CLO Performance*

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Abstract

We show that collateralized loan obligations (CLOs) add economic value by mitigating regulatory constraints imposed on financial intermediaries and addressing market incompleteness. CLO assets exhibit similar performance to loan mutual funds with nearly identical risk exposures and fees. CLO debt and equity tranches generate after-fee returns that are attractive relative to public benchmarks but commensurate with their systematic risk exposures. Before fees, equity tranches significantly outperform public benchmarks, which shows how managers capture the economic surplus created by CLOs. Temporal variation in equity performance highlights the resilience of CLOs to market volatility due to their long-term funding structure, and the erosion of returns 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. CLO investors include a broad array of financial institutions, including banks, insurers, pension funds, mutual funds, and hedge funds. 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)). Similarly, the U.S. House Financial Services Committee held hearings in June 2020 on the "Emerging Threats to Stability" created by leveraged loans and CLOs.

The importance of CLOs has also been recognized by academics. Since the 2008 financial crisis, a small but growing literature has explored the implications of CLOs for borrowers' costs of capital (Ivashina and Sun (2011), Nadauld and Weisbach (2012)), 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 financial stability (Elkamhi and Nozawa (2020)).

In this paper, we explore a different question: What market imperfections do CLOs address, and what are the associated costs? With perfect capital markets, there is no role for securitization because economic agents can costlessly transform cash flows. Thus, CLOs arise to mitigate one or more market frictions. We identify these frictions and the associated costs by testing their implications for the investment performance of CLO assets and liabilities.

We begin by constructing a novel sample 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. To evaluate the cash flows generated by CLO investments, we examine several performance metrics but focus attention on public market equivalents (PMEs) (Kaplan and Schoar (2005)) and generalized public market equivalents (GPMEs) (Korteweg and Nagel (2016)). Both measures use public market returns as a benchmark in settings where performance is based on observed cash flows to investors. The latter allows for the use of linear factor models and provides a framework for statistical inference.

We show that, on average, the pool of leveraged loans that comprise CLO assets provides returns that are similar to a broad-based index of leveraged loans. Net of fees, these returns are similar to those generated by a diversified portfolio of loan mutual funds. This similarity suggests that CLO managers, in aggregate, do not have an informational advantage over other market participants with respect to collateral quality. Put differently, the role of CLOs does not appear to be in exploiting relative mispricing in the leveraged loan market.

CLO liabilities – debt and equity tranches – are more revealing. Debt tranches offer higher returns than corporate bond indices that have the same credit rating and duration. The PME estimates are statistically and economically significantly higher than one and correspond to annualized return differences between 0.80% (for AAA and AA rated tranches) to 2.00% (for non-investment-grade tranches). While attractive, the return premiums associated with CLO debt tranches most likely reflect compensation to investors for less liquidity, higher prepayment risk, and higher systematic risk (Coval, Jurek, and Stafford (2009)).

Equity tranches, which receive the residual cash flows from the collateral pool, show no statistically significant after-fee performance on a risk-adjusted basis. This result is robust to a variety of asset-pricing models and shows that, on average, equity investors earn returns commensurate with their systematic risk exposure. However, before-fee equity returns exhibit robust and significant outperformance on a risk-adjusted basis, indicating that CLO managers are able to earn abnormal returns as "inside" equity investors. The GPME estimates imply that the average inside equity investment offers a net present value of 36 cents per dollar invested. For the average deal, this net present value amounts to $17 million or 3.6% of assets. Thus, CLOs generate significant economic surplus, which accrues to managers through fees.

In a nutshell, CLOs take advantage of the risk-adjusted return differential between syndicated loans and bonds identified by Schwert (2020). To paraphrase Gennaioli, Shleifer, and Vishny (2013), CLOs pursue a carry trade in which they pledge the returns on a loan portfolio in the worst state of the world as collateral for relatively safe debt and earn the upside in better states of the world. But, what are the market imperfections responsible for this surplus?

Transaction costs, market incompleteness, and information asymmetry are common rationales for the pooling and tranching of securities (Gorton and Metrick (2013)). While transaction costs may play a role in the pooling of loans in CLOs, they are silent on the value of tranching. Further, the pooling of corporate loans is not unique to CLOs, whose asset pools offer similar risk exposure and performance to those of loan mutual funds. Thus, any rationale for CLOs is most likely attributable to the issuance of a tranched capital structure to finance the loan portfolio.

Traditional theories for tranching are based on information asymmetry and the corresponding lemons problem that arises when financial intermediaries sell their loans.[1] 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 and are often at an informational *dis*advantage to the loan arrangers.[2] Thus, information-based theories seem ill-suited to explain the role of CLOs, especially when one considers that the same banks that arrange syndicated loans are among the largest purchasers of CLO debt.

Rather, CLOs appear to mitigate the regulatory constraints imposed on financial intermediaries. Like loan mutual funds, CLOs absorb the excess demand for credit from risky borrowers that cannot be filled by banks and insurers, whose balance sheets are constrained by capital requirements. Indeed, Irani et al. (2020) show that bank capitalization plays

[1] Some examples of information-based theories of securitization include Glaeser and Kallal (1997), Riddiough (1997), DeMarzo and Duffie (1999), and DeMarzo (2005).

[2] This distinction was critical 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).

an important role in the retention of risky syndicated loans that face high capital charges. However, unlike loan funds, CLO tranching increases the supply of "safe assets" (Gorton, Lewellen, and Metrick (2012)) in the process of filling this excess demand. These safe assets come with lower capital requirements and, as we show, offer attractive yields relative to identically rated instruments. Consequently, banks and insurers that "reach for yield" (Becker and Ivashina (2015)) are the primary purchasers of AAA and AA-rated CLO tranches (DeMarco, Liu, and Schmidt-Eisenlohr (2020), Foley-Fisher, Heinrich, and Verani (2020)).

Tranching also produces an equity claim that augments the span of tradeable claims through a unique funding structure. Unlike most levered investment vehicles that use short-term debt (e.g., hedge funds), CLOs are financed by long-term debt with maturities in excess of seven years, which practitioners refer to as "term leverage." Consequently, CLO equity exhibits a greater degree of resilience against market volatility because its financing incurs little, if any, rollover risk. Indeed, equity tranches of CLOs issued before the 2008 financial crisis performed significantly better than tranches of CLOs issued after the financial crisis. We observe similar resilience during the Covid-19 crisis, though it is too early to draw conclusions on the ultimate performance of CLOs as the crisis continues to unfold.

In addition to the previously mentioned studies, our work is related to prior research on alternative investment performance. In contrast to ABS CDOs (e.g, Coval, Jurek, and Stafford (2009), Chernenko (2017), Ospina and Uhlig (2018), Cordell, Feldberg, and Sass (2019)), our findings show that CLOs, and equity tranches in particular, greatly benefited from the higher spreads induced by the financial crisis.

Our results also offer a different perspective on recent work by Griffin and Nickerson (2020), who point out discrepancies between the credit ratings of CLO tranches and collateral 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. Thus, any risk assessment of CLO liabilities must account for this countervailing force.

Our results also offer a different perspective on the conclusions of Liebscher and Mahlmann (2017) and Fabozzi et al. (2020), who suggest that active trading by CLO managers reveals differential skill. We show that the aggregate performance of CLOs indicates no skill in collateral selection or trading. Rather, the economic rents captured by managers appear to be driven by their access to institutional capital, especially that deployed in equity tranches, where we too observe persistent differences in performance across managers.[3] However, we also find that this performance is declining over time, as revealed by declining equity returns and management fees as the market has grown.

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 collateral, debt, and equity tranches. Section 6 concludes.

1 Data

This section describes our data and sample selection. Details for replication purposes are relegated to the Internet Appendix.

1.1 CLO Information

Our primary data come from Intex Solutions, a leading provider of information on a variety of structured finance products including CLOs. Intex data are sourced directly from trustees, third-party financial institutions responsible for enforcing the indenture that governs the structure. The data are used widely by both buy- and sell-side participants in the market. The data include information on deal structures, loan-level histories of collateral holdings and transactions, cash distributions to every tranche through June 2020, and fees.

[3] The Internet Appendix provides evidence on the determinants of relative performance across managers. We find that managers play a significant role in determining the choice of collateral and leverage, but not the pricing of debt tranches after controlling for market conditions.

Figure 1 compares the coverage of the Intex CLO data to the total size of the U.S. CLO market as reported by the Securities Industry and Financial Markets Association (SIFMA). Since 2007, Intex's coverage has exceeded 90% of the entire CLO market, with near-complete coverage since the financial crisis. This difference is due to the inclusion of a small number of "balance-sheet" CLOs, collateralized bond obligations (CBOs), and more recently, commercial real estate CLOs in the SIFMA data. We exclude these vehicles from our analysis to maintain focus on a homogeneous set of deals.[4] 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 of 2008 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.[5]

Table 1 also shows that 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). We provide details on the distributions of these variables in the Internet Appendix.

[4] We also exclude resecurizations, which differ from standard CLOs because their collateral consists of CLO tranches instead of leveraged loans.

[5] 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 2,097 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 182 middle market deals worth $88 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.

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 also focus on CLOs that invest in institutional term loans, as opposed to lines of credit. In total, these requirements reduce our sample size from 2,279 to 2,231 deals – a 2% reduction.

An additional requirement is a complete history of payments to each tranche, which reduces the sample to the 2,133 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.[6]

A potential concern with this data requirement is selection bias if reporting is correlated with performance. However, our sample is only modestly affected (6.4%), with most of the reduction coming from the CLO 1.0 period. Our sample contains 84% of deals issued before 2010 and 97% 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.[7] 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)).

[6]We fill gaps in a small number of tranche payment histories using data from Bloomberg and implied balances from Intex that account for past payments and the current collateral value underlying the tranche. These adjustments are detailed in the Internet Appendix. Intex staff also assisted us by contacting their data providers to correct data errors.

[7]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.

The last column of Table 1 reports the number of deals that were fully paid down (i.e., completed) by June 2020. We concentrate on these deals for most of our analysis. CLOs have a typical maturity of eight years. Consequently, the number of completed deals mechanically declines as we approach the end of our sample horizon. CLOs also have a minimum life of two years but may be "called" by the equity investors before maturing to execute a refinancing or liquidate the deal. This optionality results in some completed deals in more recent vintages.[8] We discuss these institutional features of CLOs in more detail below.

1.3 Supplementary Data

We supplement the Intex CLO information with data from several others sources, which are detailed further 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 and Asaf Manela's websites.

[8]The option to refinance or reset the deal is a source of value for equity investors, so we combine deals in Intex to track them from origination through any refinancing or reset decisions.

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 construction of a CLO 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 from 150 to 250 distinct borrowers. Standard contract terms limit exposure to any industry to 15% of the loan pool, while the maximum exposure to an individual company is 2%. Contracts also limit the portfolio share of loans paying fixed or semi-annual (as opposed to quarterly floating) 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 assets, 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 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.[9]

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

[9] 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.

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 equity distribution 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 of the secured noteholders according to the same priority structure as interest payments.[10]

Panels A and B in Figure 3 show the time series of realized distributions to CLO debt tranches 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 and multiplying by four to obtain an annualized figure. We then weight each payout yield by the tranche size and sum to get the value-weighted average (Panel A), or take the median across CLOs (Panel B).

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 distributions coinciding with the amortization period. There are, however, exceptions when tranches are redeemed or called early, as we see significant increases in the payout yield well before the CLO matures. Finally, as a point of clarification regarding the plots' scale, the payout yields following the crisis are not zero; they are just above zero and reflect the extremely low interest rates during that period.

[10] 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.

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: (1) excess spread, and (2) overcollateralization. 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.

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 (i.e., equity is unsecured). As with interest payments, this excess collateral can be distributed to equity investors only after all of the debt tranches have been made whole. The average collateral value is approximately 112% of the face value of the secured notes. In other words, there is $1.12 in the collateral pool for each dollar of debt issued. Because leverage and overcollateralization are inversely related, Table 1 shows that overcollateralization has been increasing over time.[11]

Panels C and D of Figure 3 illustrate the excess spread in our sample. Panel C presents the principal value-weighted average coupon rates of CLO debt tranches, while Panel D presents the same for loans in the collateral pool. 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.

[11]It is worth noting that different classes of secured notes (senior, mezzanine, etc.) have different overcollateralization levels that are monotonically decreasing with the priority structure. In the median deal, AAA-rated tranches are secured with 161% of their value in collateral, while AA, A, BBB, and BB rated tranches have overcollateralization ratios of 139%, 128%, 120%, and 115%, respectively.

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. 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 90% 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 Asset Performance

Do CLOs exploit relative mispricing within the leveraged loan market? Put differently, do CLOs have skill in selecting loans for their collateral portfolios? We test this hypothesis by investigating the performance of CLO assets relative to the leveraged loan market as a whole. 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 have a complete history of fee payments for 48% of completed deals. Figure 5 reports the median annualized fees by vintage both excluding (Panel A) and including (Panel B) incentive fees that are paid if the equity IRR exceeds a specified threshold. Panel A shows that the typical fee is 50 bps of the collateral balance, although that rate declines towards the end of the sample. Panel B shows a similar picture, but highlights the steep increase in fee payments near the maturity of the CLO 1.0 vintages, which demonstrates the impact of incentive compensation on successful deals.

For deals without historical fee data, we estimate fees using the contractual fee rates specified in the offering memorandum, available for 23% of such 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 29% of deals with neither historical nor contractual fee data.

We assess the performance of CLO collateral using the public market equivalent (PME) method introduced by Kaplan and Schoar (2005). For each CLO, we discount the cash flow stream using the realized returns of a benchmark portfolio and sum the present values.

We then compute the ratio of this sum to the size of the initial investment. The result is a profitability index that measures the present value of distributions for each dollar invested. A PME greater than one indicates that investors earned more in present value terms than what they paid, while a PME less than one suggests the opposite. We 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 – in a risk-adjusted sense – performance.

We consider 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.

Table 2 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 0.97 implies that one dollar invested in CLO collateral would generate the same cash flows as 97 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.[12] The p-value from the J-test is 0.16, indicating that the average PME in Panel A is statistically indistinguishable from one.

The pre- and post-crisis eras – CLO 1.0 and CLO 2.0 – lead to a similar conclusion.

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

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 (0.98) and the overall average (0.97). 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. Regardless, the differences from one are too small in the whole sample and across eras to conclude anything other than economically similar returns between CLO assets and the LSTA Index.

Panel B presents analogous results for after-fee collateral distributions relative to a value-weighted index of loan mutual funds, an investable benchmark for both institutional and retail investors. For context, the average mutual fund in our sample has an annual fee of 62 bps, with an interquartile range of 50 bps to 77 bps in the cross-section of funds. These fees are similar to those of a 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. The *p*-values for each of these averages are all well above 35%.

In sum, the results in Table 2 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 the leveraged lending market, 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 and must be related to the liability structure.

Before turning to the liability side of the CLO, it is worth mentioning a distinguishing feature of CLOs versus other securitizations. 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 2 supports this conclusion by showing that CLO managers do not have an informational advantage relative to other market participants.[13]

4 Debt Performance

Figure 6 presents a first glimpse at the performance of debt tranches by showing time-series variation in the ratings of different CLO tranches by vintage. Tranches are grouped by their initial credit rating category: AAA, AA, A, BBB, and BB. We omit tranches initially rated in the B category because of their infrequency and sparse data. Each line presents a value-weighted average rating, in which letter ratings are converted into an ordinal count variable for visual purposes. For example, if half of the AAA-rated tranches in the 2006 vintage are still rated AAA in July of 2009 and the other half are rated AA+, the figure would show a point halfway between the AAA and AA+ notches.

Several themes emerge from the figure. First, all classes of CLO debt experienced rating declines during the 2008 financial crisis, though the severity of downgrades varied. Lower rated tranches experienced larger declines as measured by the number of notches they fell. Second, most tranches experienced a recovery in their rating starting at the end of 2010. For vintages originated closer to the start of the crisis, the recovery led to ratings increases above their original rating. For example, a number of mezzanine tranches achieved higher ratings during the economic expansion following the crisis due to improvements in excess spread and overcollateralization. Finally, with the exception of the financial crisis and its aftermath, CLO tranche ratings are generally stable over our sample period.

While informative, credit ratings do not measure investor performance. Table 3 presents two measures of economic returns (net of fees) for each rated tranche by sample period. Panel A presents internal rates of return (IRRs) by rating category for the full sample, and

[13] 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 add value through collateral selection and trading. This issue has been studied previously by Liebscher and Mahlmann (2017) and Fabozzi et al. (2020).

the CLO 1.0 and 2.0 subperiods. The IRR is computed as the discount rate equating the present value of the cash distributions to the value of the original investment. Average IRRs are monotonically related to their initial ratings, consistent with credit risk, and range from from 2.24% for AAA-rated tranches to 6.44% for B-rated tranches over the full sample. IRR volatilities follow a similar pattern and are inversely related to credit rating. These patterns hold for both CLO 1.0 and 2.0 sub-periods, though the latter period exhibits average IRRs that are more than 50 basis points (bps) higher for tranches rated between AA and BBB.

Panel B presents PMEs in the same manner as IRRs. For CLO debt tranches, corporate bonds with the same credit rating are a natural benchmark, but they suffer from a duration mismatch that creates different exposures to interest rate changes. Recall that CLO tranches are floating-rate instruments with an effective duration of less than one year. In contrast, corporate bonds are fixed-rate instruments with an average maturity of 10 years, or effective duration of about 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.[14]

Unlike IRRs, the average PMEs do not vary monotonically with credit rating, nor should they if the benchmark is accurately capturing risk. The PMEs also exhibit relatively little temporal or cross-sectional variation. The standard deviations for the full sample range from 0.03 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

[14] For the AAA benchmark, we include both AAA and AA rated corporate bonds because very few corporate issuers are rated AAA – at the time of writing there are only two, Johnson & Johnson and Microsoft. Our results are robust to including only AAA-rated bonds in the benchmark.

there are only six observations and some of which defaulted during the 2008 financial crisis.

One distinguishing feature of the estimated PMEs is that every average is greater than one, and most are statistically significantly so. In the full sample and the CLO 1.0 era, most all of these estimates are statistically different from one at the 1% level using the spatial GMM framework from Korteweg and Nagel (2016). The relative lack of statistical significance in the CLO 2.0 era is primarily due to reduced power from fewer non-overlapping time windows. Furthermore, the 25th percentile is greater than or equal to one for every rating category. Overall, the PME estimates suggest that CLO tranches have earned higher returns than similarly rated, synthetic floating-rate corporate bonds.

To put the PMEs in a returns context, we can compute the difference between the IRR and the benchmark return over the same period. Senior tranches, rated AAA and AA, earn about 65 bps 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 90 bps to 105 bps more, and junior tranches, rated BB and B, earning 200 bps more than their respective benchmarks. The high returns of CLO tranches relative to similarly rated bonds explains their appeal to regulated investors, such as banks and insurance companies, who fund the bulk of CLO issuance. These investors are constrained by capital requirements based on credit ratings that incentivize them to seek high-yielding debt within each rating category (Becker and Ivashina (2015)).

Although the results in Table 3 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. First of all, 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.[15] 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) show that although CLOs have lower bid-ask spreads than corporate bonds, they trade much less frequently and have higher costs of failed trades. Finally, CLO debt is almost always callable, with a standard non-call period of between six months and two years (Standard & Poor's (2018)). In contrast, Becker et al. (2018) show that only one-fifth of investment-grade corporate bonds have a call feature, while three-quarters of non-investment-grade corporate bonds are callable.

Ultimately, CLO debt offers high returns relative to similarly rated debt, but it is difficult to discern whether this difference reflects outperformance or compensation for risk exposures. Regardless, the findings in Table 3 explain the appeal of CLO debt to regulated investors. Banks and insurance companies, who 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)) by selecting the highest yielding debt instruments in a rating category. CLO debt tranches offer an attractive return relative to similarly rated securities.

[15]Our results provide an interesting contrast to the empirical findings in Coval, Jurek, and Stafford (2009). Whereas they find that investment-grade 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 standard asset-pricing intuition.

5 Equity Performance

Distributions to CLO equity investors depend on the difference in cash flows coming in from the collateral pool and going out to pay CLO debtholders. Therefore, the realized performance of CLO equity is informative about differences between the pricing of leveraged loans and CLO tranches that cannot be discerned from the analyses described above.

Table 4 presents after-fee equity performance results by annual vintage, era, and over the entire sample period.[16] Panel A reports internal rates of return (IRRs), which averaged 10.0% 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 fund vintages from 2000 to 2008, which is lower than the average IRR of 13.1% for CLOs issued over that period.

In contrast to the steady returns of CLO debt, equity IRRs exhibit significant variation over time. Somewhat surprising is the robust performance of CLOs issued between 2005 and 2007, just before the financial crisis. Median IRRs for these three years are all above 13%, despite an average lifetime that encompasses the Great Recession. Panels E and F of Figure 3 and our discussion of them provided 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 even larger liquidating payments to equityholders.

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

[16]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.

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 most 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 4 present public market equivalent (PME) estimates that reinforce these findings. We use two benchmarks for our calcuations. The first is the S&P 500 Index, which is motivated by the observation that many alternative asset managers compare their performance to broad market indices (Kaplan and Schoar (2005)). The second is the S&P 500 Banks sub-index, a portfolio of the largest bank stocks. We refer to these two measures as PME Market and PME Bank, respectively.

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 make money for their equityholders 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 debt securities, their liabilities have similar exposure 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 government subsidies.

Panel B reports an average PME Market of 1.35, implying that CLO equity earned higher returns than the index. 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 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 interquartile range. CLO equity performance has become more homogeneous over time.

Panel C presents results on PME Bank. The relatively poor performance of banks during and after the crisis leads to PMEs that are substantially larger when compared to their counterparts in Panel C. The overall average PME of 2.47 is impressive, but as with prior panels, there are significant differences between pre-crisis and post-crisis CLOs. Buying CLO equity prior to 2009 earned investors 3.45 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 higher returns than CLO equity since the financial crisis.

The three panels of Table 4 paint a consistent picture of CLO equity performance and identify another rationale for CLOs. CLO equity mitigates market incompleteness by providing a levered equity claim that is largely immune to rollover risk. Term leverage is a unique feature of CLO equity that enables managers to attract funds to the bottom of the vehicle's capital structure. This funding structure also provides a surprising degree of resilience in the face of market volatility, as seen in the performance of the deals issued immediately prior to the financial crisis.

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

5.1 Temporal Variation

Table 4 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 potentially responsible for these changes.

First, the liability structure of CLO 2.0 deals differs from that of CLO 1.0 deals. As previously discussed, post-crisis CLOs have materially higher debt servicing costs due to an increase in the credit spreads on newly issued CLO securities. In addition, revisions in rating agency criteria, which we discuss above, reduced the AAA-rated fraction of CLO issuance from 73% to 61%. 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 increased. 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%, including 140 new entrants. As noted earlier, the most recently issued vintages (2017 to 2019) have lower initial distributions than earlier post-crisis vintages. Further, Figure 5 shows a significant decline in management fees since 2017.

Third, censoring of more recent deals may lead to selection concerns; however, the evidence suggests that this is not a significant concern. 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. The evidence on payouts provided in Figure 3 shows that post-crisis CLOs, regardless of completed status, have higher financing costs and make lower equity distributions than pre-crisis CLOs.

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 5.3.

5.2 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.[17] To evaluate the performance of "inside" equity held by CLO managers, we add the estimated management fees described in Section 3 to the after-fee equity distributions to form a panel of before-fee equity payouts.

Table 5 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%, the senior and subordinated management fees totaling 50 bps of the collateral balance are equivalent to approximately 5% of the equity balance per year.

As a result, the average IRR increases by more than half, rising from 10.0% to 16.2%, while the PMEs increase by approximately 20%. While the time-series patterns are similar to those found in Table 4, an important difference in levels emerges for CLO 2.0 deals. The level of PMEs moves closer to one, statistically indistinguishable for the S&P 500 benchmark.

5.3 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). This framework accounts for the beta exposure of test assets and conducts statistical inference in a way that accounts for correlation across deals. Specifically, the GPME discounts cash flows with an exponentially

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

affine stochastic discount factor (SDF),

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

summing each CLO's discounted cash flows and averaging across all deals. Distributions are normalized to an initial investment of \$1. 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 the 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 6 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.

Panel A reports GPME estimates for equity performance on an after-fee basis for "outside" investors. The CAPM specification reveals a positive GPME that is statistically significant at the 10% level. However, the other two specifications reveal that this result is highly sensitive to model choice. Both the Fama-French and He-Kelly-Manela specifications reveal economically small and statistically insignificant GPMEs. Thus, there is no consistent evidence that CLO equity adds value to an outside investor's portfolio because she could obtain a similar risk-adjusted return by investing in public market factors.

Panel B reports analogous estimates for "inside" equity investments by CLO managers, inclusive of estimated fees. In contrast to 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 36 and 72 cents per dollar invested above what they could earn by investing in public market factors.[18]

Overall, these results provide a clear picture on the questions of whether CLOs create value and to whom any value creation accrues. CLO managers are able to earn "alpha" over public benchmarks, but after management fees are accounted for, outside equity investors earn a return that is in line with public risk factors. Based on the preceding analysis of CLO collateral performance, we can rule out managers' skill at selecting collateral as a driver of this outperformance. Therefore, it seems that CLO managers are able to earn excess returns by exploiting marketwide differences between the pricing of loans and bonds (Schwert (2020)). Although we cannot take a strong stand on whether loans trade at a discount or bonds trade at a premium (or both), our finding that CLO equity performance is declining over time is consistent with the notion that this "arbitrage" is disappearing as competition among CLO managers increases and more capital flows towards this opportunity.

5.4 The Covid-19 Crisis

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 if CLO equity, thus far, exhibits a resilience similar to that during the 2008 financial crisis.

Figure 7 presents several measures of interim performance of CLOs outstanding in the respective crises. The left side of each panel is based on data from December 2007 to June 2010, while the right side covers March 2019 to June 2020. The scale of the y-axes in each row of plots is the same, allowing for direct comparisons across the two periods, while 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 such as IRRs and PMEs. The ultimate performance of outstanding CLOs is difficult to assess accurately until the vehicles mature or are called

[18]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 before accounting for the price paid by investors for their services.

early because the tranches are long-dated options that trade in an illiquid secondary market.

Panel A shows that equity distributions have been largely unaffected by the first few months of the Covid-19 crisis, hovering between 10% and 15% annualized since March 2019. With the longer perspective offered by the previous 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 period, moving 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, with the average deal paying 10% and the median deal paying nothing to equity investors, the result of failed coverage tests that diverted cash flows to repay senior tranches.

Although we are unable to foresee what will happen in the current crisis, the evidence from the financial crisis suggests that it is unsurprising to see CLO equity distributions holding steady three months into the Covid-19 crisis. It will 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 standing of CLOs, Panel B of Figure 7 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). This ratio measures the gross recovery rate if the collateral were liquidated at current market values without price impact. Values greater than one correspond to a full recovery, while values below one correspond to loss of principal.

There are several differences in Panel B that 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, respectively. Second, coverage ratios are significantly higher today than they were a decade ago, a result of the lower leverage in CLO 2.0 relative to CLO 1.0 transactions. In 2019, AAA-rated tranches were secured by collateral worth 150% of the their face value, whereas coverage was less than 120% for AAA tranches in the run-up to the financial crisis. Third, the magnitudes of the coverage ratio declines in the current crisis is, thus far, more modest than the declines during the 2008 crisis. For example, AAA-rated tranche coverage ratios fell 26% from 1.16 in August 2008 to 0.85 in January 2009. In contrast, AAA coverage ratios only fell by 13% from January 2020 to the end of March 2020. Finally, during the 2008 crisis, all debt tranches were undercollateralized by significant margins. Even AAA-rated tranches experienced collateralization ratios below 0.90 in early 2009, while lower-rated tranches were deeply underwater. In the current crisis, coverage ratios fell below one for only the BBB- and BB-rated tranches, and by May 2020, only non-investment-grade tranches remain undercollateralized.

Lastly, Panel C presents the composition of collateral by credit rating during the two crises. There are two notable differences between the two plots. First, the shares of CLO collateral rated B and B- were higher, and the share rated B+ lower, prior to the current crisis than before the financial crisis. Related, 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 prior 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. Combined, these patterns indicate that fewer downgrades are necessary in the current crisis to trigger the failure of coverage tests and that test failures may come sooner after the initial shock than they did in the financial crisis.

To sum up, CLO equity tranches have proven resilient to the early stages of the Covid-19 crisis, but there is substantial uncertainty about their performance moving ahead. Indeed, it is likely that the recent spike in 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 CLO debt investors. Ultimately, the performance of outstanding CLOs will depend on the realized level of defaults and the evolution of credit spreads over the coming years.

6 Conclusion

This paper provides novel evidence on the sources of value creation by CLOs and the economic forces responsible for the widespread securitization of corporate loans by exploring the performance of CLO assets and liabilities over the last 20 years. Our key findings are as follows. CLO collateral offers similar returns to a broad-based index of leveraged loans. Debt tranches offer returns that are higher than corporate bonds with the same rating and duration, but these returns are likely driven by illiquidity, prepayment risk, and higher systematic risk exposure. Equity tranches also earn returns commensurate with their risk exposure on an after-fee basis. However, when fees are included to reflect inside equity investments by CLO managers, we find significant outperformance relative to public equity factors. Finally, we observe declining performance in equity tranches over the sample period.

These results point to several conclusions regarding the market imperfections for which CLOs are designed to address. CLOs are not a vehicle by which managers take advantage of their expertise in loan selection, though there is heterogeneity in managerial performance. The pooling of loans by CLOs is not a distinguishing feature, as we observe similar performance of loan mutual funds that serve the same purpose. Rather, we conclude that the primary source of value creation by CLOs stems from their tranched capital structures which, interestingly, have little to do with overcoming the informational frictions that are central to many theories of securitization.

CLO capital structures cater to two distinct sets of demands. The first is that of regulated financial intermediaries seeking to minimize capital charges with highly rated bonds while "reaching for yield" (Becker and Ivashina (2015)). The second is that of risk-seeking investors desiring levered exposure to the loan market with long-term financing that eliminates rollover risk. Any "skill" possessed by CLO managers as a group is related to accessing the capital that funds these vehicles, especially at the lower end of the liability structure. This skill has earned large financial rewards due to differences in pricing between leveraged loans and higher-rated tranche securities, but these rewards appear to be in decline as capital flows into the CLO market.

While our study has provided insight into the economic forces responsible for CLOs, many questions remain. Of immediate interest is how these vehicles will perform as the Covid-19 crisis continues to unfold and, related, what are the implications of any defaults to systemically important financial institutions. It is also important to understand further the implications of the rise of CLOs for the corporate borrowers that they ultimately fund. We look forward to future research that addresses these and other related issues.

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Figure 1: Intex Coverage of the CLO Market

This figure plots the aggregate amount of U.S. dollar CLOs outstanding in the Intex sample by year and compares it to the aggregate U.S. market size reported by SIFMA.

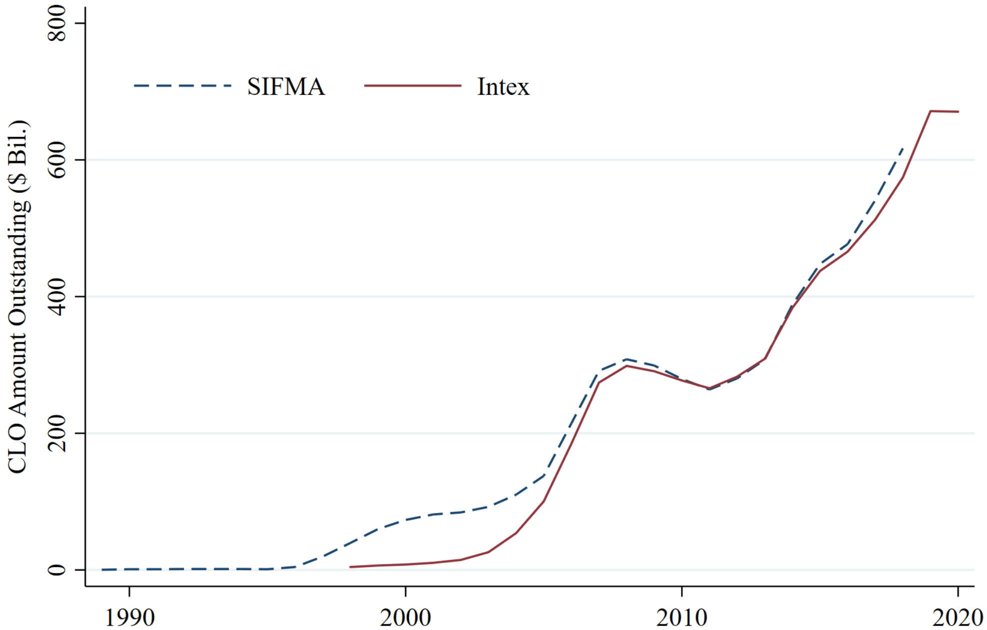


Figure 2: CLO Life Cycle

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

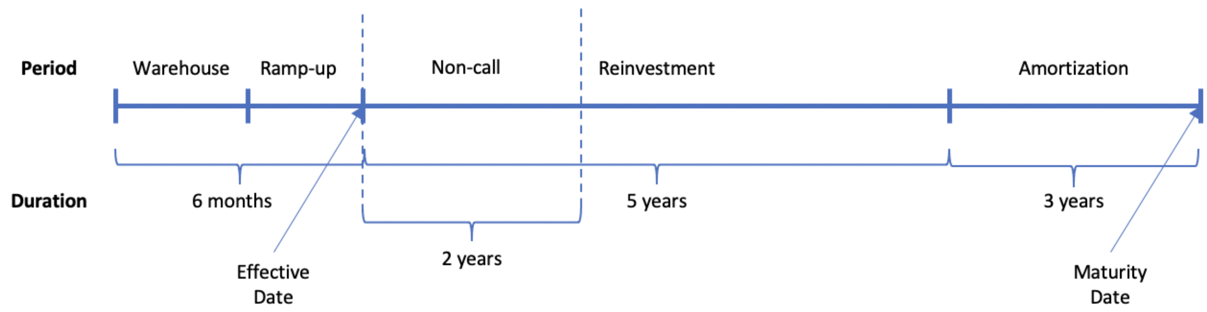
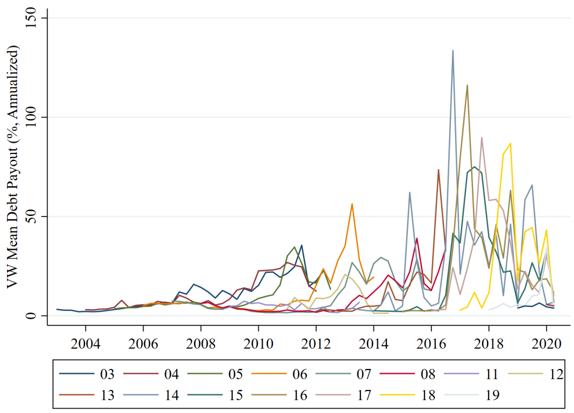


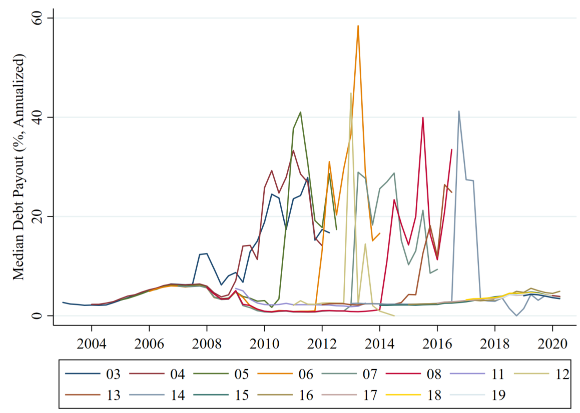
Figure 3: History of CLO Interest Rates and Cash Distributions

This figure presents the history of debt and equity tranche distributions by vintage. The top and bottom rows report the value-weighted average and median annualized after-fee distributions for CLO debt and equity tranches, respectively. The middle row reports the value-weighted average coupon rates on CLO debt tranches and loans in the collateral pool, respectively. The sample is restricted to vintage-quarter observations with at least five deals and at least 25% of the initial debt outstanding. Distributions and tranche information are from Intex and loan coupon rates are from IHS Markit.

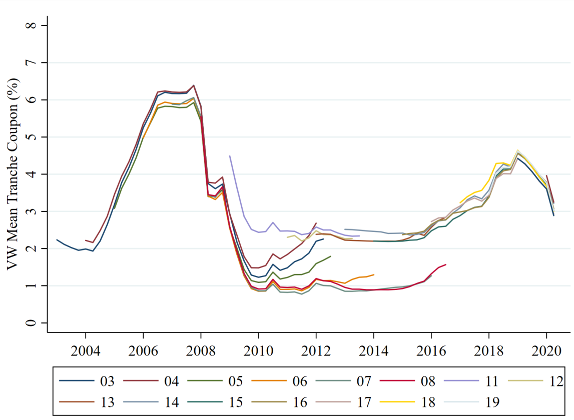
Panel A: VW Mean Debt Distribution



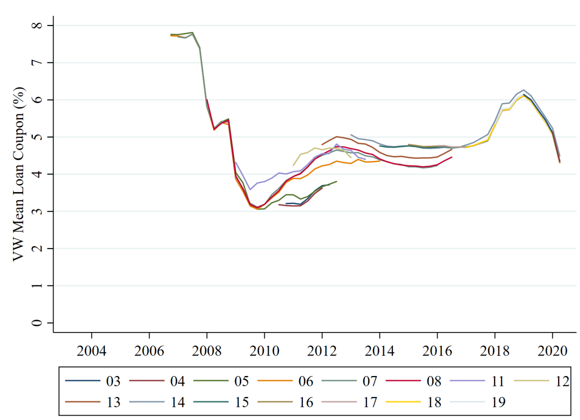
Panel B: Median Debt Distribution



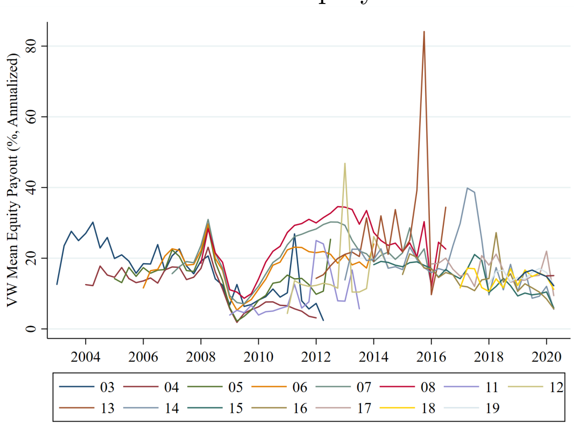
Panel C: VW Mean Debt Tranche Coupon Rate



Panel D: VW Mean Collateral Coupon Rate



Panel E: VW Mean Equity Distribution



Panel F: Median Equity Distribution

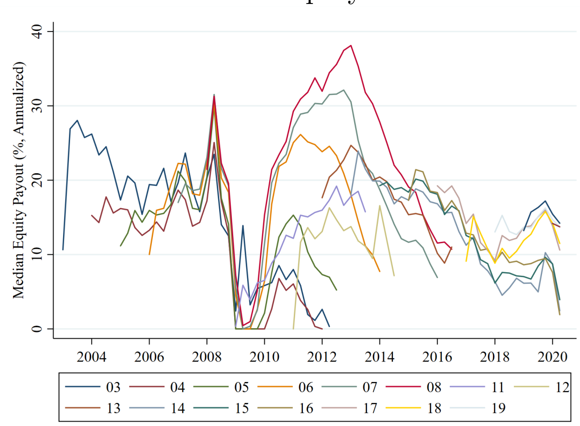


Figure 4: CLO Liability Structure

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.

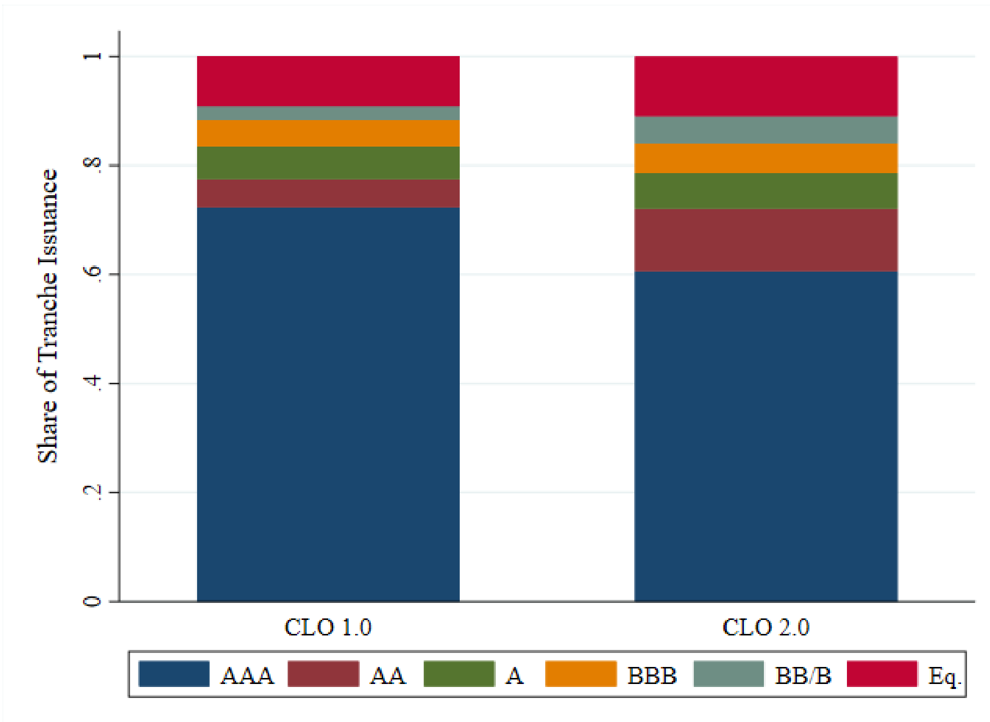
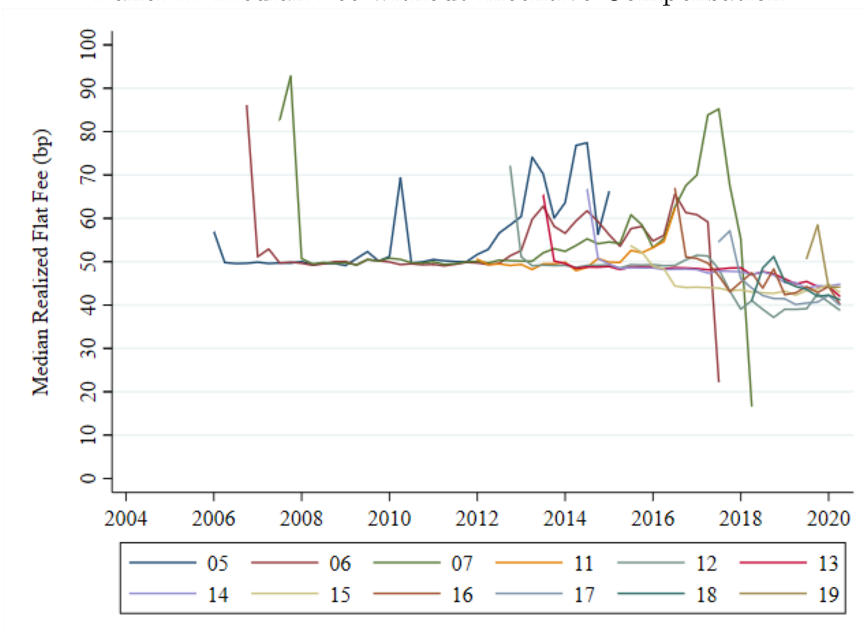


Figure 5: History of Management Fees

This figure presents the history of realized management fee payments by vintage. Panel A reports the median annualized senior plus subordinated fee excluding incentive compensation, while Panel B reports the median annualized fee including incentive compensation. Fees are reported as a fraction of the deal's collateral balance, in basis points. The sample is restricted to vintage-quarter observations with at least ten deals. Data on management fees are from Intex.

Panel A: Median Fee without Incentive Compensation



Panel B: Median Fee with Incentive Compensation

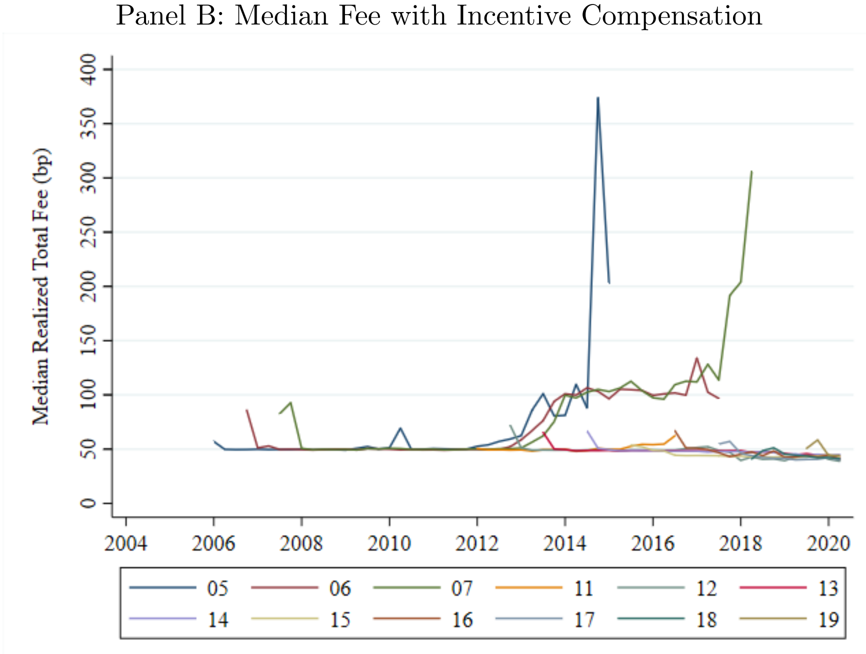
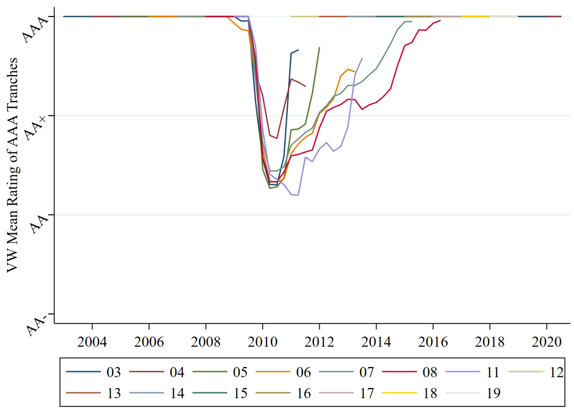


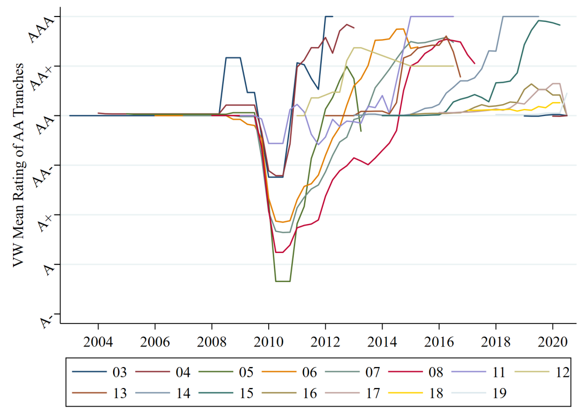
Figure 6: History of Tranche Credit Ratings

This figure presents the history of tranche credit ratings by vintage. Each panel reports the value-weighted average rating by vintage for a different initial rating category. The sample is restricted to vintage-quarter observations with at least 25% of the initial debt outstanding. Historical credit ratings are from Bloomberg.

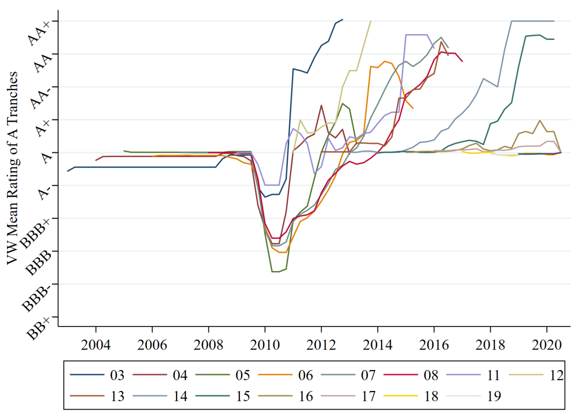
Panel A: AAA Tranches



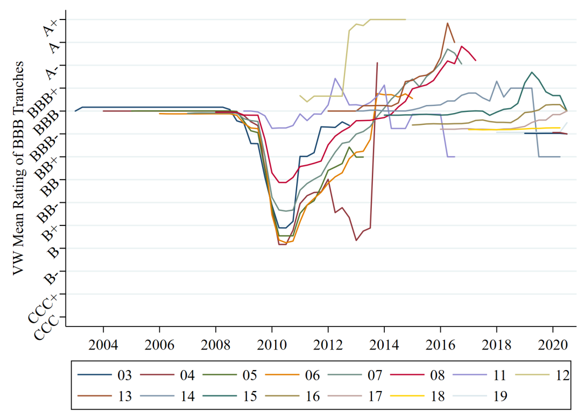
Panel B: AA Tranches



Panel C: A Tranches



Panel D: BBB Tranches



Panel E: BB Tranches

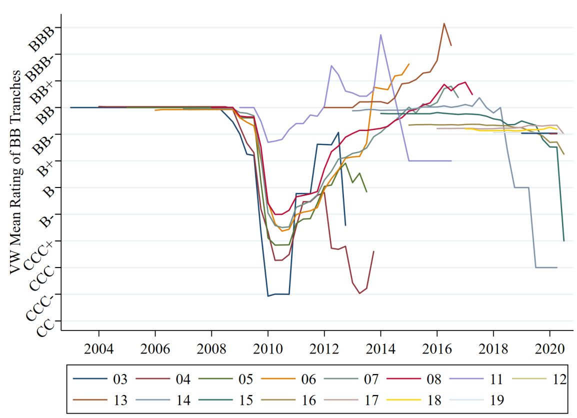
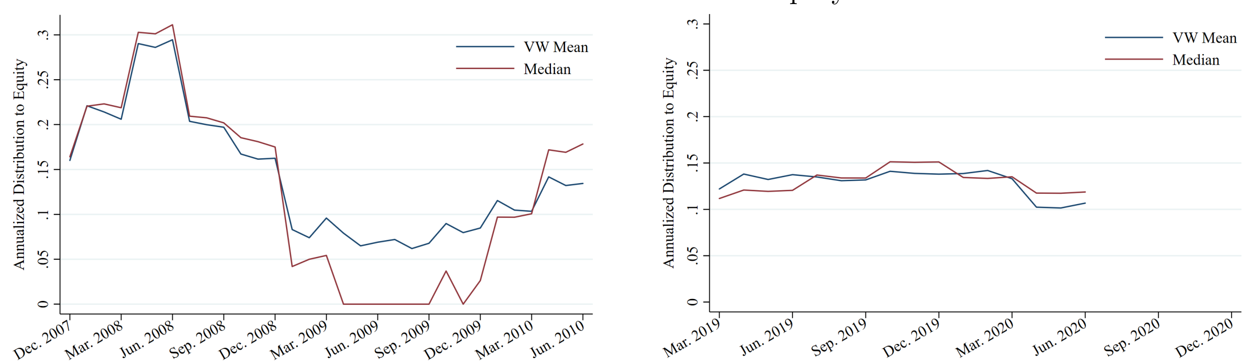


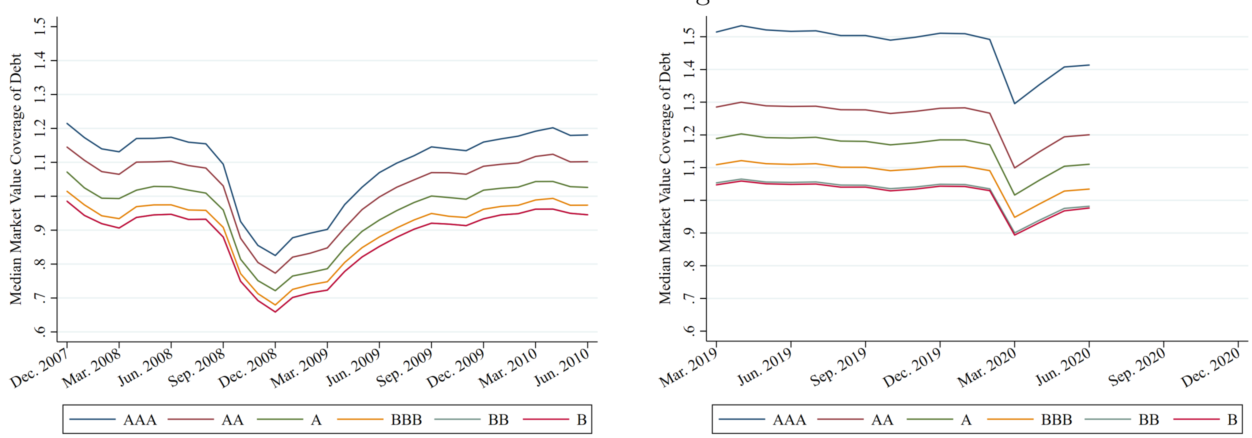
Figure 7: CLO Performance during the Financial and Covid-19 Crises

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

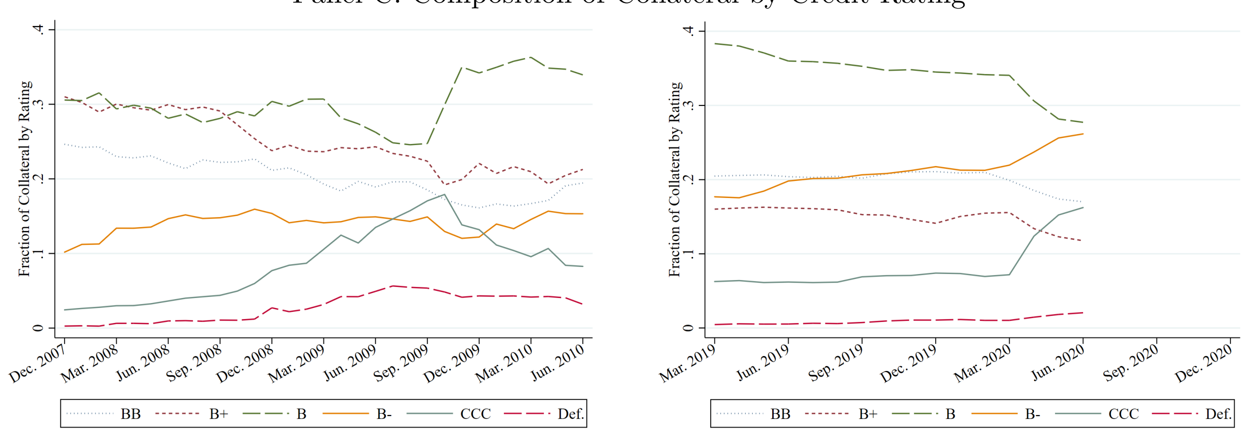


Table 1: Summary Statistics

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

Vintage	Deal Count	Issuance Amount ($ Bil.)	Mean Deal Size ($ Mil.)	Mean Leverage Ratio	Deals with Nonmissing Distributions	Completed Deals
1997-2002	30	14.8	436.5	0.922	21	20
2003	31	13.2	424.6	0.916	25	25
2004	65	30.5	469.2	0.909	50	48
2005	99	48.6	490.6	0.906	80	79
2006	175	90	514.3	0.907	156	152
2007	169	95.7	566.3	0.908	150	146
2008	41	42.1	1,026.3	0.909	30	27
2009	5	4.7	944.6	0.905	2	2
2010	12	4.5	372.5	0.903	10	9
2011	30	14.6	487.6	0.901	28	27
2012	114	53.1	465.4	0.898	112	92
2013	171	84.8	496.0	0.896	168	61
2014	239	128.4	537.2	0.893	237	69
2015	192	103.2	537.6	0.893	190	20
2016	172	82.6	480.5	0.894	171	13
2017	206	111.6	541.9	0.893	200	1
2018	277	143.8	519	0.893	274	0
2019	251	120.6	480.6	0.893	229	1
CLO 1.0	615	339.6	552.1	0.903	514	499
CLO 2.0	1,664	847.3	509.2	0.888	1,619	293
Full Sample	2,279	1186.8	520.8	0.892	2,133	792

Table 2: 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 Leveraged Loan 100 Index, with before-fee collateral cash flows estimated as the sum of estimated management fees and after-fee distributions to all CLO tranches. Panel B reports the after-fee PME versus a value-weighted portfolio of loan mutual funds, with after-fee collateral cash flows estimated as the sum of after-fee distributions to all CLO tranches. For the full sample PME estimates, we construct a J-test of the null hypothesis that the PME equals one using the spatial GMM covariance matrix from Korteweg and Nagel (2016), which accounts for correlated performance across deals by assuming that correlation declines with the degree of overlap in their time windows. *, **, and *** denote p-values less than 0.10, 0.05, and 0.01, respectively.

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

Vintage	Mean	StDev	p10	p25	p50	p75	p90	Obs.
1997-2002	0.97	0.06	0.92	0.93	0.97	1.01	1.05	19
2003	0.97	0.02	0.94	0.95	0.96	0.99	1.00	25
2004	0.91	0.18	0.84	0.94	0.96	0.98	1.00	48
2005	0.98	0.06	0.92	0.95	0.97	1.00	1.05	79
2006	0.96	0.06	0.92	0.94	0.96	0.98	1.01	152
2007	0.97	0.07	0.92	0.93	0.96	0.98	1.03	146
2008	0.87	0.10	0.66	0.85	0.91	0.93	0.95	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	0.97	0.04	0.94	0.96	0.97	0.98	1.01	92
2013	0.99	0.08	0.95	0.97	0.98	1.01	1.06	61
2014	0.99	0.07	0.96	0.96	0.98	1.00	1.04	69
2015	1.05	0.23	0.94	0.97	0.99	1.03	1.30	20
2016	0.94	0.08	0.86	0.94	0.95	0.98	1.02	13
CLO 1.0	0.96***	0.09	0.91	0.94	0.96	0.98	1.02	498
CLO 2.0	0.98	0.09	0.94	0.96	0.97	0.99	1.04	293
Full Sample	0.97	0.09	0.92	0.94	0.97	0.99	1.03	791

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

Vintage	Mean	StDev	p10	p25	p50	p75	p90	Obs.
1997-2002	1.07	0.07	1.02	1.03	1.05	1.12	1.17	18
2003	1.06	0.02	1.04	1.05	1.05	1.08	1.09	25
2004	0.98	0.20	0.89	1.02	1.04	1.06	1.07	48
2005	1.04	0.06	0.99	1.02	1.04	1.06	1.10	79
2006	1.02	0.06	0.99	1.01	1.02	1.04	1.07	152
2007	1.02	0.07	0.98	1.00	1.02	1.04	1.08	146
2008	0.95	0.10	0.73	0.92	0.98	1.01	1.05	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	0.99	0.04	0.96	0.98	0.99	1.01	1.03	92
2013	1.01	0.07	0.97	0.98	1.00	1.02	1.07	61
2014	1.00	0.08	0.97	0.98	0.99	1.01	1.05	69
2015	1.06	0.23	0.96	0.98	1.00	1.04	1.33	20
2016	0.95	0.08	0.86	0.95	0.96	0.98	1.03	13
CLO 1.0	1.02	0.09	0.98	1.00	1.03	1.05	1.08	497
CLO 2.0	1.00	0.09	0.96	0.98	0.99	1.01	1.05	293
Full Sample	1.01	0.09	0.97	0.99	1.01	1.04	1.08	790

Table 3: 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	2.33	0.73	1.44	1.72	2.26	2.83	3.34	491
AA-Rated	2.39	0.84	1.57	1.73	2.17	2.80	3.48	423
A-Rated	2.98	2.58	1.96	2.14	2.71	3.74	4.45	477
BBB-Rated	3.75	5.17	2.80	3.18	3.85	4.92	5.70	476
BB-Rated	6.20	5.99	4.87	5.35	6.10	7.76	9.53	368
B-Rated	-1.64	34.53	-63.30	7.16	9.64	11.49	22.20	6
CLO 2.0 (2010-2016)								
AAA-Rated	2.10	0.42	1.69	1.81	2.01	2.33	2.58	289
AA-Rated	3.06	0.86	2.45	2.70	2.96	3.26	3.76	283
A-Rated	3.86	0.60	3.25	3.48	3.76	4.09	4.73	281
BBB-Rated	4.83	0.75	4.08	4.36	4.75	5.12	5.85	271
BB-Rated	6.30	1.03	5.21	5.69	6.15	6.69	7.51	257
B-Rated	7.00	0.92	5.98	6.28	6.86	7.54	7.97	86
Full Sample (1997-2016)								
AAA-Rated	2.24	0.64	1.53	1.78	2.12	2.62	3.23	780
AA-Rated	2.66	0.91	1.62	1.99	2.62	3.11	3.56	706
A-Rated	3.30	2.12	2.03	2.41	3.38	3.95	4.59	758
BBB-Rated	4.14	4.18	2.94	3.52	4.37	5.04	5.77	747
BB-Rated	6.24	4.64	4.99	5.48	6.13	7.17	8.97	625
B-Rated	6.44	8.42	5.98	6.30	6.92	7.61	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	1.04***	0.03	1.02	1.03	1.04	1.06	1.07	491
AA-Rated	1.02***	0.04	0.99	1.00	1.02	1.04	1.06	423
A-Rated	1.02***	0.08	0.97	0.98	1.01	1.04	1.10	477
BBB-Rated	1.05***	0.10	0.98	1.01	1.05	1.09	1.15	475
BB-Rated	1.20***	0.13	1.11	1.14	1.20	1.26	1.33	368
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	0.03	0.99	1.01	1.02	1.04	1.06	289
AA-Rated	1.05*	0.05	1.00	1.03	1.04	1.06	1.09	283
A-Rated	1.08**	0.05	1.02	1.06	1.08	1.10	1.13	281
BBB-Rated	1.09**	0.06	1.02	1.07	1.09	1.12	1.15	271
BB-Rated	1.06	0.06	1.00	1.03	1.06	1.08	1.12	257
B-Rated	1.11	0.08	1.03	1.07	1.10	1.13	1.17	86
Full Sample (1997-2016)								
AAA-Rated	1.04***	0.03	1.01	1.02	1.04	1.05	1.07	780
AA-Rated	1.03***	0.04	0.99	1.01	1.03	1.05	1.08	706
A-Rated	1.04	0.07	0.97	1.00	1.03	1.08	1.12	758
BBB-Rated	1.07***	0.09	0.99	1.02	1.07	1.11	1.15	746
BB-Rated	1.14***	0.13	1.02	1.06	1.13	1.21	1.29	625
B-Rated	1.13*	0.20	1.03	1.07	1.10	1.14	1.22	92

Table 4: 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	13.40	13.40	0.38	3.14	8.07	21.42	33.71	20
2003	3.32	7.92	-4.12	-1.72	3.42	8.06	12.44	25
2004	6.46	7.15	-6.00	3.41	6.75	11.01	14.27	48
2005	11.98	11.55	5.48	8.94	13.24	17.16	21	79
2006	15.76	8.60	9.13	12.37	16.70	20.02	22.61	152
2007	16.96	11.99	8.71	15.53	18.51	21.97	26.20	146
2008	1.48	20.46	-28.90	-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	9.19	-6.54	0.08	7.02	12.71	16.96	9
2011	12.54	11.61	3.16	8.38	14.12	19.70	22.60	27
2012	7.09	9.50	-2.70	4.70	8.00	12.33	16.02	92
2013	5.51	11.52	-4.65	2.24	5.79	9.64	17.90	61
2014	0.06	10.49	-16.42	-7.22	2.52	7.38	10.67	69
2015	2.87	13.40	-16.80	-1.51	7.03	10.33	15.95	20
2016	-3.47	26.64	-42.02	-3.84	4.52	12.05	15.58	13
CLO 1.0	13.02	12.21	1.81	8.86	15.22	19.76	23.52	499
CLO 2.0	4.83	12.34	-8.79	0.31	6.88	11.51	16.56	293
Full Sample	9.99	12.87	-3.78	4.83	11.78	17.84	21.82	792

Panel B: Public Market Equivalent versus S&P 500

Vintage	Mean	StDev	p10	p25	p50	p75	p90	Obs.
1997-2002	1.50	0.69	0.73	0.88	1.40	1.86	2.36	19
2003	0.91	0.32	0.61	0.75	0.85	1.06	1.28	25
2004	1.08	0.34	0.61	0.89	1.03	1.26	1.54	48
2005	1.48	0.45	1.02	1.22	1.47	1.77	2.04	79
2006	1.77	0.55	1.21	1.44	1.77	2.04	2.28	152
2007	2.05	0.58	1.36	1.80	2.07	2.36	2.71	146
2008	1.12	0.54	0.33	0.70	1.15	1.53	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	0.81	0.16	0.61	0.73	0.83	0.91	1.01	92
2013	0.84	0.21	0.62	0.74	0.83	0.94	1.12	61
2014	0.81	0.19	0.58	0.67	0.83	0.94	1.01	69
2015	0.87	0.18	0.63	0.80	0.89	0.98	1.10	20
2016	0.76	0.27	0.35	0.67	0.85	0.93	1.00	13
CLO 1.0	1.65***	0.64	0.84	1.21	1.68	2.05	2.38	498
CLO 2.0	0.83***	0.20	0.59	0.72	0.84	0.95	1.08	293
Full Sample	1.35**	0.65	0.67	0.85	1.16	1.82	2.19	791

Panel C: Public Market Equivalent versus Bank Stocks

Vintage	Mean	StDev	p10	p25	p50	p75	p90	Obs.
1997-2002	1.95	1.27	0.90	1.09	1.36	2.81	3.33	19
2003	1.54	0.73	0.86	0.91	1.46	1.90	2.40	25
2004	2.11	0.81	0.95	1.71	2.02	2.50	3.06	48
2005	3.08	1.07	1.92	2.37	3.07	3.79	4.37	79
2006	4.02	1.38	2.63	3.27	4.00	4.71	5.28	152
2007	4.39	1.37	2.49	3.72	4.49	5.13	5.86	146
2008	1.67	0.87	0.47	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	0.79	0.16	0.60	0.70	0.79	0.89	0.98	92
2013	0.83	0.22	0.61	0.71	0.81	0.94	1.09	61
2014	0.80	0.17	0.60	0.67	0.81	0.91	0.98	69
2015	0.84	0.16	0.62	0.78	0.85	0.97	1.01	20
2016	0.67	0.24	0.30	0.61	0.69	0.87	0.89	13
CLO 1.0	3.45***	1.59	1.35	2.27	3.49	4.55	5.30	498
CLO 2.0	0.81***	0.19	0.60	0.69	0.82	0.92	1.06	293
Full Sample	2.47***	1.80	0.68	0.85	2.01	3.98	4.90	791

Table 5: "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. The sample contains completed deals that paid down 99% of their senior debt by June 2020. Panel A reports internal rates of return, Panel B reports the public market equivalent (PME) versus the S&P 500 index, and Panel C reports the PME versus the S&P 500 Banks sub-index. For the PME estimates in Panels B and C, we construct a J-test of the null hypothesis that the PME equals one using the spatial GMM covariance matrix from Korteweg and Nagel (2016), which accounts for correlated performance across deals by assuming that correlation declines with the degree of overlap in their time windows. *, **, and *** denote p-values less than 0.10, 0.05, and 0.01, respectively.

Panel A: Internal Rate of Return (%)

Vintage	Mean	StDev	p10	p25	p50	p75	p90	Obs.
CLO 1.0	19.34	12.58	7.59	14.01	20.91	26.77	30.85	499
CLO 2.0	10.76	12.64	-2.43	6.60	12.60	17.62	22.16	293
Full Sample	16.17	13.26	2.21	10.58	17.80	24.62	29.39	792

Panel B: Public Market Equivalent versus S&P 500

Vintage	Mean	StDev	p10	p25	p50	p75	p90	Obs.
CLO 1.0	2.03***	0.78	1.06	1.49	2.02	2.55	2.97	498
CLO 2.0	0.97	0.22	0.72	0.85	0.98	1.09	1.20	293
Full Sample	1.64***	0.82	0.80	0.99	1.41	2.27	2.78	791

Panel C: Public Market Equivalent versus Bank Stocks

Vintage	Mean	StDev	p10	p25	p50	p75	p90	Obs.
CLO 1.0	4.23***	1.95	1.64	2.75	4.26	5.65	6.57	498
CLO 2.0	0.94*	0.22	0.70	0.82	0.95	1.07	1.18	293
Full Sample	3.01***	2.22	0.81	1.00	2.47	4.93	6.14	791

Table 6: 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

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

summing each CLO's discounted cash flows and averaging across all deals. Distributions are normalized to an initial investment of \$1. 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	0.291*	−0.045	−0.007
	[0.080]	[0.199]	[0.948]
SDF Parameters			
a	0.001	−0.048	−0.013
	(0.002)	(0.012)	(0.006)
b_1	3.934	5.148	15.539
	(0.498)	(0.280)	(1.319)
b_2		−2.586	−17.977
		(1.128)	(2.020)
b_3		−17.940	
		(2.375)	

Panel B: "Inside" Equity Performance

	CAPM	Fama-French	He-Kelly-Manela
GPME	0.721**	0.362***	0.361
	[0.010]	[0.001]	[0.137]
SDF Parameters			
a	0.002	−0.065	0.004
	(0.002)	(0.109)	(0.007)
b_1	3.521	5.823	12.204
	(0.685)	(1.483)	(2.814)
b_2		20.049	−13.398
		(11.764)	(3.636)
b_3		−34.234	
		(13.910)	