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 December 2020, 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 70 cents per dollar invested, gross of fees. This NPV amounts to approximately $35 million, or 7% of total assets, for the typical deal. Net of management fees, the NPV is 40 cents per dollar invested, implying that managers capture approximately 43% 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.

The pass-through structure of CLOs implies that these abnormal returns are due to risk-adjusted price differentials between the leveraged loans in the collateral pool and the secured notes issued to finance the vehicle. 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 0.7% for AAA and AA-rated tranches to 1.9% for non-investment-grade 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 or abnormal returns, these results shed light on the appeal of CLO debt tranches. The majority of funding for CLOs is comprised 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 that are willing to pay high risk-adjusted spreads for loans due to an inadequate supply of intermediated credit (Schwert (2020)), intermediaries that are 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 increasing capital flows have begun to

[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.

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), De-

Marzo 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, contributing to the broader literature on the risk and return of securitization vehicles (e.g., Longstaff and Rajan (2008), Erel, Nadauld, and Stulz (2014), Chernenko (2017), Ospina and Uhlig (2018), Cordell, Feldberg, and Sass (2019)).

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.

[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).

Finally, our results 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 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. Sections 3 through 5 examine the performance of CLO equity, assets, and debt, respectively. Section 6 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 December 2020.

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) and JPMorgan Chase. 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.[3]

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 2,250 deals.

[3]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.

An additional requirement is a complete history of payments to each tranche, which reduces the sample to the 2,131 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 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 6.5% reduction in observations coming from the CLO 1.0 period. Our sample contains 81% of deals issued before 2010 and 98% 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.[4] 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 June 2020. We set June 2020 as the cutoff for completed deals to ensure the availability of benchmark returns. This choice has a negligible impact on our results as only five deals paid down between July and December 2020. 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

[4]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 0.25% for investment-grade tranches and 1.48% 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.

"called" by the equity investors before maturity to execute a refinancing or liquidate the deal. This optionality results in some completed deals in 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.

1.3 Supplementary Data

We supplement the Intex CLO information with data from several others 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 index returns from Bloomberg and factor returns from Ken French's and Asaf Manela'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.[5]

Once effective, the CLO enters two overlapping but distinct phases, detailed in Figure 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 follow a similar waterfall, with one caveat. Principal payments received during the reinvestment period are used to invest in new loans. Those received after the reinvestment period, during the amortization phase, are used to pay down the principal

[5]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.

of the secured noteholders according to the same priority structure as interest payments.[6]

Panels A and B in Figure 3 show the time series of realized interest and principal payments to CLO debt tranches by vintage. To ease the presentation, we aggregate vintages into four groups: 1997-2004, 2005-2009, 2010-2016, and 2017-2019. The Internet Appendix reports analogous figures by annual vintage. The payout yield is computed for each CLO by taking the ratio of the quarterly distribution to the size of the initial investment. We multiply interest payments by four to obtain an annualized figure. We then weight each payout yield by the tranche size and sum to compute the value-weighted average.

The figure shows that distributions adhere to the life cycle described above. The first few years of the CLO consist exclusively of interest payments followed by large increases in principal distributions coinciding with the amortization period. There are, however, exceptions when tranches are redeemed or called early, as we see significant increases in the principal payout yield before the CLO matures.

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

[6] 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 delever the capital structure of the CLO and protect senior investors against the loss of principal.

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 C and D of Figure 3 illustrate the excess spread in our sample. Panel C presents the principal value-weighted average coupon rate of loans in the collateral pool. Panel D 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 pass-through nature of the CLO vehicle. 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 E and F in Figure 3 show the time series of after-fee distributions to CLO equity tranches by vintage group. The patterns in these plots stand in stark contrast to those observed for CLO debt in Panels A and B. Payout yields to equity investors are more volatile at the outset of the CLO and show greater sensitivity 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. Though, 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 (see Panel C of Figure 3). 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 73% 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 Equity Performance

Building on the discussion above, 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 10.3% 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 13.5% 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

[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.

financial crisis. Mean and median IRRs for these three years are all above 13%, despite an average lifetime that encompasses the Great Recession. Panels E and F of Figure 3 offered a preview of these results. Recall that CLO managers of these pre-crisis vintages were able to 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

[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.

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 to broad market indices (Kaplan and Schoar (2005)), suggesting that the S&P 500 Index is a practically relevant benchmark. Additionally, the low beta of senior secured loans in the asset pool coupled with a high degree of leverage implies an equity beta not far from one. Thus, the S&P 500 Index is also an economically 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 1.35, 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 2.49 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 3.48 times what they would have earned investing in bank equities. The analogous multiplier is only 0.81 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.

In the remaining subsections, we further explore these patterns in CLO equity performance and the economic mechanisms behind them.

3.1 Temporal Variation

Table 2 reveals a clear temporal pattern in equity performance. The distributions of IRRs and PMEs show a leftward shift and reduction in dispersion from the CLO 1.0 to CLO 2.0 eras. There are several forces likely responsible for these changes

As previously discussed, 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 deals also have a significantly smaller fraction of AAA-rated debt. 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, competition among CLO managers has increased as capital has flowed into the CLO market. There are 144 managers in our sample for CLOs issued prior to 2010. For CLOs issued since then, there are 195 managers, an increase of 35%. There are also 140 new entrants in the market since 2010. The entry of managers has coincided with growth in CLO issuance volume, increasing the demand for leveraged loans (Ivashina and Sun (2011), Nadauld and Weisbach (2012)) and the supply of CLO tranches, both of which negatively affect the excess spread. As a result, we observe that the most recently issued vintages (2017 to 2019) have lower initial distributions than earlier post-crisis vintages.

The effects of increasing competition are also seen in management fees, which we present in Figure 5. We have a complete history of fee payments for 69% of completed deals. 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 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 bps and 30 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 basis points (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. More relevant to the competitive landscape is the reduction in fees since 2017, consistent with managers competing to attract investors.[9]

Third, the relatively strong performance of CLO 1.0 deals, which benefited from higher

[9] 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 the contract and are not made available to the CLO trustee.

loan spreads induced by the crisis, suggests that CLO equity can 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.

Fourth, censoring of more recent 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 evidence suggests that this is not a significant concern. Figure 3 shows that recently issued CLOs, regardless of completed status, have higher financing costs and make lower initial equity distributions than pre-crisis CLOs. 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.

Finally, it is possible that misspecification of the PME discount rate leads to a spurious pattern. For this to happen, it must be the case that the risk premia on the benchmarks either (i) increased over time by more than that on CLO equity, or (ii) decreased by less than that on CLO equity. Unfortunately, data limitations preclude us from ruling out this possibility. However, we do take steps to address a potential disconnect in the systematic risk exposure of CLO equity and our benchmarks over the entire sample in Section 3.3 below.

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.[10] To evaluate the performance of

[10] 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

"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.

Table 3 shows that all of the 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 exhibited in Figure 5.

As a result, the average IRR increases by more than 50% when fees are included, rising from 10.3% to 16.8%. The PMEs increase by approximately 20%. 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 Does CLO Equity Generate Alpha?

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 correlation 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

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).

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

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.

Table 4 presents the results from our GPME analysis of CLO equity. For robustness, we consider three asset pricing models in our tests of abnormal performance: the capital asset pricing model (CAPM), the Fama and French (1993) three-factor model, and the intermediary asset pricing model from He, Kelly, and Manela (2017). The third model is particularly relevant here because it has been shown to successfully price risky fixed-income assets including corporate bonds and credit default swaps. In the Internet Appendix, we show that our results are robust to alternative pricing models.

Panel A reports GPME estimates for equity performance on an after-fee basis for "outside" investors. All three specifications reveal a positive GPME that is statistically significant at the 1% level. The estimates imply that in present value terms, outside equity investors earn between 40 and 67 cents per dollar invested above what they could earn by investing in public market factors. Although the GPME framework does not provide factor loadings for the test assets, the similarity in magnitude between these estimates and the PMEs in Table 2 suggests that the market beta of CLO equity is close to one.[12]

Panel B 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 in every specification. Economically, the point estimates imply that in present value terms, CLO managers earn between 70 and 106 cents per dollar invested

[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.

above what they could earn by investing in public market factors. The difference between the GPME estimates for "outside" and "inside" equity implies that the present value of manager compensation amounts to between 30 and 45 cents per dollar of equity raised, or between 36% and 48% of the surplus created by CLO issuance. Because managers often hold a portion of the equity tranche, these shares are likely conservative estimates of the surplus extracted by managers.[13]

Overall, these results imply that CLO managers are able to earn "alpha" over public benchmarks that is shared between themselves and outside equity investors. The pass-through nature of the CLO structure implies that this outperformance must come from market-wide differences between the pricing of leveraged loans and CLO debt tranches. Although we cannot 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. Further, our finding that CLO equity performance is declining over time suggests that this "arbitrage" opportunity is disappearing as more capital flows toward it.

3.4 Performance in Crises

It is too early to tell how CLOs will weather the Covid-19 crisis, which continues to unfold. However, we can examine how CLOs have responded to the early stages of the crisis to see whether CLO equity is exhibiting similar resilience to market volatility that it showed during the financial crisis. By extension, our analysis can also shed light on the current risks borne by CLO investors.

Figure 6 presents several measures of interim performance for CLOs outstanding in the financial crisis and the Covid-19 crisis. The left side of each panel is based on data from

[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.

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 shows that equity distributions have been largely unaffected by the initial phase of the Covid-19 crisis, hovering between 10% and 15% on an annualized basis since March 2019. Payout yields fell slightly during the second and third quarters of 2020, but rebounded to their pre-crisis level by the fourth quarter. With the longer perspective offered by the financial crisis, we can see that it takes time for a shock to pass through to CLO equity investors. Equity distributions were more volatile in this earlier period, increasing from 15% to 30% over the first half of 2008, then returning to 20% and declining gradually through the collapse of Lehman Brothers in 2008. Distributions dropped sharply three months later and remained at a low level until early 2010. 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.

Although the Covid-19 crisis continues to unfold, the evidence from the financial crisis suggests that it is unsurprising to see CLO equity distributions holding steady at this stage of the crisis. It could take time for collateral deterioration to show up in payouts. However, relative to the early stages of the financial crisis, CLO equity distributions are starting from a lower level today, which means that a smaller reduction in loan cash flows due to default will be necessary to shrink payouts.

For a more forward-looking lens on the condition of CLOs, Panel B 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 B are worth noting. First, coverage ratios respond to fundamental shocks more quickly than distributions, as indicated by the steep drops following the Lehman Brothers bankruptcy and the imposition of economic shutdowns to fight Covid-19. Second, coverage ratios are significantly higher today than they were a decade ago, a result of lower leverage in CLO 2.0 transactions. In 2019, AAA-rated tranches were secured by collateral worth 1.5 times their face value, whereas coverage was less than 1.2 for AAA tranches in the run-up to the financial crisis. Third, the magnitudes of the coverage ratio declines in the Covid-19 crisis are smaller than the declines during the 2008 crisis. For example, AAA-rated tranche coverage ratios fell 26% from 1.16 in the third quarter of 2008 to 0.85 in the first quarter of 2009. In contrast, AAA coverage ratios only fell by 13% in the first quarter of 2020. Finally, during the financial crisis, all debt tranches were undercollateralized, with even AAA-rated tranches experiencing collateralization ratios below 0.90 in early 2009. In March 2020, only tranches rated BBB and below were underwater, and by the end of 2020, median coverage ratios were above one in all rating categories.

Lastly, Panel C presents the composition of collateral by credit rating during the two crises. There are two notable differences between the plots. First, the shares of CLO collateral rated B and B- were higher, and the share rated B+ lower, prior to the Covid-19 crisis than prior to the financial crisis. In 2019, the CCC+ and lower share was already near the 7.5% limit that triggers a coverage test failure for most deals, whereas it took until early 2009 to cross that threshold in the financial crisis. Second, the share of loans rated CCC+ and lower rose sharply at the start of the Covid-19 crisis, in contrast to the gradual downgrades observed in the financial crisis.

To sum up, CLO equity has proven resilient thus far in the Covid-19 crisis, but there is substantial uncertainty about its performance moving ahead. Indeed, it is possible that further loan downgrades will lead to the failure of coverage tests and the temporary diversion of cash flows to repay debt investors. However, current levels of overcollateralization indicate that the market does not expect significant principal losses for at least the investment-grade CLO debt tranches. Ultimately, the performance of outstanding CLOs will depend on the realized level of defaults and the evolution of credit spreads over the coming years.

4 Asset Performance

How are CLO managers able to generate abnormal equity returns? To answer this question, we begin by exploring the performance of CLO assets to determine whether managers have skill in selecting and trading loans. To do so, we require information on collateral cash flows and fees. Because Intex does not contain data on the cash flows generated by the CLO collateral, 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.

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 choose not to evaluate CLO collateral against standard factor models because prior research (e.g., Bai, Bali, and Wen (2019)) has found them unable to explain corporate bond returns and, as such, of limited use for risk adjustment. Thus, we limit our discussion here to the relative performance of CLO collateral, and avoid statements concerning abnormal risk-adjusted performance.

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 0.96 implies that one dollar invested in CLO collateral would generate the same cash flows as 96 cents invested in the leveraged loan index over our sample 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 (0.96), the difference is economically small and insignificantly different from both the CLO 2.0 average (0.97) and the overall average (0.96). 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.

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.[14]

5 Debt Performance

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.[15]

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 from 2.30% for AAA-rated tranches to 6.31% for B-rated tranches over the full sample. IRR volatilities follow a similar pattern and are inversely related to credit rating. These patterns hold cross the CLO 1.0 and 2.0 eras, though the latter period exhibits average IRRs that are more than 0.5% higher for tranches rated between AA and BBB.

[14]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).

[15]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.

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.[16]

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 0.06 for AAA-rated tranches to 0.20 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 Nagel (2016). Furthermore, the 25th percentile is greater than or equal to one for all but the A rating category. Overall, the PME estimates suggest that CLO tranches have earned

[16]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.

higher returns than similarly rated, synthetic floating-rate corporate bonds.

To put the PMEs in a returns context, we compute the difference between the IRR and the benchmark return over the same period. Senior tranches, rated AAA and AA, earn about 0.7% more per year than similarly rated floating-rate corporate bonds. This return differential increases for lower-rated tranches, with mezzanine tranches, rated A and BBB, earning 0.9% to 1.0%, and junior tranches, rated BB and B, earning 1.7% to 1.9% more than their respective benchmarks.

Although the results in Table 6 are suggestive of abnormal performance, we stop short of drawing that conclusion. It is plausible, if not likely, that the relative outperformance is 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 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)).[17] 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.

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

[17] Our results provide an interesting contrast to the empirical findings in Coval, Jurek, and Stafford (2009). Whereas they find that investment-grade credit default swap index (CDX) tranches are priced similarly to corporate bonds with the same credit rating, which suggests a mispricing of systematic risk exposure, we find that CLO tranches are priced at a discount to corporate bonds, consistent with asset-pricing intuition.

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 it is not.

In sum, CLO debt offers high returns relative to similarly rated debt, but it is difficult to discern whether this difference reflects abnormal performance or compensation for risk exposures. Regardless, the findings in Table 6 explain the appeal of CLO debt to regulated investors. 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)).

6 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, though this outperformance likely reflects unmeasured risk exposure rather than abnormal returns. 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 SIFMA from 1989 to 2000 and from JPMorgan Chase from 2001 to 2020.

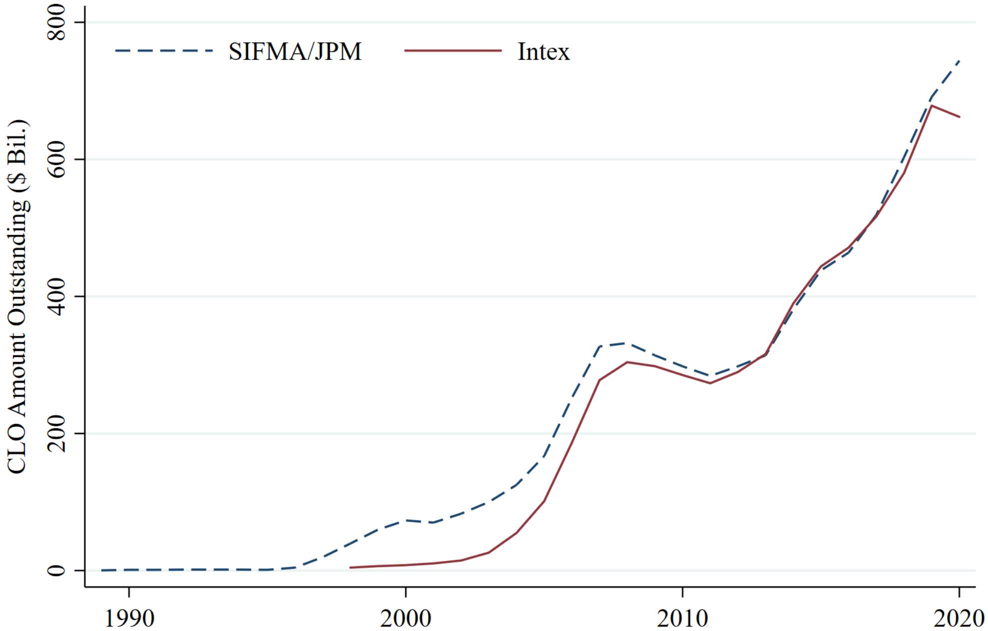


Figure 2: CLO Life Cycle

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

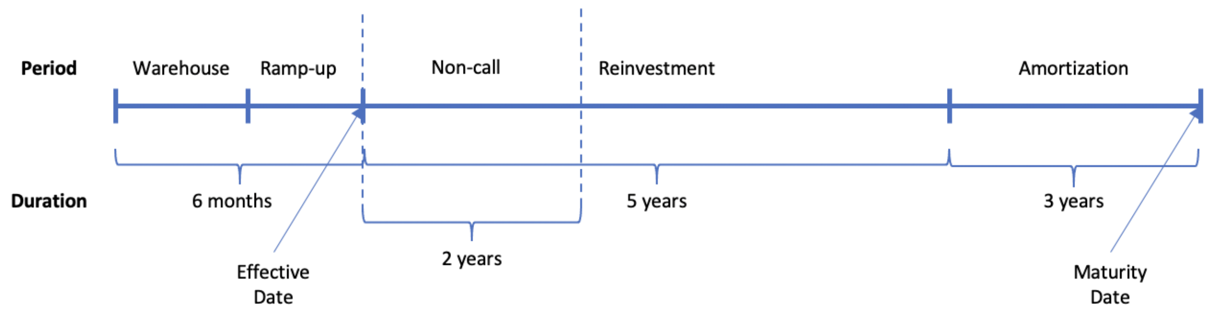


Figure 3: History of CLO Interest Rates and Cash Distributions

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 top row reports the value-weighted mean annualized interest and principal payments to debt tranches. The second row reports the value-weighted mean coupon rate on loans in the collateral pool and debt tranches. The bottom row reports the value-weighted mean and median annualized distributions to equity tranches. 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.

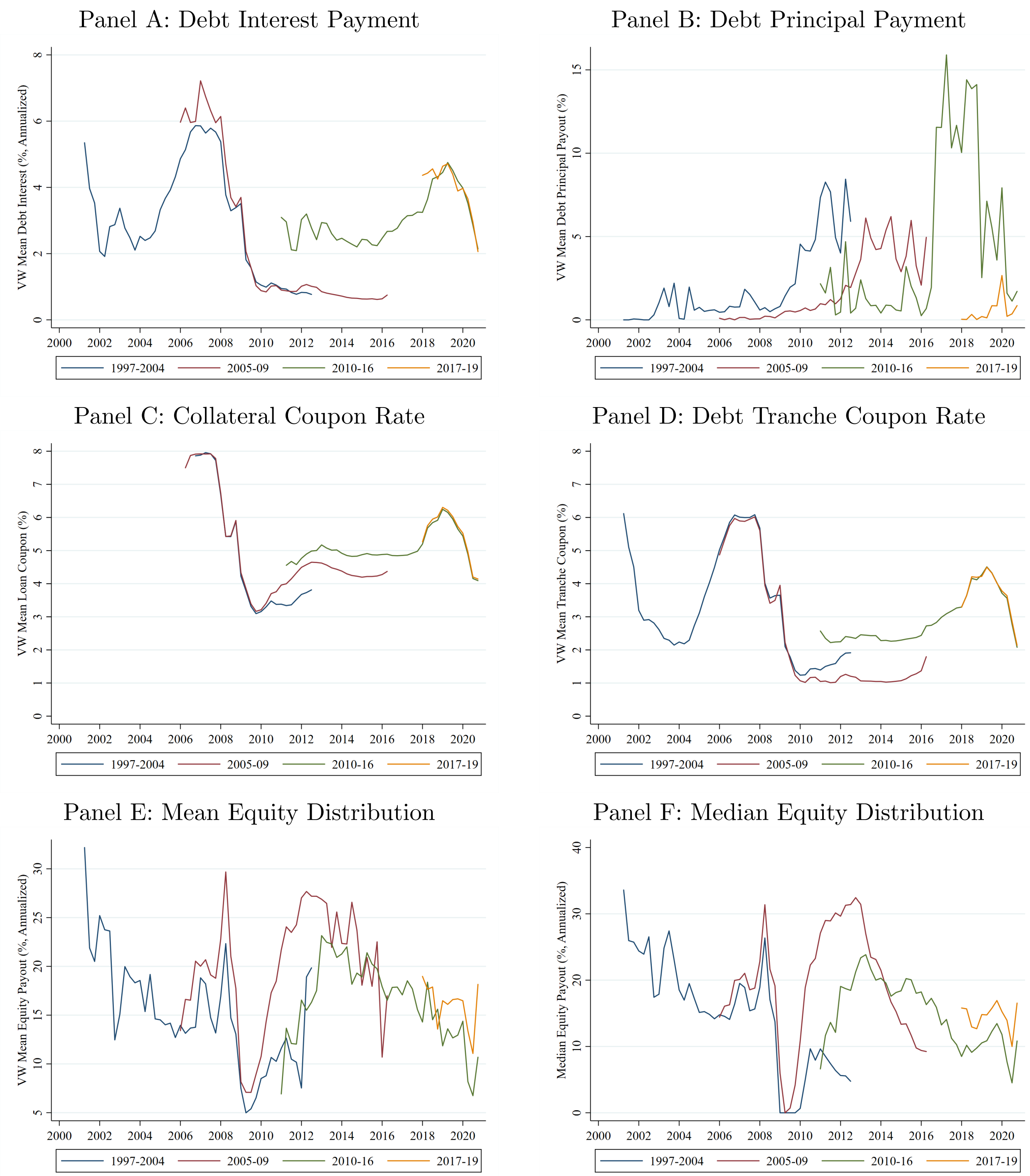


Figure 4: CLO Liability Structure

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.

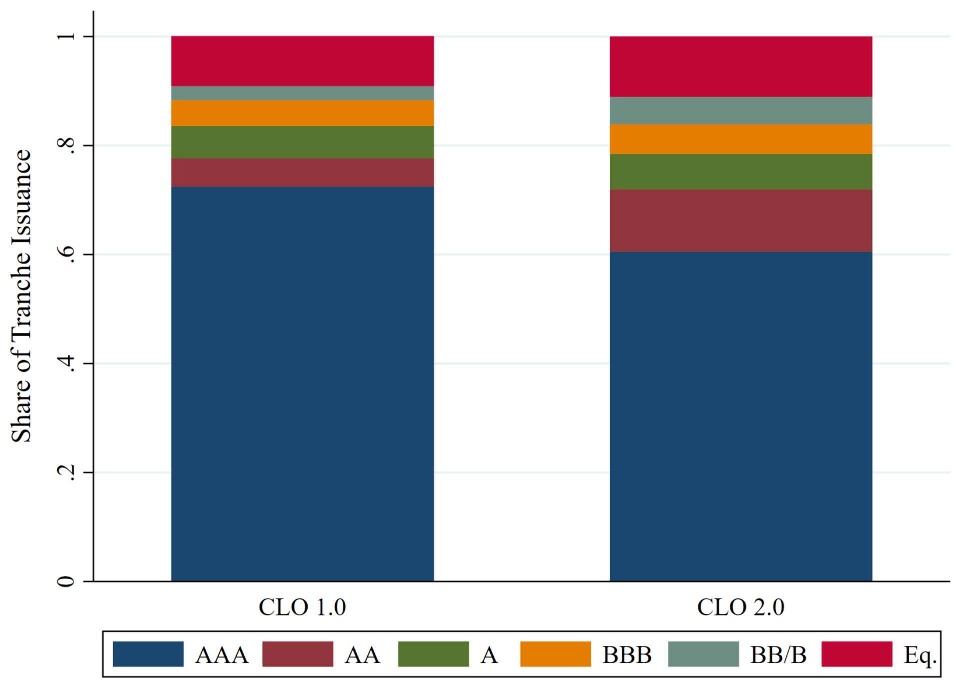


Figure 5: History of Management Fees

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.

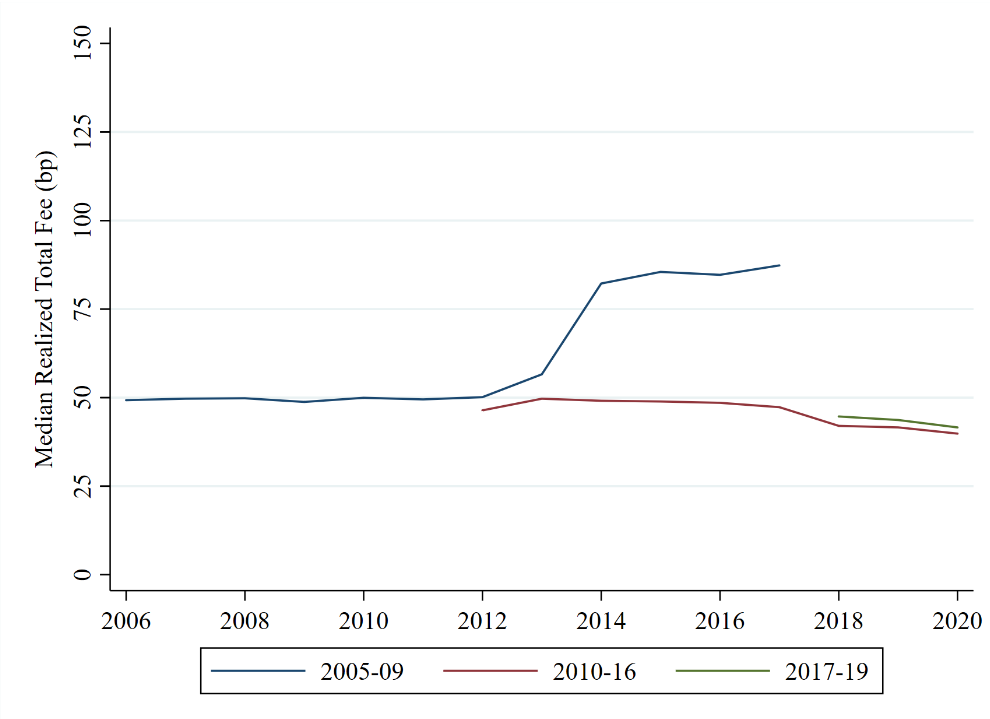
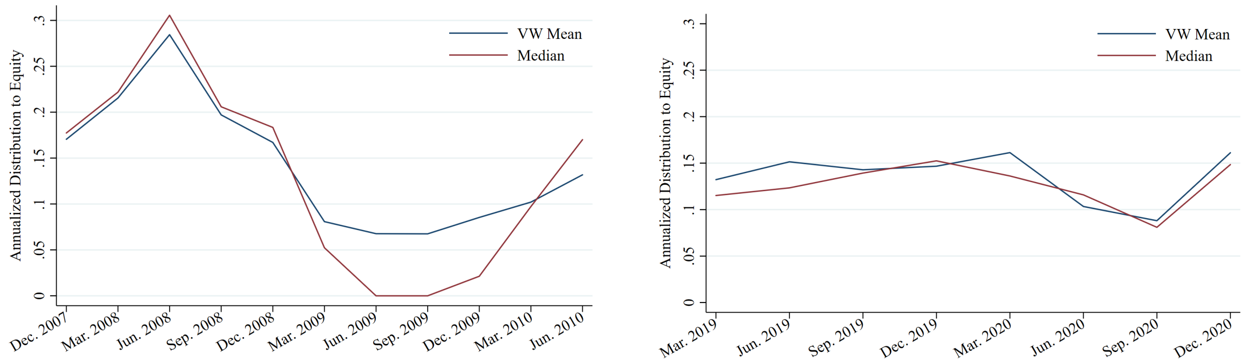


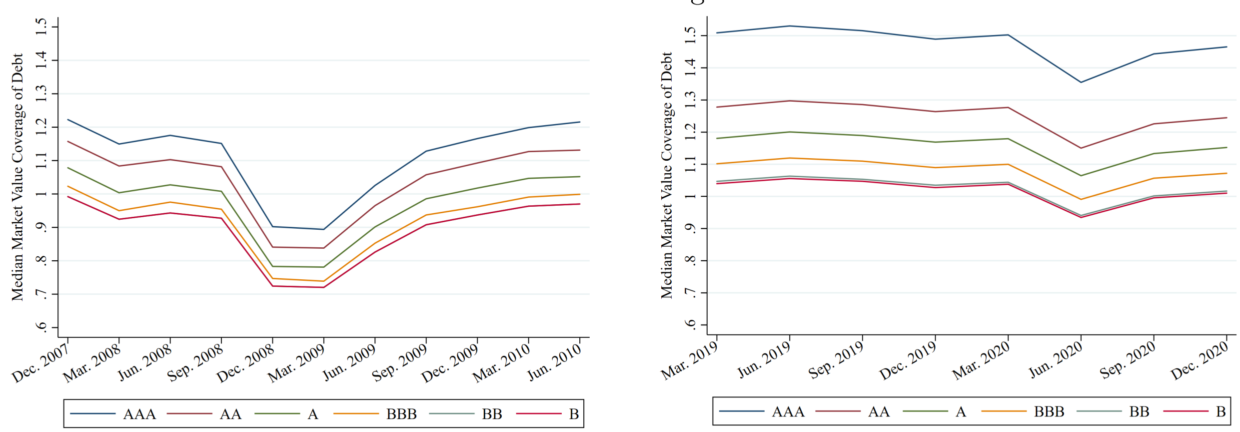
Figure 6: CLO Performance during the Financial and Covid-19 Crises

This figure plots the equity distributions, market value coverage ratios, and composition of collateral by credit rating for CLOs outstanding around the financial crisis of 2008 (left column) and the Covid-19 crisis of 2020 (right column). Panel A reports value-weighted average and median annualized distributions for CLO equity tranches. Panel B 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 C reports the fraction of CLO collateral in each rating category or in default. Distributions and tranche information are from Intex and collateral prices are from IHS Markit.

Panel A: Annualized Distributions to Equity Investors



Panel B: Market Value Coverage of Debt Tranches



Panel C: Composition of Collateral by Credit Rating

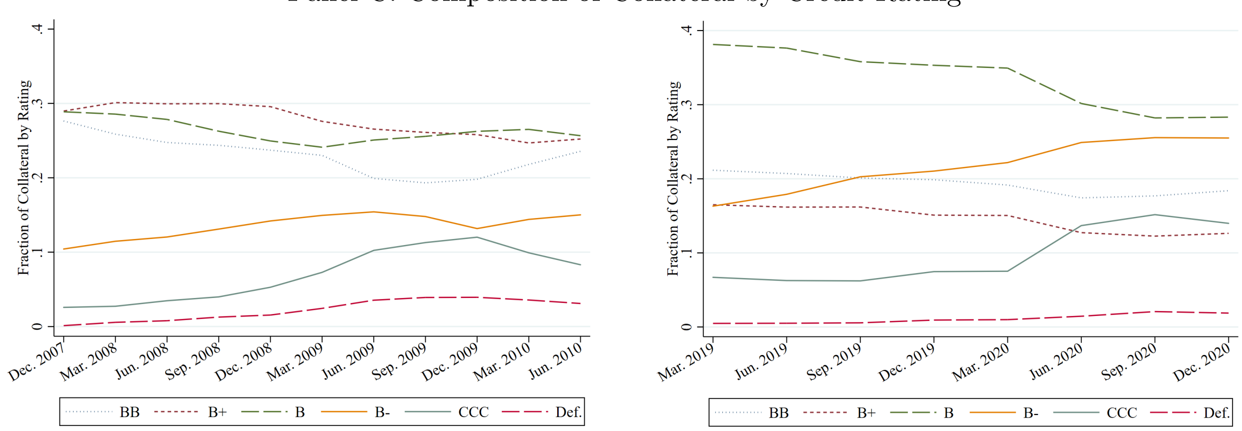


Table 1: Summary Statistics

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	19	18
2003	31	13.2	424.6	0.916	25	25
2004	65	30.5	469.2	0.909	45	45
2005	99	48.6	490.6	0.906	77	76
2006	173	89.0	514.4	0.907	149	148
2007	169	95.7	566.3	0.909	146	144
2008	37	40.8	1,103.5	0.909	28	27
2009	3	2.5	829.2	0.906	2	2
2010	11	4.4	399.1	0.906	10	9
2011	30	14.6	487.6	0.903	27	27
2012	115	53.5	464.8	0.900	110	89
2013	171	84.8	496.0	0.897	169	61
2014	239	128.4	537.2	0.895	233	67
2015	194	103.8	535.2	0.894	191	18
2016	173	82.8	478.5	0.895	170	12
2017	207	112.1	541.7	0.893	202	1
2018	278	144.2	518.6	0.893	274	0
2019	255	122.0	478.5	0.893	254	1
CLO 1.0	607	335.1	552.0	0.906	491	485
CLO 2.0	1,673	850.6	508.4	0.888	1,640	285
Full Sample	2,280	1,185.7	520.0	0.892	2,131	770

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 June 2020. 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	11.75	12.57	-0.50	2.11	6.48	20.43	23.88	18
2003	2.63	8.63	-7.37	-2.62	3.11	8.06	12.44	25
2004	7.10	7.10	-3.34	3.44	6.53	11.30	14.55	45
2005	13.06	7.65	6.42	9.14	13.63	17.63	21.37	76
2006	15.99	8.24	9.21	12.79	16.73	20.02	22.44	148
2007	17.52	9.22	8.50	15.58	18.51	21.96	26.21	144
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	5.92	9.18	-6.54	0.08	7.02	12.71	16.95	9
2011	12.55	11.56	3.16	8.38	14.12	19.70	22.60	27
2012	7.52	9.27	-0.75	5.05	8.37	12.57	16.16	89
2013	5.59	11.61	-4.65	2.25	5.84	9.70	18.86	61
2014	-0.15	10.57	-16.43	-7.35	1.52	7.36	10.86	67
2015	2.05	13.92	-18.85	-2.27	6.18	10.22	16.20	18
2016	0.30	13.45	-17.70	-6.19	3.36	9.30	14.62	12
CLO 1.0	13.37	11.03	2.21	9.14	15.50	19.88	23.40	485
CLO 2.0	5.10	11.39	-8.71	0.31	6.83	11.58	16.59	285
Full Sample	10.31	11.85	-3.33	4.87	11.91	17.92	21.82	770

Panel B: Public Market Equivalent versus S&P 500

Vintage	Mean	StDev	p10	p25	p50	p75	p90	Obs.
1997-2002	1.47	0.71	0.73	0.87	1.35	1.81	2.42	18
2003	0.89	0.33	0.55	0.71	0.83	1.06	1.28	25
2004	1.12	0.37	0.62	0.90	1.03	1.27	1.57	45
2005	1.51	0.44	1.02	1.23	1.47	1.79	2.05	76
2006	1.78	0.55	1.21	1.46	1.77	2.04	2.27	148
2007	2.06	0.57	1.36	1.80	2.07	2.33	2.72	144
2008	1.11	0.55	0.33	0.70	1.15	1.52	1.75	27
2009	0.57	0.29	0.36	0.36	0.57	0.77	0.77	2
2010	0.84	0.21	0.55	0.62	0.95	1.02	1.07	9
2011	0.94	0.24	0.72	0.79	0.98	1.10	1.27	27
2012	0.82	0.16	0.63	0.73	0.83	0.92	1.01	89
2013	0.85	0.22	0.62	0.74	0.83	0.95	1.12	61
2014	0.81	0.19	0.58	0.67	0.83	0.94	1.01	67
2015	0.85	0.18	0.62	0.76	0.87	0.94	1.09	18
2016	0.78	0.18	0.46	0.71	0.82	0.90	0.98	12
CLO 1.0	1.66***	0.64	0.86	1.21	1.69	2.06	2.37	485
CLO 2.0	0.84***	0.19	0.60	0.73	0.84	0.95	1.07	285
Full Sample	1.35***	0.65	0.67	0.84	1.18	1.84	2.19	770

Panel C: Public Market Equivalent versus Bank Stocks

Vintage	Mean	StDev	p10	p25	p50	p75	p90	Obs.
1997-2002	1.95	1.31	0.89	1.04	1.35	2.66	3.51	18
2003	1.51	0.74	0.86	0.90	1.35	1.90	2.40	25
2004	2.19	0.85	1.05	1.71	2.03	2.56	3.29	45
2005	3.13	1.04	1.95	2.38	3.10	3.86	4.39	76
2006	4.05	1.37	2.67	3.29	4.02	4.71	5.21	148
2007	4.39	1.34	2.58	3.72	4.49	5.10	5.87	144
2008	1.66	0.89	0.45	0.95	1.75	2.26	2.60	27
2009	0.50	0.18	0.37	0.37	0.50	0.62	0.62	2
2010	0.90	0.24	0.57	0.64	1.05	1.11	1.13	9
2011	0.87	0.24	0.60	0.73	0.88	1.06	1.18	27
2012	0.80	0.15	0.61	0.70	0.80	0.90	0.98	89
2013	0.84	0.22	0.61	0.71	0.81	0.94	1.12	61
2014	0.80	0.18	0.59	0.67	0.80	0.92	0.98	67
2015	0.82	0.15	0.61	0.75	0.84	0.92	1.00	18
2016	0.68	0.16	0.42	0.63	0.68	0.83	0.88	12
CLO 1.0	3.48***	1.58	1.36	2.28	3.58	4.55	5.26	485
CLO 2.0	0.81***	0.19	0.60	0.69	0.81	0.92	1.06	285
Full Sample	2.49***	1.80	0.68	0.86	2.01	4.03	4.90	770

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 June 2020. 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	20.13	12.09	7.77	14.59	21.86	27.98	31.80	485
CLO 2.0	11.03	11.55	-2.37	6.67	12.65	17.49	22.27	285
Full Sample	16.76	12.67	2.43	10.83	18.04	25.32	30.37	770

Panel B: Public Market Equivalent versus S&P 500

Vintage	Mean	StDev	p10	p25	p50	p75	p90	Obs.
CLO 1.0	2.10***	0.81	1.07	1.54	2.08	2.64	3.06	485
CLO 2.0	0.97***	0.21	0.72	0.85	0.98	1.09	1.20	285
Full Sample	1.68***	0.85	0.81	1.00	1.43	2.34	2.86	770

Panel C: Public Market Equivalent versus Bank Stocks

Vintage	Mean	StDev	p10	p25	p50	p75	p90	Obs.
CLO 1.0	4.38***	2.02	1.67	2.80	4.44	5.89	6.78	485
CLO 2.0	0.95***	0.21	0.70	0.82	0.95	1.07	1.18	285
Full Sample	3.11***	2.31	0.81	1.00	2.53	5.09	6.35	770

Table 4: GPME Analysis of CLO Equity Performance

This table presents estimates of the generalized public market equivalent (GPME) from Korteweg and Nagel (2016) for CLO equity. Panel A is based on "outside" (net of fees) equity distributions, while Panel B is based on "inside" (gross of fees) equity distributions. The GPME discounts CLO equity distributions with the SDF

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

summing each CLO's discounted cash flows and averaging across all deals. Distributions are normalized to an initial investment of $1. In each column, r_m is the excess return of the CRSP value-weighted index. In the second column, we use the Fama and French (1993) three-factor model, in which r_x and r_y are the SMB and HML factors. In the third column, we use the intermediary asset pricing model from He, Kelly, and Manela (2017), in which r_x is the value-weighted return on the portfolio of primary dealer equities. 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.

Panel A: "Outside" Equity Performance

	CAPM	Fama-French	He-Kelly-Manela
GPME	0.675***	0.398***	0.480***
	[0.000]	[0.000]	[0.001]
SDF Parameters			
a	−0.006	−0.009	−0.012
	(0.003)	(0.004)	(0.004)
b_1	2.242	1.701	5.263
	(0.502)	(0.300)	(0.443)
b_2		1.272	−4.768
		(0.475)	(0.573)
b_3		−4.991	
		(0.590)	

Panel B: "Inside" Equity Performance

	CAPM	Fama-French	He-Kelly-Manela
GPME	1.057***	0.696***	0.930***
	[0.000]	[0.000]	[0.000]
SDF Parameters			
a	−0.006	−0.008	−0.010
	(0.003)	(0.004)	(0.003)
b_1	2.241	1.669	4.491
	(0.508)	(0.301)	(0.349)
b_2		0.747	−3.237
		(0.366)	(0.582)
b_3		−5.132	
		(0.665)	

Table 5: Collateral Performance of Completed Deals

This table reports statistics on the after-fee performance of CLO collateral by vintage. The sample contains completed deals that paid down 99% of their senior debt by June 2020. 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	0.96	0.06	0.91	0.92	0.95	1.00	1.05	18
2003	0.99	0.06	0.94	0.95	0.96	1.00	1.09	25
2004	0.91	0.18	0.91	0.93	0.96	0.97	1.02	45
2005	0.97	0.04	0.92	0.95	0.97	1.00	1.03	76
2006	0.96	0.06	0.92	0.94	0.97	0.98	1.01	148
2007	0.97	0.06	0.92	0.94	0.96	0.99	1.03	144
2008	0.87	0.10	0.66	0.85	0.89	0.93	0.94	27
2009	0.76	0.08	0.71	0.71	0.76	0.81	0.81	2
2010	0.95	0.05	0.87	0.93	0.97	0.98	1.01	9
2011	0.96	0.05	0.93	0.94	0.97	0.99	1.01	27
2012	0.96	0.07	0.94	0.96	0.97	0.98	1.01	89
2013	0.99	0.06	0.95	0.97	0.98	1.01	1.06	61
2014	0.99	0.04	0.95	0.96	0.98	1.00	1.03	67
2015	0.98	0.04	0.94	0.96	0.97	0.99	1.03	18
2016	0.95	0.03	0.91	0.94	0.95	0.97	1.00	12
CLO 1.0	0.96***	0.08	0.91	0.94	0.96	0.98	1.02	485
CLO 2.0	0.97***	0.06	0.94	0.96	0.97	0.99	1.03	285
Full Sample	0.96***	0.08	0.92	0.94	0.97	0.99	1.02	770

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	1.02	1.04	1.11	1.17	17
2003	1.08	0.06	1.04	1.05	1.06	1.08	1.16	25
2004	0.98	0.20	0.99	1.01	1.04	1.05	1.10	45
2005	1.04	0.04	0.99	1.01	1.03	1.05	1.09	76
2006	1.02	0.06	0.98	1.00	1.02	1.03	1.06	148
2007	1.02	0.05	0.98	0.99	1.01	1.04	1.08	144
2008	0.94	0.10	0.73	0.92	0.97	1.01	1.03	27
2009	0.81	0.02	0.80	0.80	0.81	0.83	0.83	2
2010	0.96	0.05	0.89	0.94	0.98	0.99	1.01	9
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	1.00	1.01	1.03	89
2013	1.01	0.06	0.97	0.98	1.00	1.03	1.07	61
2014	1.00	0.03	0.96	0.98	0.99	1.01	1.04	67
2015	0.99	0.04	0.96	0.97	0.99	1.00	1.04	18
2016	0.96	0.03	0.92	0.96	0.96	0.98	1.00	12
CLO 1.0	1.02	0.09	0.98	1.00	1.02	1.04	1.08	484
CLO 2.0	0.99	0.06	0.96	0.98	0.99	1.01	1.04	285
Full Sample	1.01	0.08	0.96	0.99	1.01	1.04	1.07	769

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 June 2020. 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	2.44	1.52	1.42	1.73	2.26	2.86	3.40	480
AA-Rated	2.42	1.34	1.57	1.73	2.16	2.77	3.41	416
A-Rated	2.96	2.67	1.95	2.13	2.69	3.64	4.35	467
BBB-Rated	3.75	5.31	2.80	3.18	3.80	4.87	5.66	465
BB-Rated	6.19	6.14	4.85	5.33	6.09	7.70	9.52	359
B-Rated	-1.64	34.5	-63.3	7.16	9.64	11.5	22.2	6
CLO 2.0 (2010-2016)								
AAA-Rated	2.06	1.00	1.68	1.81	2.00	2.33	2.61	284
AA-Rated	3.02	1.23	2.46	2.69	2.96	3.26	3.72	278
A-Rated	3.81	1.11	3.25	3.47	3.75	4.10	4.75	276
BBB-Rated	4.75	1.19	3.98	4.35	4.74	5.12	5.83	268
BB-Rated	6.22	1.37	5.11	5.65	6.14	6.67	7.52	256
B-Rated	6.86	1.49	5.93	6.24	6.79	7.52	7.97	86
Full Sample (1997-2016)								
AAA-Rated	2.30	1.36	1.52	1.78	2.10	2.62	3.27	764
AA-Rated	2.66	1.33	1.62	1.97	2.59	3.11	3.56	694
A-Rated	3.27	2.26	2.02	2.38	3.36	3.94	4.58	743
BBB-Rated	4.11	4.32	2.93	3.48	4.34	5.03	5.71	733
BB-Rated	6.20	4.77	4.99	5.46	6.11	7.16	8.92	615
B-Rated	6.31	8.49	5.93	6.24	6.89	7.55	8.31	92

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	1.05***	0.06	1.02	1.03	1.04	1.06	1.08	480
AA-Rated	1.02***	0.06	0.99	1.00	1.02	1.03	1.06	416
A-Rated	1.02***	0.07	0.97	0.98	1.01	1.04	1.09	467
BBB-Rated	1.05***	0.11	0.98	1.00	1.05	1.09	1.15	465
BB-Rated	1.20***	0.14	1.11	1.14	1.19	1.26	1.33	359
B-Rated	1.40*	0.71	0.32	1.30	1.45	1.61	2.31	6
CLO 2.0 (2010-2016)								
AAA-Rated	1.02***	0.05	0.98	1.01	1.03	1.04	1.06	284
AA-Rated	1.04***	0.06	1.00	1.03	1.05	1.07	1.09	278
A-Rated	1.08***	0.06	1.02	1.06	1.08	1.10	1.13	276
BBB-Rated	1.08***	0.07	1.02	1.07	1.09	1.12	1.15	268
BB-Rated	1.05***	0.07	1.00	1.03	1.06	1.08	1.12	256
B-Rated	1.09***	0.08	1.02	1.07	1.10	1.13	1.15	86
Full Sample (1997-2016)								
AAA-Rated	1.04***	0.06	1.01	1.02	1.04	1.05	1.07	764
AA-Rated	1.03***	0.06	0.99	1.01	1.03	1.05	1.08	694
A-Rated	1.04***	0.07	0.97	0.99	1.03	1.08	1.12	743
BBB-Rated	1.06***	0.10	0.98	1.02	1.07	1.11	1.15	733
BB-Rated	1.14***	0.14	1.02	1.06	1.13	1.21	1.29	615
B-Rated	1.11***	0.20	1.02	1.07	1.10	1.13	1.18	92