.83	1.21	1.66	2.05	2.36	502
CLO 2.0	0.81***	0.21	0.57	0.70	0.82	0.94	1.05	335
Full Sample	1.31***	0.65	0.64	0.81	1.12	1.79	2.18	837

Panel C: Public Market Equivalent versus Bank Stocks

Vintage	Mean	StDev	p10	p25	p50	p75	p90	Obs.
1997-2002	1.94	1.27	0.90	1.09	1.36	2.75	3.31	19
2003	1.54	0.73	0.86	0.91	1.45	1.88	2.39	25
2004	2.15	0.87	0.94	1.70	2.02	2.56	3.22	49
2005	3.08	1.07	1.93	2.37	3.09	3.78	4.38	79
2006	3.99	1.37	2.63	3.22	3.98	4.63	5.23	153
2007	4.35	1.40	2.37	3.72	4.43	5.04	5.99	148
2008	1.67	0.89	0.47	0.95	1.73	2.25	2.66	27
2009	0.54	0.23	0.38	0.38	0.54	0.70	0.70	2
2010	0.83	0.31	0.39	0.64	0.91	1.07	1.14	10
2011	0.87	0.24	0.61	0.70	0.90	1.07	1.16	27
2012	0.79	0.16	0.61	0.70	0.78	0.89	0.99	94
2013	0.83	0.22	0.61	0.71	0.80	0.92	1.08	66
2014	0.79	0.17	0.61	0.68	0.80	0.90	0.97	77
2015	0.79	0.19	0.53	0.64	0.81	0.91	1.00	31
2016	0.69	0.24	0.38	0.59	0.71	0.86	0.89	18
CLO 1.0	3.44***	1.58	1.35	2.28	3.47	4.51	5.26	502
CLO 2.0	0.80***	0.20	0.58	0.68	0.80	0.91	1.04	335
Full Sample	2.38***	1.79	0.66	0.84	1.77	3.88	4.81	837

Table 3: "Inside" Equity Performance of Completed Deals

This table reports statistics on the performance of "inside" CLO equity by vintage using gross of fee distributions. The sample contains completed deals that paid down 99% of their senior debt by March 2021. CLO 1.0 refers to issuance from 1997 to 2009, while CLO 2.0 refers to issuance from 2010 onward. Panel A reports internal rates of return, Panel B reports the public market equivalent (PME) versus the S&P 500 Index, and Panel C reports the PME versus the S&P 500 Banks sub-index. For the PME estimates in Panels B and C, we construct a J-test of the null hypothesis that the PME equals one using the spatial GMM covariance matrix from Korteweg and Nagel (2016), which accounts for correlated performance across deals by assuming that correlation declines with the degree of overlap in their time windows. *, **, and *** denote p-values less than 0.10, 0.05, and 0.01, respectively.

Panel A: Internal Rate of Return (%)

Vintage	Mean	StDev	p10	p25	p50	p75	p90	Obs.
CLO 1.0	19.96	12.86	7.54	14.52	21.71	27.96	32.13	502
CLO 2.0	9.76	13.62	-2.86	4.55	12.04	17.14	21.95	335
Full Sample	15.88	14.08	1.21	9.83	17.31	25.00	30.37	837

Panel B: Public Market Equivalent versus S&P 500

Vintage	Mean	StDev	p10	p25	p50	p75	p90	Obs.
CLO 1.0	2.09***	0.82	1.06	1.54	2.05	2.65	3.06	502
CLO 2.0	0.95***	0.23	0.68	0.82	0.96	1.07	1.19	335
Full Sample	1.63***	0.86	0.79	0.96	1.36	2.28	2.85	837

Panel C: Public Market Equivalent versus Bank Stocks

Vintage	Mean	StDev	p10	p25	p50	p75	p90	Obs.
CLO 1.0	4.35***	2.02	1.66	2.82	4.33	5.86	6.81	502
CLO 2.0	0.94***	0.22	0.70	0.81	0.94	1.06	1.17	335
Full Sample	2.99***	2.30	0.78	0.98	2.19	4.92	6.31	837

Table 4: GPME Analysis of CLO Performance

This table presents estimates of the generalized public market equivalent (GPME) from Korteweg and Nagel (2016) for CLO equity, collateral, and debt tranches. The GPME is the expected sum of cash flows discounted using the SDF

$$M^h_{t+h} = \exp\left(ah - b_1 r^h_{m,t+h} - b_2 r^h_{x,t+h} - b_3 r^h_{y,t+h}\right),$$

where the parameters a and b are chosen to price the factor payoffs exactly. Cash flows are normalized to an initial investment of $1. In each column, r_m is the excess return of the CRSP value-weighted index. The second through fifth columns substitute the total return on the following benchmarks for r_x: the S&P/LSTA U.S. Leveraged Loan 100 Index, the Bloomberg-Barclays U.S. Corporate High Yield Bond Index, the CBOE S&P 500 Put-Write Index, and the value-weighted portfolio of primary dealer equities from He, Kelly, and Manela (2017). The final column uses the Fama and French (1993) three-factor model with r_x and r_y as the SMB and HML factors. Implied Equity is the weighted average of collateral and debt GPMEs from equation (2). Standard errors of the SDF parameter estimates are in parentheses. We report p-values of the J-test that the GPME equals zero in brackets. *, **, and *** denote p-values less than 0.10, 0.05, and 0.01, respectively.

	CAPM	CAPM+LL	CAPM+HY	CAPM+PUT	HKM	FF3
After-Fee GPME Estimates						
Equity	0.651***	0.554***	0.352***	0.562***	0.469***	0.358***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.001]	[0.000]
Collateral	−0.033	0.047	0.034	0.001	−0.060	0.082**
	[0.728]	[0.276]	[0.722]	[0.988]	[0.285]	[0.020]
Debt Tranches	−0.089	0.007	0.013	−0.045	−0.101	0.061*
	[0.473]	[0.898]	[0.926]	[0.530]	[0.226]	[0.075]
Implied Equity	0.472	0.404	0.222	0.412	0.317	0.271
Before-Fee GPME Estimates						
Equity	1.091***	0.939***	0.661***	0.962***	0.876***	0.717***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Collateral	0.005	0.081*	0.062	0.036	−0.024	0.113***
	[0.954]	[0.065]	[0.513]	[0.495]	[0.664]	[0.002]
Debt Tranches	−0.089	0.007	0.013	−0.045	−0.101	0.061*
	[0.473]	[0.898]	[0.926]	[0.530]	[0.226]	[0.075]
Implied Equity	0.834	0.692	0.504	0.723	0.663	0.547
SDF Parameters						
a	−0.007	−0.006	−0.007	−0.011	−0.014	−0.010
	(0.004)	(0.002)	(0.003)	(0.003)	(0.005)	(0.005)
b_1	2.333	0.293	−1.466	−0.099	4.809	1.828
	(0.529)	(0.539)	(0.726)	(0.853)	(0.828)	(0.337)
b_2		2.288	3.649	3.576	−1.937	1.135
		(0.471)	(0.423)	(1.230)	(0.308)	(0.457)
b_3						−5.299
						(0.609)

Table 5: Collateral Performance of Completed Deals

This table reports statistics on the performance of CLO collateral by vintage. The sample contains completed deals that paid down 99% of their senior debt by March 2021. CLO 1.0 refers to issuance from 1997 to 2009, while CLO 2.0 refers to issuance from 2010 onward. Panel A reports the before-fee public market equivalent (PME) versus the S&P/LSTA U.S. Leveraged Loan 100 Index, with before-fee collateral cash flows estimated as the sum of estimated management fees and after-fee distributions to all CLO tranches. Panel B reports the after-fee PME versus a value-weighted portfolio of loan mutual funds, with after-fee collateral cash flows estimated as the sum of after-fee distributions to all CLO tranches. For the full sample PME estimates, we construct a J-test of the null hypothesis that the PME equals one using the spatial GMM covariance matrix from Korteweg and Nagel (2016), which accounts for correlated performance across deals by assuming that correlation declines with the degree of overlap in their time windows. *, **, and *** denote p-values less than 0.10, 0.05, and 0.01, respectively.

Panel A: Before-Fee Public Market Equivalent versus LSTA Index

Vintage	Mean	StDev	p10	p25	p50	p75	p90	Obs.
1997-2002	0.97	0.06	0.92	0.92	0.97	1.01	1.05	19
2003	0.97	0.02	0.94	0.95	0.96	0.99	1.00	25
2004	0.91	0.18	0.85	0.94	0.96	0.98	1.00	49
2005	0.98	0.06	0.92	0.95	0.97	1.00	1.06	79
2006	0.97	0.06	0.92	0.95	0.97	0.99	1.02	153
2007	1.01	0.47	0.93	0.94	0.97	0.99	1.04	148
2008	0.87	0.10	0.66	0.85	0.90	0.93	0.95	27
2009	0.76	0.08	0.70	0.70	0.76	0.81	0.81	2
2010	0.92	0.12	0.72	0.90	0.96	0.97	1.01	10
2011	0.96	0.05	0.93	0.94	0.97	0.99	1.01	27
2012	0.96	0.07	0.93	0.95	0.97	0.98	1.01	94
2013	0.99	0.07	0.96	0.97	0.98	1.01	1.06	66
2014	1.00	0.09	0.95	0.97	0.98	1.00	1.03	77
2015	1.03	0.23	0.93	0.95	0.98	1.00	1.04	31
2016	0.96	0.11	0.91	0.94	0.95	0.97	1.03	18
CLO 1.0	0.97**	0.27	0.92	0.94	0.97	0.99	1.03	502
CLO 2.0	0.98***	0.10	0.94	0.96	0.97	0.99	1.03	335
Full Sample	0.98***	0.22	0.92	0.95	0.97	0.99	1.03	837

Panel B: After-Fee Public Market Equivalent versus Loan Mutual Funds

Vintage	Mean	StDev	p10	p25	p50	p75	p90	Obs.
1997-2002	1.07	0.07	1.02	1.03	1.05	1.12	1.17	18
2003	1.06	0.02	1.04	1.05	1.06	1.08	1.09	25
2004	0.99	0.20	0.91	1.02	1.04	1.06	1.08	49
2005	1.04	0.06	0.99	1.02	1.04	1.06	1.10	79
2006	1.02	0.06	0.98	1.00	1.02	1.04	1.07	153
2007	1.06	0.46	0.98	1.00	1.02	1.04	1.08	148
2008	0.95	0.10	0.73	0.92	0.98	1.01	1.05	27
2009	0.81	0.02	0.79	0.79	0.81	0.83	0.83	2
2010	0.93	0.12	0.74	0.91	0.97	0.98	1.01	10
2011	0.98	0.05	0.95	0.96	0.98	1.00	1.01	27
2012	0.98	0.08	0.96	0.98	0.99	1.01	1.03	94
2013	1.00	0.06	0.97	0.98	0.99	1.02	1.06	66
2014	1.01	0.10	0.97	0.98	0.99	1.01	1.04	77
2015	1.04	0.22	0.94	0.96	0.99	1.01	1.05	31
2016	0.97	0.11	0.91	0.96	0.96	0.98	1.04	18
CLO 1.0	1.03	0.26	0.98	1.00	1.03	1.05	1.08	501
CLO 2.0	1.00	0.10	0.96	0.97	0.99	1.01	1.04	335
Full Sample	1.02	0.21	0.96	0.99	1.01	1.04	1.07	836

Table 6: Debt Performance of Completed Deals

This table reports statistics on the performance of CLO debt by initial rating category. The sample contains completed deals that paid down 99% of their senior debt by March 2021. CLO 1.0 refers to issuance from 1997 to 2009, while CLO 2.0 refers to issuance from 2010 onward. Panel A reports internal rates of return, while Panel B reports the PME versus synthetic floating-rate corporate bonds in the same rating category. Floating-rate corporate bond returns are based on swapping the fixed-rate cash flows using the maturity-matched swap rate at issuance. We explain the mark-to-market valuation of swapped bonds in the Internet Appendix. Each panel reports the performance of tranches by initial rating category, with the sample split into CLO 1.0 (before 2010), CLO 2.0 (2010 and later), and the full sample of completed deals (1997 to 2016). For the PME estimates in Panel B, we construct a J-test of the null hypothesis that the PME equals one using the spatial GMM covariance matrix from Korteweg and Nagel (2016), which accounts for correlated performance across deals by assuming that correlation declines with the degree of overlap in their time windows. *, **, and *** denote p-values less than 0.10, 0.05, and 0.01, respectively.

Panel A: Internal Rate of Return (%)

Vintage	Mean	StDev	p10	p25	p50	p75	p90	Obs.
CLO 1.0 (1997-2009)								
AAA-Rated	2.38	1.22	1.44	1.71	2.26	2.87	3.35	494
AA-Rated	2.44	1.34	1.57	1.73	2.17	2.81	3.49	424
A-Rated	2.98	2.64	1.95	2.14	2.71	3.74	4.41	481
BBB-Rated	3.91	5.96	2.80	3.18	3.83	4.93	5.71	478
BB-Rated	6.24	6.06	4.86	5.33	6.10	7.77	9.54	371
B-Rated	-1.64	34.53	-63.3	7.16	9.64	11.5	22.2	6
CLO 2.0 (2010-2016)								
AAA-Rated	2.36	2.41	1.69	1.82	2.06	2.41	2.79	329
AA-Rated	3.28	2.44	2.47	2.72	3.01	3.35	3.87	325
A-Rated	4.05	2.39	3.26	3.49	3.79	4.20	4.9	322
BBB-Rated	5.03	2.49	4.05	4.39	4.80	5.21	6.05	311
BB-Rated	6.48	2.30	5.22	5.75	6.21	6.90	8.08	292
B-Rated	7.03	1.47	5.96	6.33	6.98	7.71	8.52	103
Full Sample (1997-2016)								
AAA-Rated	2.37	1.79	1.53	1.78	2.15	2.67	3.26	823
AA-Rated	2.80	1.94	1.63	2.03	2.70	3.20	3.64	749
A-Rated	3.41	2.60	2.02	2.43	3.43	3.99	4.69	803
BBB-Rated	4.35	4.92	2.94	3.56	4.42	5.08	5.87	789
BB-Rated	6.35	4.78	4.99	5.50	6.17	7.25	8.98	663
B-Rated	6.55	7.82	5.94	6.35	7.04	7.80	8.82	109

Panel B: Public Market Equivalent versus Synthetic Floating-Rate Corporate Bonds

Vintage	Mean	StDev	p10	p25	p50	p75	p90	Obs.
CLO 1.0 (1997-2009)								
AAA-Rated	1.03***	0.05	1.01	1.02	1.03	1.03	1.05	494
AA-Rated	1.05***	0.06	1.02	1.02	1.04	1.06	1.09	424
A-Rated	1.04***	0.07	0.98	1.00	1.03	1.06	1.11	481
BBB-Rated	1.08***	0.12	1.01	1.03	1.08	1.12	1.18	478
BB-Rated	1.20***	0.16	1.10	1.14	1.19	1.26	1.34	371
B-Rated	1.57**	0.80	0.34	1.47	1.63	1.80	2.59	6
CLO 2.0 (2010-2016)								
AAA-Rated	1.02***	0.10	0.97	0.99	1.01	1.03	1.04	329
AA-Rated	1.05***	0.11	0.99	1.02	1.04	1.06	1.09	325
A-Rated	1.08***	0.11	1.01	1.06	1.08	1.10	1.13	322
BBB-Rated	1.09***	0.12	1.01	1.06	1.09	1.12	1.15	311
BB-Rated	1.05***	0.10	0.98	1.01	1.04	1.07	1.11	292
B-Rated	1.12***	0.12	1.03	1.07	1.10	1.14	1.20	103
Full Sample (1997-2016)								
AAA-Rated	1.02***	0.08	0.99	1.01	1.02	1.03	1.04	823
AA-Rated	1.05***	0.08	1.01	1.02	1.04	1.06	1.09	749
A-Rated	1.06***	0.09	0.99	1.01	1.05	1.09	1.13	803
BBB-Rated	1.09***	0.12	1.01	1.04	1.08	1.12	1.17	789
BB-Rated	1.13***	0.16	1.00	1.04	1.12	1.21	1.29	663
B-Rated	1.14***	0.23	1.03	1.07	1.10	1.16	1.23	109