CLO Performance*

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Abstract

We present evidence on the performance of collateralized loan obligations (CLOs). CLO debt tranches have consistently outperformed their benchmarks over the last twenty years, though by a small amount. CLO equity tranches issued before the 2008 crisis outperformed their benchmarks by a wide margin – a consequence of the "term leverage" in CLO structures that amplified the effects of the post-crisis economic recovery. Equity has underperformed its benchmarks since the crisis. Cross-sectional variation in CLO equity performance is driven to a large extent by persistent differences across CLO managers. Top-performing managers select loans with higher coupon rates and generate more value by trading in the secondary market.

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Collateralized loan obligations (CLOs) are an economically important asset class. Almost $200 billion of capital was raised by CLOs in 2018, compared to $130 billion raised by venture capital funds that same year (Pitchbook (2019)). CLO investors cover a broad spectrum of the economy including banks, insurers, pension funds, and hedge funds. Yet, there is no large sample evidence of the investment performance of CLOs.

This paper fills that gap by exploiting novel data on CLOs and leveraged loans. Our data contain information on almost all aspects of the CLO market including: after-fee distributions to CLO investors, the identify and trading behavior of CLO managers, and contract terms and pricing information for loans in the collateral pool. Since 2007, our data encompass over 90% of the U.S. CLO market.

We begin by assessing the performance of the entire CLO liability structure. CLOs fund the acquisition of loans in the collateral pool by issuing several claims, or tranches, that fall into two broad categories: secured notes and subordinated notes. Secured notes are debt claims secured by the collateral pool and are further classified by their own priority structure and credit rating: senior (AAA-rated), mezzanine (AA to BBB-rated), and junior (BB to B-rated). Subordinated notes are equity-like claims, unsecured by the collateral pool and the residual claimant on any income generated by the pool.

Secured notes' average internal rates of return (IRR) range from 2.16% for AAA-rated tranches to 6.91% for B-rated tranches. To evaluate relative performance, we construct public market equivalents, or PMEs (Kaplan and Schoar (2005)). Our benchmark for each debt tranche is an identically rated portfolio of synthetic floating-rate corporate bonds constructed using fixed-rate corporate bonds and interest rate swaps. These benchmarks are constructed to closely match the credit risk and duration of CLO tranches, as well as the relative illiquidity of CLOs, which trade in over-the-counter (OTC) secondary markets.

The average PMEs for debt tranches range from 1.03 for AA-rated tranches to 1.15 for BB-rated tranches. In other words, for each $1 invested in CLO debt, investors would have to buy more than $1 of corporate bonds to achieve the same payoff in present value

terms. This outperformance is stable across CLOs originated before and after 2010, which practitioners refer to as "CLO 1.0" and "CLO 2.0" transactions. This consistency is in stark contrast to other types of collateralized debt obligation (CDO) issued before the financial crisis, especially the asset-backed security CDOs that suffered large losses across all rated tranches (Cordell, Feldberg, and Sass (2019)).

Equity tranches have average IRRs that range from 4.41% to 19.08% across annual vintages. The overall average IRR is 12.41%, with a standard deviation of 8.2%. To evaluate the relative performance of equity tranches, we rely on two benchmarks: the S&P 500 Index and the S&P 500 Banks sub-index, a portfolio of the largest bank stocks. The former is a common reference point for investors in alternative assets (Kaplan and Schoar (2005)). The latter is a better match for the risk characteristics of CLOs, which are in many ways like banks - an asset portfolio of loans financed with a highly levered capital structure. However, unlike the debt benchmarks, the public equity benchmarks are significantly more liquid than CLO equity, which trades infrequently in the secondary market.

The average equity tranche PME using the S&P 500 as a benchmark (PME Market) is 1.40, while the PME relative to the portfolio of bank stocks (PME Bank) is 2.56. The discrepancy in these estimates stems from the relatively poor performance of bank stocks during and after the financial crisis of 2008. More interesting than the performance differential across benchmarks is that across CLOs 1.0 and 2.0. The average Market and Bank PMEs for CLOs issued prior to 2010 are 1.75 and 3.75, respectively, indicating that these deals outperformed their benchmarks by substantial margins. The corresponding averages for CLOs issued since 2010 are 0.88 and 0.85, which implies that investors would have been better off holding public equities instead of CLO equity in the post-crisis period.

The reason for this stark, almost counterintuitive, difference is a unique feature of CLO equity claims that practitioners refer to as "term leverage." CLOs originated before the crisis bought loans and issued secured notes at relatively low spreads over LIBOR. The 2008 crisis brought about large increases in spreads that declined with the passing of the crisis,

but remained relatively high during the subsequent period of low interest rates (Roberts and Schwert (2020)). As the collateral pool turned over because of maturing loans, prepayments, and amendments, CLO managers were able to take advantage of higher spreads on new loans, while the spreads on CLO debt tranches remained fixed at the lower pre-crisis levels. The result was a windfall of excess cash flow paid out to equityholders.

We examine the mechanisms responsible for heterogeneity in performance, focusing attention on equity tranches because the debt tranches exhibit little variation within rating class. There is a strong positive relation between leverage and equity performance – an intuitive relation that has been more difficult to uncover in public equity markets (Gomes and Schmid (2010)). Lower CLO debt coupon rates leave more cash flow for equity investors and correlate with better performance, as do higher coupon rates on loans in the collateral pool. Finally, CLOs that trade more actively and accumulate collateral by purchasing loans at a discount and selling them at a premium are able to generate more residual cash flow and better performance for equityholders.

Closer inspection reveals that the CLO managers responsible for these decisions are also responsible for persistent differences in CLO performance. Manager fixed effects are highly statistically significant in all of our performance regressions and generate a spread in IRRs in excess of 12%. Additionally, top-performing managers are almost two times as likely to continue their relatively strong performance on subsequent deals, even those issued several years later. We use a two-stage regression framework to show that the economic mechanisms behind performance, described above, are driven in large part by between-manager variation. In particular, we find that top-performing managers select collateral with higher coupon rates and generate more value by trading loans in the secondary market.

Previous research on CLOs examines the liability structure and credit ratings of CLOs (Newman et al. (2008), Benmelech and Dlugosz (2009)); the relative performance of loans in the collateral pool (Benmelech, Dlugosz, and Ivashina (2012)); and the implications of securitization for corporate borrowers (Ivashina and Sun (2011), Shivdasani and Wang (2011),

Nadauld and Weisbach (2012)) and lenders (Wang and Xia (2014), Bord and Santos (2015), Peristiani and Santos (2019)). More recently, Loumioti and Vasvari (2019) and Elkamhi and Nozawa (2020) study the effects of coverage tests, or covenants, on the actions of CLO managers. Our focus on the performance of CLO investments and managers is a novel contribution to this line of work.

Our study is also related to research on collateralized debt obligations backed by other assets, such as mortgages and asset-backed securities (e.g, Coval, Jurek, and Stafford (2009), Chernenko (2017), Ospina and Uhlig (2018), Cordell, Feldberg, and Sass (2019)). Aside from differences in collateral, our results show that CLOs, and the equity tranche in particular, greatly benefited from the higher spreads induced by the 2008 crisis, in contrast to other types of CDO.

Finally, our paper is related to other work studying the performance of alternative investments (e.g., Kaplan and Schoar (2005), Harris, Jenkinson, and Kaplan (2014)), and the broader literature studying whether financial managers possess skill (see Berk, van Binsbergen, and Miller (2020) for a review). It is interesting, if not surprising, that our findings of managerial skill and persistence are as strong, if not stronger, than those found in private equity, where managers play a significant role in influencing the value of the investment. Other than trading, CLO managers are largely passive with respect to the value of the loans that comprise the collateral pool.

The remainder of the paper is organized as follows. Section 1 presents our data sources and sample construction. Section 2 explains the relevant institutional details and the mechanisms governing payments to investors. Sections 3 and 4 investigate the performance of CLO debt and equity tranches, respectively. Section 5 examines whether and how managers generate persistently different performance. Section 6 concludes.

1 Data

Our primary data come from Intex Solutions, a leading provider of data on a variety of structured finance products including CLOs. Intex data are sourced directly from trustees and used widely by both buy- and sell-side participants in the market. The data include information on deal structures, the loan-level histories of collateral holdings and transactions, and most importantly for this paper, the complete history of cash distributions to every tranche through March 2020.

We obtain information on the loans in CLOs' collateral pools by merging the Intex data with IHS Markit's Loan Pricing database. The IHS Markit data includes loan characteristics and a daily panel of secondary market quotes from 2002 to present. These quotes are sourced from dealers in the over-the-counter market for leveraged loans and used by loan mutual funds and other institutional investors to mark their portfolios to market.

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.[1]

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 the market 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.[2]

[1]The SIFMA data include "balance-sheet" CLOs, collateralized bond obligations (CBOs), and more recently, commercial real estate CLOs, which we exclude from our analysis. Thus, our data offer near-comprehensive coverage of the universe of standard CLOs.

[2]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 2,207 broadly syndicated loan deals with a collateral value of $1.15 trillion, accounting for the bulk of our sample. In the latter type of deal, the CLO manager plays a dual role,

Table 1 also shows that the typical deal size is around $500 million with a leverage (debt-to-value) ratio of just over 90%. 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.

1.1 Sample Selection

To understand the performance of CLOs, we require certain information be present in the data. This section discusses these requirements at a high level, relegating the details to the Internet Appendix.

Our data requirements include the following: the identity of the collateral manager, distribution information to each tranche, the presence of a AAA-rated and equity tranche in the deal, leverage of at last 50%, and U.S. dollar denominated tranches. These screens reduce the Intex sample from 2,379 to 2,185 deals, or by just over 8%.

The final requirement is a complete history of payments to each tranche, which reduces the sample to the 1,832 deals reported in the bottom row of Table 1. CLO distributions are reported to Intex by the trustee, a third-party financial institution responsible for enforcing the indenture that governs the secured tranches. Missing data on distributions are attributable to two reasons. The first reason is the growth of Intex as a data provider over the last two decades. As a result, historical deals – CLOs 1.0 – are less populated than more recent deals. The second force is the relaxation of reporting requirements for CLO trustees after all secured tranches have been repaid. This relaxation can result in missing liquidation payments to equity tranches.

A potential concern with this last requirement is nonrandom selection, or more pointedly, selection on performance. Fortunately, this screen reduces our sample size by a relatively modest amount (16%). Nonetheless, we find CLO tranche default rates among our data

originating loans to small and medium size companies and purchasing them in a CLO that they manage. In aggregate, there are 194 middle market deals worth $93 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.

are broadly similar to those reported by Standard & Poor's (2014) for rated CLOs issued between 1994 and 2013.[3] Furthermore, all defaulted tranches are from the CLO 1.0 era in both our data and Standard & Poor's. While comforting, we must ultimately recognize the limitations of our data, though it is the best data currently available.

The last column of Table 1 shows the number of deals that were fully paid down by March 2020, which form the basis for most of our analysis. CLOs have a finite maturity, typically about 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, defined by their "non-call period," that is typically two years from the effective date (i.e., the date at which the manager has completed forming the collateral portfolio and begins managing it). At the completion of the non-call period, equityholders may call the outstanding tranches to execute a refinancing or liquidate the deal. This feature results in some completed deals in more recent vintages.

2 Institutional Details

This section briefly describes the life-cycle and distribution mechanisms of a typical CLO. For more details, see Benmelech and Dlugosz (2009) or Standard & Poor's (2018).

2.1 CLO Life Cycle

CLO managers begin by securing a line of credit with a bank to purchase the loans that will comprise the collateral pool. These loans consist primarily of floating-rate, senior secured credit agreements with maturities between five and seven years. Most loans are rated BB or B, i.e., below investment-grade, and are referred to as "leveraged loans" because of their

[3]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. Our sample is similar to the universe of U.S. CLOs in this regard, with a default rate of of 0.14% for investment-grade tranches and 0.93% for non-investment-grade tranches over the same period.

high risk.[4] The typical CLO holds hundreds of loans diversified across dozens of industries. Exposure to any industry is contractually limited to 15% of the loan pool, while the maximum exposure to a single company is 2%. Finally, contracts limit the number of loans paying fixed or semi-annual (as opposed to quarterly) coupons. 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.

As previously mentioned, there are secured and unsecured claims, 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 the vehicle from interest rate risk. Different 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, and to a lesser extent AA-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.

With the issuance proceeds received from investors, the CLO manager pays down the line of credit and continues 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 par 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

[4]Most CLOs allow up to 7.5% of the pool to be invested in loans rated CCC+ or lower without triggering any effect on the valuation of collateral in coverage tests.

intervals. Covenants, such as coverage tests, become effective.[5]

After the effective date, the CLO enters two overlapping but distinct phases. The first is the non-call period that usually spans two years after the effective date. During this period, none of the tranches can be called by the equityholders, which prevents the refinancing or early liquidation of the deal and thereby protects debt investors from some prepayment risk.

The reinvestment phase also begins immediately after the effective date and lasts four to five years. During this phase, the CLO manager actively trades loans to manage the credit quality and aggregate par value of the collateral pool. In doing so, the manager must continue to satisfy the collateral quality requirements and coverage tests to ensure an alignment of incentives with CLO investors.

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

Like any investment, CLO performance is based on the timing and magnitude of distributions received by investors. These cash flows are distributed to investors according to a "waterfall," or priority structure set forth in the CLO indenture.

Interest received from the collateral pool is first used to pay administrative expenses and senior management fees. The remainder is used to pay interest on the secured notes beginning with the senior noteholders, followed by the mezzanine noteholders, and then the junior noteholders. The priority of subordinated management fees varies from deal to deal, but the typical structure involves a fixed fee before equity is paid and an incentive fee

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

conditional on the equity distribution exceeding a prespecified threshold.[6]

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 waterfall.[7]

Panels A and B in Figure 2 show the time series of realized distributions to CLO debtholders 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 simply 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.

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.

[6]The typical fee structure is a senior fee of 0.15% and a subordinated fee of 0.35%. Both fees are based on the principal value of collateral in the pool. In addition, many deals pay an incentive fee if distributions to equityholders exceed a prespecified threshold. Our data on tranche distributions are based on the actual cash flows, after the payment of fees according to the priority waterfall.

[7]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.

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 paying the required interest, this spread generates cash flow that is greater than that required to make interest payments to debtholders. The excess is distributed to equityholders.

Panels C and D of Figure 2 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.

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-crisis and post-crisis vintages.

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 equityholders only after all of the debtholders 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.[8]

[8]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.

Panels E and F in Figure 2 show the time series of typical distributions to CLO equityholders by vintage. The patterns in these plots stand in stark contrast to those observed for debtholders in Panels A and B. Specifically, payout yields to equityholders 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 Investors Service (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 secured

noteholders in newly issued CLOs (see Panel C of Figure 2). 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, the spreads on the funding side of the CLO remained fixed at low, pre-crisis levels. The net effect is that pre-crisis CLOs earned higher excess spreads after the crisis, despite losing some collateral value to defaults during the crisis.

3 Secured Note (Debt) Performance

3.1 Credit Ratings

Figure 3 presents a first glimpse at the performance of secured notes 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 rarity 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 secured notes 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 BBB-rated 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 are limited in their ability to measure investor performance. Absent changes in payouts that occur only in the event of default, ratings changes may be uncorrelated with realized returns. Thus, we turn our attention to cash flow based measures of CLO debt performance.

3.2 Economic Returns

3.2.1 Internal Rate of Return

Table 2 presents measures of economic returns for each rated tranche over the full sample of completed deals issued from 1997 to 2016, as well as for the CLO 1.0 (pre-2010) and 2.0 (2010 to present) periods.[9] As a reminder, all distributions are net of management fees, which implies that our performance measures are net of fees as well.

Panel A presents internal rates of return (IRRs). IRR is computed as the discount rate that sets the present value of the cash distributions equal to the value of the original investment. Debt tranche IRRs are monotonically related to their initial ratings, commensurate with credit risk. Average IRRs range from 2.16% for AAA-rated tranches to 6.91% for B-rated tranches over the full sample. The cross-sectional dispersion in IRRs within tranches, like the averages, is decreasing with the credit rating. Looking across the CLO 1.0 and 2.0 sub-periods, there are a few noticeable differences. Average returns for all of the sub-AAA investment-grade tranches (AA, A, BBB) are almost one percentage point higher in the post-crisis period.

3.2.2 Public Market Equivalent

While informative, IRRs are limited in their use as a performance assessment tool because there is no obvious point of reference. Thus, we follow Kaplan and Schoar (2005) in comput-

[9]Since our data reflect performance through March 2020, these returns represent performance on deals that were fully paid down before the initial impact of the COVID-19 crisis.

ing public market equivalents (PMEs). For each CLO tranche, we discount the distributions by the realized returns to 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.

Strictly speaking, tranches with PMEs greater (less) than one outperform (underperform) their benchmarks. What is less clear is whether any abnormal performance can be considered excess compensation for the risk of the investment. Put differently, the economic interpretation of the PME depends critically on getting the discount rates correct, which can only happen if the systematic risk of the benchmark investment accurately represents that of the CLO tranche (Korteweg and Nagel (2016)).

Corporate bonds with the same rating as the CLO tranches are a natural benchmark, but they suffer from a duration mismatch that causes differential exposure 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 problem, 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. For these calculations, we use bond quotes from Bank of America Merrill Lynch and swap rates from Bloomberg. We compute benchmark indices for each rating category by value-weighting the synthetic floating-rate returns of individual bonds.

Panel B presents the PMEs for each rated tranche using our synthetic floating-rate corporate bond benchmarks. 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 0.13 for BB-rated tranches. If we compare PMEs across the two subperiods, we see largely similar distributions.

The one distinguishing feature of the estimated PMEs is that every average is greater than one. Furthermore, the 25th percentile is greater than or equal to one for every rating category and the 10th percentile is barely below one for only the AA and A rated tranches. Overall, the PME estimates suggest that CLO tranches have outperformed similarly rated, synthetic floating-rate corporate bonds. However, statistically speaking, we are unable to reject the null hypothesis that the estimated means are different from one because the overlapping windows over which we observe the CLOs lead to relatively little independent variation.[10]

4 Subordinated Note (Equity) Performance

Table 3 presents equity performance results by vintage-year. Panel A presents estimated IRRs, the last row of which shows an average IRR of 12.41% 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 buyout fund vintages from 2000 to 2008, which is lower than the average IRR of 15.3% for CLOs issued over that period.

IRRs exhibit significant variation over time, ranging from a low of 4.41% for the 2003 vintage to a high of 19.08% for the 2007 vintage. The robust performance of pre-crisis CLOs, issued between 2005 and 2007, is particularly interesting. Median IRRs for these three years are all above 13%, despite an average lifetime that encompasses the Great Recession.

Panel B presents multiple on invested capital (MOIC) estimates, computed as the sum of all distributions divided by the equity investment. While not a focus of this paper, it does

[10]In the Internet Appendix, we report estimates of Korteweg and Nagel's (2016) GPME, a variant of the PME that relaxes the assumption that beta equals one and allows for robust statistical inference. The GPME indicates that CLO debt tranches do not outperform their benchmark. However, statistical power is again limited by our short sample period, resulting in imprecise estimates of the GPME.

offer another point of comparison with other alternative investments. Harris, Jenkinson, and Kaplan (2014) find an average MOIC of 1.55 for the 2000 to 2008 vintage buyout funds, compared to an average MOIC of 2.14 for CLOs issued over the same period.

More central to the focus of this paper are Panels C and D, which present PME estimates based on two benchmarks. The first benchmark 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 benchmark 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 many 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. Of course, there are also important differences, such as banks' activities other than commercial lending and the influence of government subsidies. Ultimately, either benchmark may lead to biased PME estimates. However, any bias should have a negligible effect on comparisons between deals, but for leverage effects that we investigate below.[11]

Panel C reports an average PME Market of 1.40, implying that CLO equity outperformed the index. Once again this compares favorably against the PMEs of buyout funds, which Harris, Kaplan, and Jenkins (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 Panels A and B. We also note a decrease in the dispersion of PMEs over time. The average interquartile range falls from 0.52 before the

[11] Consistent with our choice of bank stocks as a benchmark, 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.

financial crisis to 0.20 after the crisis.

Panel D 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 2.56 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 3.75 times what they would have earned investing in bank equities. The analogous multiplier is only 0.85 for vintages from 2009 onward, implying that bank stocks have performed better than CLO equity since the financial crisis.

The four panels of Table 3 provide a consistent picture of CLO equity performance, with the last two panels suggesting an average outperformance of benchmarks due to the success of pre-2008 crisis CLOs. This consistency across measures is unsurprising, as all four metrics depend on the timing and level of distributions. Table 4 shows that the correlation between the PME measures is 0.97, the correlation between the MOIC and both PMEs is over 0.92, and the correlation between IRR and the other three measures ranges from 0.75 to 0.88.

4.1 Discussion

Several features of our results stand out, the first of which is the impressive performance of pre-crisis CLO vintages. Panels E and F of Figure 2 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, equityholders 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 really amplified the effects of the increased cash flow is a unique feature of CLO equity that practitioners refer to as "term leverage." Because a CLO is a closed-end vehicle funded with long-term debt, the equity tranche is able to maintain a levered position over

the life of the vehicle – up to ten years. This is in stark contrast to most other levered investments (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.

Another feature of equity performance that stands out is a leftward shift and a reduction in the dispersion of the performance distributions over time. Performance of post-crisis CLOs is worse across all performance metrics and cross-sectional differences in performance are smaller relative to pre-crisis CLOs. There are several forces responsible for these changes.

First, the liability structure of CLO 2.0 deals is different 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 the criteria used by credit rating agencies reduced the AAA-rated fraction of CLOs from approximately 70% to 60%. 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 increased among CLO managers. There are 115 managers responsible for the CLOs issued prior to 2008. For CLOs issued since then, there are 231 – market participation doubled. As noted earlier, the most recently issued vintages (2017 to 2019) have lower initial distributions than the early post-crisis vintages, consistent with intensifying competition among managers resulting in lower excess spreads.

Third, because all of our results are net of fees, they do not provide an accurate gauge of "inside equity" performance, or the performance of equity held by CLO managers. The

Internet Appendix provides a deeper examination of this issue, which we briefly summarize here. We construct a synthetic series of inside equity distributions by adding a 0.15% senior management fee in every quarter and a 0.35% subordinated fee in quarters with a non-zero equity distribution. The results reveal a similar time-series pattern in performance, but the level of PMEs moves from just below one to just above one in the post-crisis period. Thus, CLO managers who retain equity have slightly outperformed the broad equity market and the portfolio of large U.S. banks, even though their outside equity investors have underperformed.

A final comment pertains to the potential for selection bias in our results. Only a fraction of the 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. Although we cannot directly test for the effects of selection, we should note that the evidence on distributions in Figure 2 fully supports the interpretation provided here. In particular, we observe that post-2008 crisis CLOs, regardless of completed status, have higher financing costs and make lower equity distributions than pre-2008 crisis CLOs.

5 CLO Managers

There are 2,379 CLO deals issued over our sample period, but only 297 unique CLO managers. Figure 4 shows that the distribution of deals per manager is highly skewed in both the entire dataset and the subsample of completed deals. So, while the plurality of managers are one-time issuers, the majority of deals are handled by managers with previous experience. Coupled with the active role that managers play in constructing and managing the asset portfolio, these findings raise the following questions: Do managers affect equity performance, and if so, how?

5.1 Do Managers Matter?

We answer this question by testing for the presence of manager fixed effects in equity performance regressions. Specifically, we estimate the following error component model:

$$\text{Performance}_{i,v,m} = \beta_0 + \upsilon_v + \mu_m + \varepsilon_{i,v,m}, \tag{1}$$

where $\text{Performance}_{i,v,m}$ is one of the four performance measures: IRR, MOIC, PME Market, or PME Bank. The indices denote CLO i of quarterly vintage v managed by manager m. Vintage and manager fixed effects are denoted υ_v and μ_m, respectively. $\varepsilon_{i,v,m}$ is a CLO-specific error term.

Table 5 demonstrates the importance of managers in three ways. First, manager fixed effects are responsible for substantial increases in the adjusted R^2 of the regression – from 9% for PME Bank to 33% for IRR. Second, an F-test of the null hypothesis that the manager fixed effects are jointly zero is rejected at all meaningful significance levels. Finally, the distribution of estimated manager fixed effects illustrates just how much economic variation there is in performance across different managers. For example, the difference in average IRRs between the top (90th percentile) and bottom (10th percentile) performers is over 12% per year. The corresponding difference in PME Bank estimates is almost 1.7.

5.2 Is Managerial Performance Persistent?

Managers clearly have substantial influence on CLO equity returns. What is less clear is whether that influence is persistent, because one-time successes (or failures) can skew estimates in a small sample.

Table 6 investigates this issue by estimating performance transition matrices in which each "state" corresponds to a tercile of the performance distribution. Performance is measured relative to deals issued in the same annual vintage to mitigate the effect of differences in issuance timing.

Panel A presents transition matrices for sequential deals based on the PME benchmarked by the S&P 500 Banks sub-index. In the Internet Appendix, we present similar results based on the other performance measures. Asterisks denote statistically significant differences from the probabilities implied by a uniform distribution (1/3), accounting for within-manager correlation in errors.

The large diagonal estimates imply significant stickiness in performance, especially at the upper and lower ends of the performance distribution. The probabilities of being in the top or lower third of the relative performance distribution, conditional on having been in the same tercile in the previous deal, are over 53% and significantly different from the null of 33% at the 1% level.

We should note that these transition probabilities are conditional on the manager raising a follow-on fund and that fund having reached the end of its life. Both of these events depend on the performance of the initial fund. The probabilities of raising another fund are 94%, 91%, and 86% for managers in the top, middle, and bottom deciles. The probabilities of those deals being completed are 83%, 76%, and 77%, respectively. These patterns show that better-performing managers not only have persistently better returns, they are also better able to raise new funds.

One potential concern with interpreting these results as implying persistent differences in managerial ability is that sequential CLOs may have overlap in assets. In untabulated results, we find that the average collateral pool has 60% of the same assets as the manager's previous CLO. This is significantly higher than the 22% average across all pairs of CLOs. To address this concern, we re-estimate the transition matrix imposing a minimum time gap between follow-on deals to allow for the expiration of loans through maturation or prepayment.

Panel B of Table 6 examines a transition matrix imposing a one-year minimum gap between deals for each manager. The results show a similar degree of persistence to the unconstrained specification in Panel A, despite a reduction in average holdings overlap to 47%. Finally, Panel C imposes a seven-year minimum gap, approximately equal to the

average realized life of CLOs in our sample. The overlap in holdings is less than ten percent for this sample and this small degree of overlap exists over less than half the life of the follow-on CLO. Yet, the persistence of the upper and lower terciles are similar in magnitude to those found in Panels A and B, despite losing 75% of the sample. The decline in statistical significance in Panel C appears due to low power.

The degree of persistence revealed in Table 6 is similar to that shown by Kaplan and Schoar (2005) for private equity funds. This is somewhat surprising in light of the uniform structure of CLOs (Benmelech and Dlugosz (2009)) and the fact that leveraged loans trade in an active secondary market. The features of private equity that allow for consistent outperformance, such as access to deal flow and the ability to make operational changes, are not present in this setting.

5.3 How Do Managers Generate Different Performance?

Persistent differences in managerial performance must come from one of a limited number of economic channels. We first identify these channels with the following regression.

$$\text{Performance}_{i,v,m} = \beta_0 + \beta X_{i,v,m} + \upsilon_v + \varepsilon_{i,v,m}, \tag{2}$$

Index and variable definitions are the same as for equation discussed above. The covariate vector, $X_{i,v,m}$, includes the characteristics of the collateral pool and the terms of the tranche securities.

Table 7 presents the regression results. As expected, CLOs with more leverage, lower funding costs, and higher coupon rates among the collateral earn higher equity returns. "Par building" refers to buying loans at a discount, or selling at a premium, to increase the par amount of collateral in the pool. Unsurprisingly, greater par building leads to greater equity returns. Finally, and perhaps less obvious, more turnover in the loan portfolio is associated

with higher equity returns.[12]

The results in Table 7 are reassuring in that the differences in CLO performance are driven by structural differences that one would expect to drive performance. By definition, CLO managers are responsible for these differences, as they are the decision makers. Coupled with our previous results highlighting the importance of managerial fixed effects, these findings show that managers differentiate their performance by how they structure the CLO. What is unclear is on which of these channels managers rely to differentiate their performance.

To address this issue, we estimate a two-stage regression system that restricts variation in the determinants of performance to the variation driven by time-invariant differences across managers. Specifically, we estimate the following model:

$$\begin{aligned} \text{Performance}_{i,v,m} &= \beta_0 + \beta X_{i,v,m} + \upsilon_v + \varepsilon_{i,v,m}, \\ X^{(k)}_{i,v,m} &= \gamma_0 + \mu_m + \upsilon_v + \xi_{i,m,v} \end{aligned} \tag{3}$$

where all variables and indices are as previously defined. The system in equation (3) has a simple interpretation. Managers can only affect CLO performance through the actions they take to affect the CLO structure. These actions are captured by the vector $X_{i,v,m}$. In other words, the exclusion restriction is that there are no other channels through which managers can affect the performance of the CLO but through their construction of the CLO assets and liabilities, and their trading behavior.

Table 8 presents the results. Panel A reports second-stage estimates that bear a striking resemblance to the estimates in Table 7, which uses the same explanatory variables. Specifically, we see that better-performing deals have higher leverage and a lower cost of debt capital, a higher average coupon rate on loans in the collateral pool, and more active trading that results in improved overcollateralization. The coefficients are similar in magnitude to

[12]In the Internet Appendix, we show that these conclusions are robust to controlling for time-invariant manager characteristics. One notable difference is that the coefficient on average loan coupon becomes insignificant after the inclusion of manager fixed effects, which highlights the role of manager "style" in determining performance.

those in Table 7, which suggests that differences across managers account for almost all of the variation that matters for equity performance.

To shed light on which of the deal characteristics are affected most by managers, Panel B summarizes the first-stage regression estimates in a manner similar to Table 5. Of the five regressions, only the coupon rate on debt tranches is insensitive to the identity of the collateral manager. This contrasts with anecdotal evidence from practitioners that suggests they think about the manager's reputation and experience when investing in CLO debt tranches. However, it is consistent with our finding that debt performance exhibits little cross-sectional variation. In further support of this interpretation, we show in the Internet Appendix that managers explain far less variation and exhibit insignificant persistence in debt performance.

The other channels affecting CLO performance, leverage, loan coupon rates, and trading behavior, all depend significantly on differences across managers. Manager fixed effects explain between 20% (leverage) and 38% (turnover) of cross-sectional variation in these deal characteristics. Ultimately, it appears that managers play an important role in determining the performance of CLOs, primarily through the selection and trading of loan collateral, but also through the degree of leverage taken by the vehicle.

5.4 Discussion

What traits enable top-performing managers to consistently distinguish themselves from others? While a complete answer to this question is beyond the scope of this paper, we discuss several possible explanations here.

While anti-competitive behavior cannot be definitively ruled out, there are a number of features suggesting it may not be a first-order consideration. The CLO market consists of almost 300 distinct managers in our sample and market concentration is relatively low. The top 40 managers account for 50% of CLO issuance. This degree of concentration pales in comparison to the leveraged loan underwriting market, in which the top four arrangers are

involved in almost every transaction (Schwert (2020)). In addition, the secondary market for leveraged loans is more competitive and liquid than the markets for the assets of buyout and venture capital funds, investment vehicles that exhibit similar degrees of persistence to CLOs. The leveraged loan market shares similar liquidity characteristics to that of corporate bonds.

Reputation and skill in collateral selection are likelier explanations for persistent performance differentials. The top CLO managers based on number of deals and performance include some of the largest and most well recognized investment banks and private equity groups: Credit Suisse Asset Management, Blackstone's GSO credit investing arm, Ares Management, and the Carlyle Group are the top four managers by all-time issuance.

Another piece of evidence pointing to the role of reputation and skill is the short time interval between deals. The mean (median) interval between deals in our sample is 0.72 (0.38) years, which is substantially shorter than the expected life of a CLO – about seven years. Therefore, the investors in follow-on deals have little knowledge of how the prior deal will perform at the time of their investment.

6 Conclusion

Our study quantifies the performance of CLO investments over the last twenty years. CLO debt has exhibited modest, but steady, outperformance relative to its benchmark. CLO equity has also outperformed its benchmark(s), but only in deals issued before the 2008 financial crisis. Since then, CLO equity performance has slightly underperformed its benchmarks.

In quantifying these results, we were able to identify a unique feature of CLO equity that practitioners refer to as "term leverage." CLO equity is a levered position supported by long-term debt, which allows investors to maintain highly levered investments for an extended period. This feature was largely responsible for the impressive performance of the pre-financial crisis CLOs.

Driving this performance was the central role of CLO managers, who consistently distinguish themselves as top (or bottom) performers. These persistent performance differentials are due to the ability of top managers to select high-yielding collateral and to execute trades at better prices.

An interesting question now, in the midst of the COVID-19 crisis, regards how the outstanding CLO 2.0 deals will perform. This is a question that has received enormous attention from practitioners, regulators, and policymakers. Practitioners are concerned about performance in these stressful times. Regulators and policymakers are concerned about the potential risks of CLO debt defaults to the banking system and broader economy.

While still early, we do have evidence to suggest that the current crop of CLOs may not experience the same outstanding performance as the CLOs issued prior to the financial crisis. First, recently issued CLOs have significantly lower excess spreads than CLOs issued before the financial crisis, which gives them less cushion to continue making equity distributions through a downturn. Second, market commentators are almost unanimous in arguing that corporate default rates will be higher, and loan recoveries lower, than in the previous recession. This would be bad news for CLO equity and junior tranche investors. However, for senior and mezzanine investors, the improved overcollateralization of post-crisis CLOs will allow them to bear more loan defaults than pre-crisis CLOs could have before debt tranches will begin to experience losses. We look forward to seeing how this situation unfolds.

References

Benmelech, Efraim and Jennifer Dlugosz, 2009, The alchemy of CDO credit ratings, *Journal of Monetary Economics* 56, 617-634.

Benmelech, Efraim, Jennifer Dlugosz, and Victoria Ivashina, 2012, Securitization without adverse selection: The case of CLOs, *Journal of Financial Economics* 106, 91-113.

Berk, Jonathan B., Jules H. van Binsbergen, and Max Miller, 2020, Mutual funds: Skill and performance, *Journal of Portfolio Management.* 46, 17-31.

Berndt, Antje, Rohan Douglas, Darrell Duffie, and Mark Ferguson, 2018, Corporate credit risk premia, *Review of Finance* 22, 419-454.

Bord, Vitaly M., and Joao A.C. Santos, 2015, Does securitization of corporate loans lead to riskier lending? *Journal of Money, Credit, and Banking* 47, 415-444.

Chernenko, Sergey, 2017, The front men of Wall Street: The role of CDO collateral managers in the CDO boom and bust, *Journal of Finance* 72, 1893-1936.

Cordell, Larry, Greg Feldberg, and Danielle Sass, 2019, The role of ABS CDOs in the financial crisis, *Journal of Structured Finance* 25, 10-27.

Coval, Joshua, Jakub Jurek, and Erik Stafford, 2009, Economic catastrophe bonds, *American Economic Review* 99, 628-666.

Elkamhi, Redouane, and Yoshio Nozawa, 2020, Too big to diversify: A stress test on collateralized loan obligations, Working paper, University of Toronto.

Gomes, Joao F., and Lukas Schmid, 2010, Levered returns, *Journal of Finance* 65, 467-494.

Harris, Robert S., Tim Jenkinson, and Steven N. Kaplan, 2014, Private equity performance: What do we know? *Journal of Finance* 69, 1851-1882.

Ivashina, Victoria, and Zheng Sun, 2011, Institutional demand pressure and the cost of corporate loans, *Journal of Financial Economics* 99, 500-522.

Kaplan, Steve and Antoinette Schoar, 2005, Private equity performance: Returns, persistence, and capital flows, *Journal of Finance* 60, 1791-1823.

Korteweg, Arthur, and Stefan Nagel, 2016, Risk-adjusting the returns to venture capital, *Journal of Finance* 71, 1437-1470.

Longstaff, Francis A., and Brett W. Myers, 2014, How does the market value toxic assets? *Journal of Financial and Quantitative Analysis* 49, 297-319.

Loumioti, Maria and Florin P. Vasvari, 2019, Portfolio performance manipulation in collateralized loan obligations, *Journal of Accounting and Economics* 67, 438-462.

Mitchell, Mark, and Todd Pulvino, 2012, Arbitrage crashes and the speed of capital, *Journal of Financial Economics* 104, 469-490.

Moody's Investors Service, 2018, Annual default study: Corporate default and recovery rates, 1920-2017.

Nadauld, Taylor D. and Michael S. Weisbach, 2012, Did securitization affect the cost of corporate debt? *Journal of Financial Economics* 105, 332-352.

Newman, Daniel, Frank J. Fabozzi, Douglas J. Lucas, and Laurie S. Goodman, 2008, Empirical evidence on CDO performance, *Journal of Fixed Income* 18, 32-40.

Ospina, Juan, and Harald Uhlig, 2018, Mortgage-backed securities and the financial crisis of 2008: A post-mortem, Working paper, University of Chicago.

Pitchbook, 2019, US venture capital investment reached $130.9 billion in 2018, surpassing dot-com era.

Peristiani, Stavros, and Joao A.C. Santos, 2019, CLO trading and collateral manager bank affiliation, *Journal of Financial Intermediation* 39, 47-58.

Roberts, Michael R., and Michael Schwert, 2020, Interest rates and the design of financial contracts, Working paper, University of Pennsylvania.

Schwert, Michael, 2020, Does borrowing from banks cost more than borrowing from the market? *Journal of Finance* 75, 905-947.

Shivdisani, Anil, and Yihui Wang, 2011, Did structured credit fuel the LBO boom? *Journal of Finance* 66, 1291-1328.

Standard & Poor's, 2018, S&P Global Ratings CLO Primer.

Standard & Poor's, 2014, Twenty Years Strong: A Look Back at U.S. CLO Ratings Performance from 1994 through 2013.

Wang, Yihui and Han Xia, 2014, Do lenders still monitor when they can securitize loans? *Review of Financial Studies* 27, 2354-2391.

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.

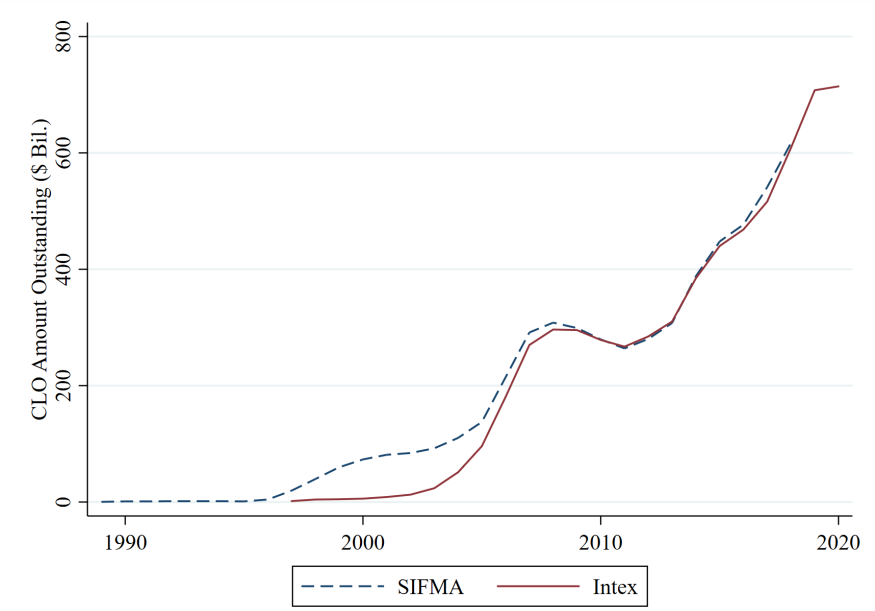
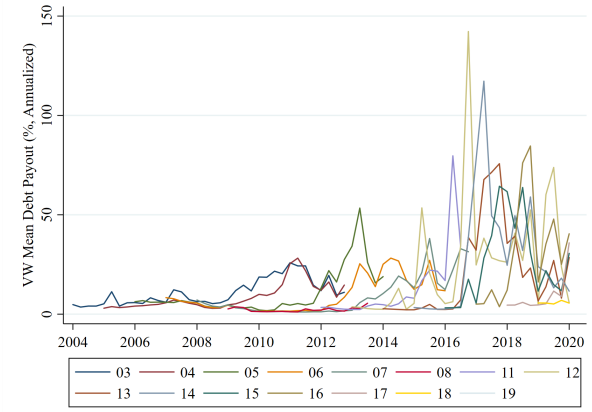


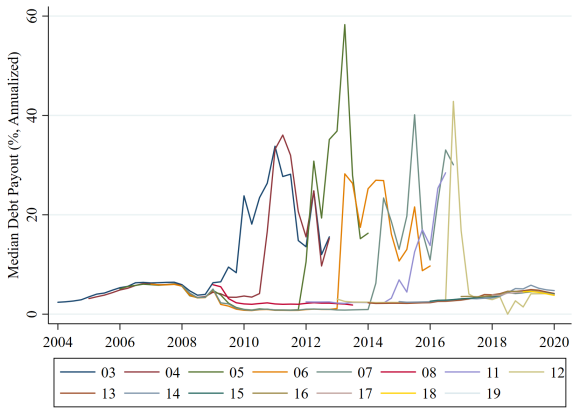
Figure 2: History of CLO Interest Rates and Cash Distributions

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 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.

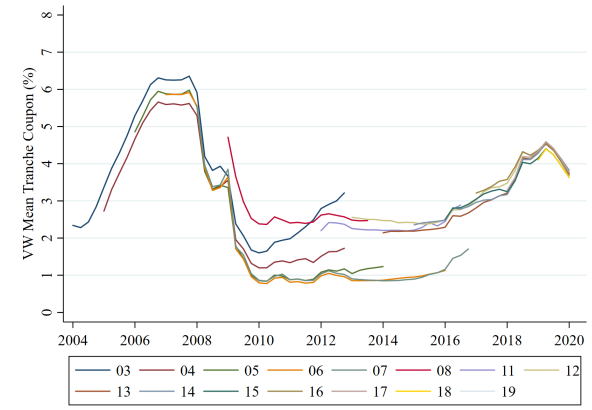
Panel A: VW Mean Debt Distribution



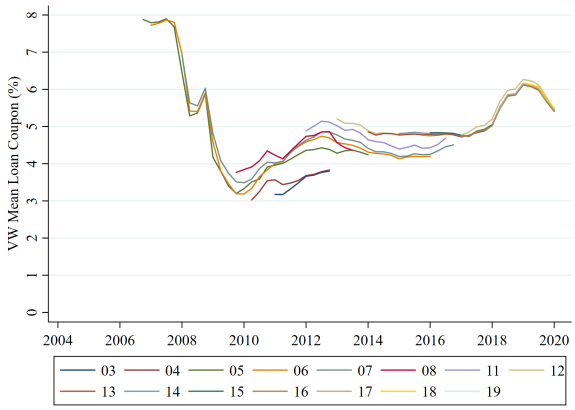
Panel B: Median Debt Distribution



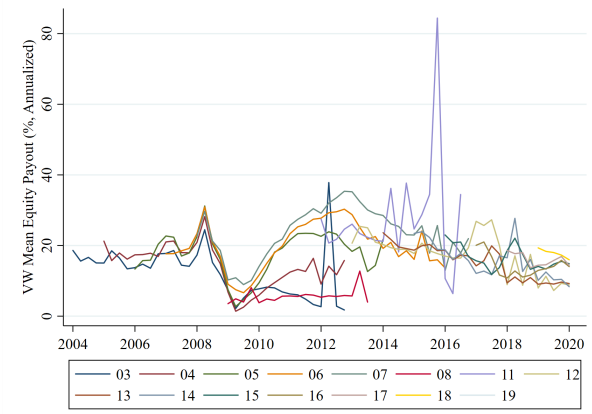
Panel C: VW Mean Debt Tranche Coupon Rate



Panel D: VW Mean Collateral Coupon Rate



Panel E: VW Mean Equity Distribution



Panel F: Median Equity Distribution

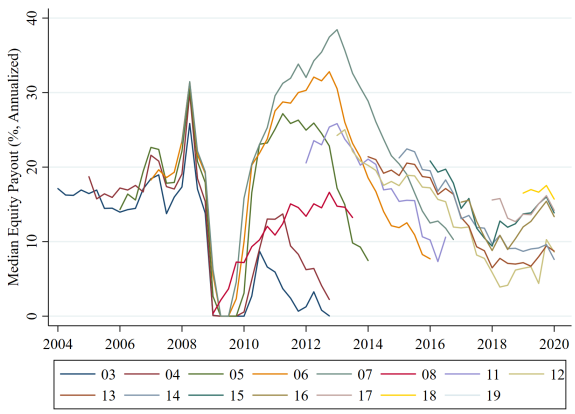
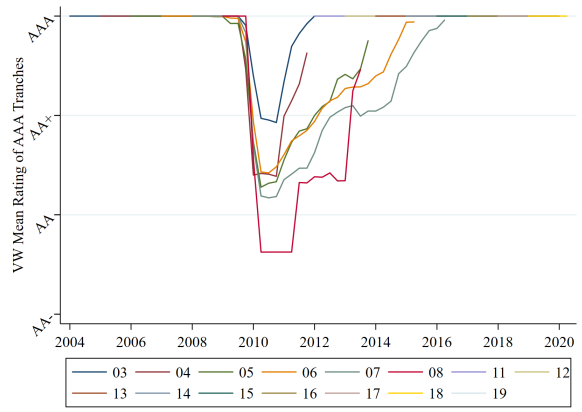


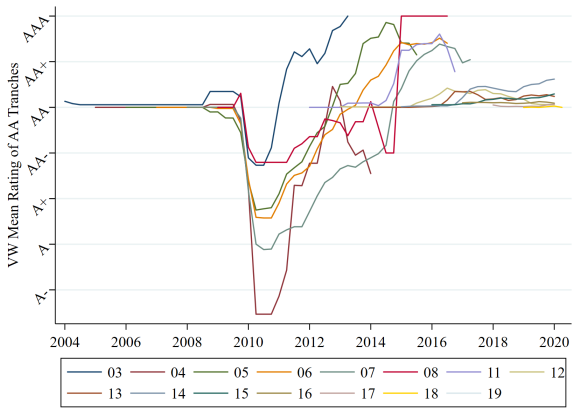
Figure 3: History of Tranche Credit Ratings

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.

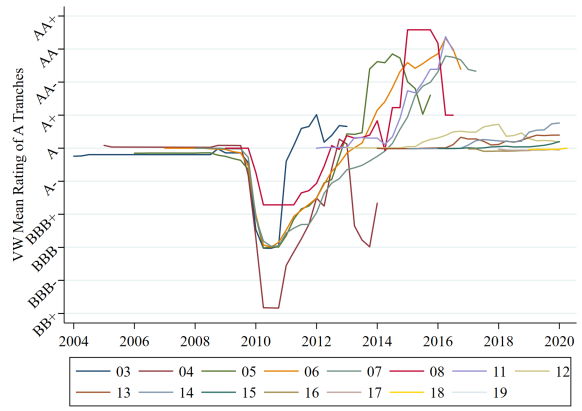
Panel A: AAA Tranches



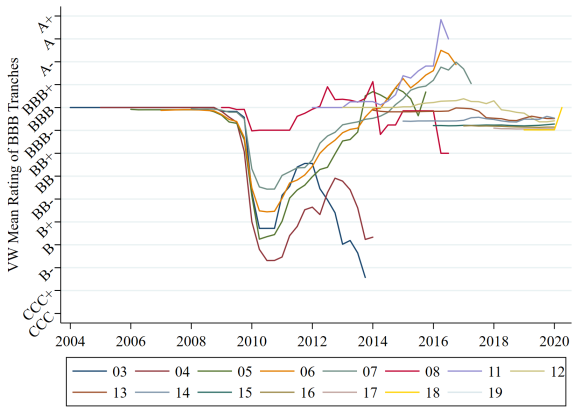
Panel B: AA Tranches



Panel C: A Tranches



Panel D: BBB Tranches



Panel E: BB Tranches

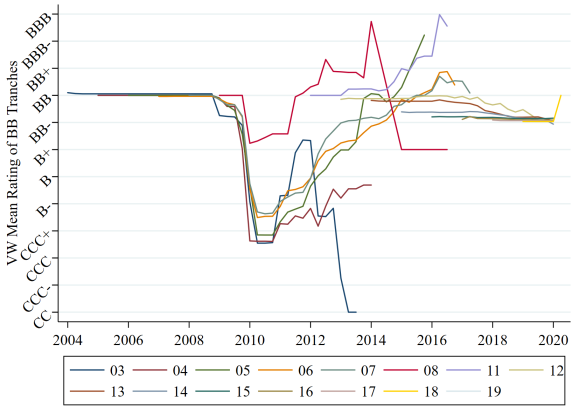
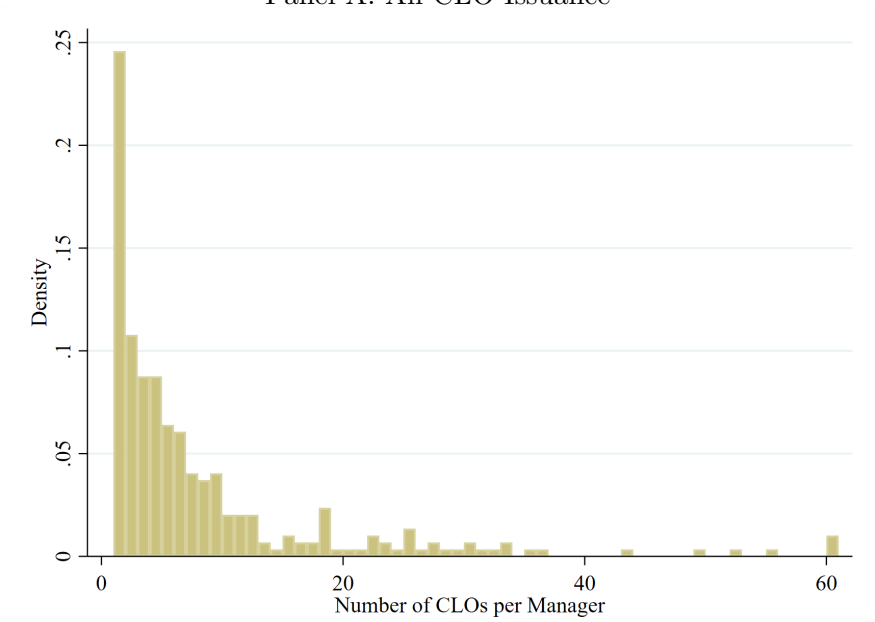


Figure 4: Distribution of CLO Issuance by Manager

This figure plots histograms of the number of CLOs issued by each manager in the Intex sample. Panel A is based on all issued deals and Panel B is based on completed deals. There are 297 managers in the full sample and 154 managers with at least one completed deal.

Panel A: All CLO Issuance



Panel B: Completed Deals

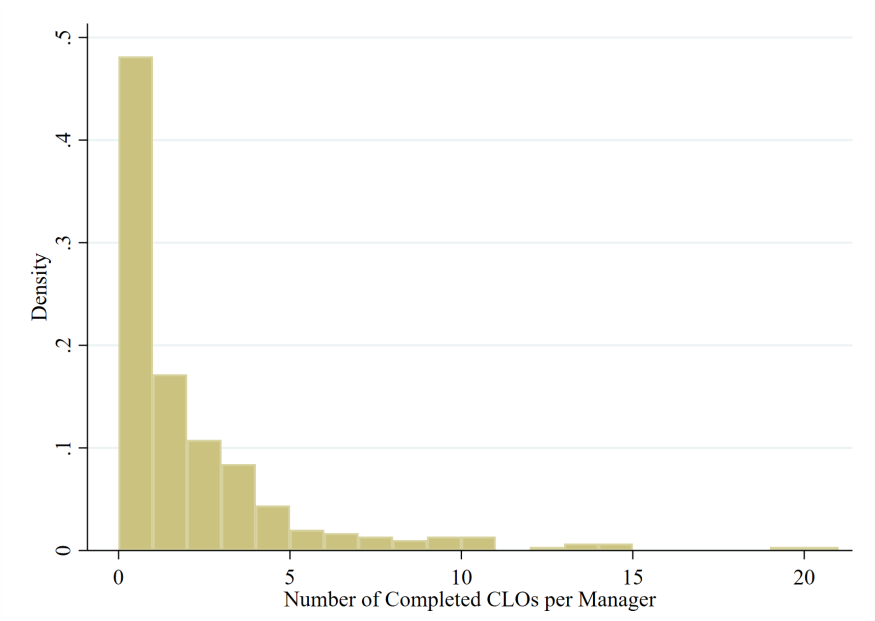


Table 1: Summary Statistics

This table summarizes the CLO sample from Intex by vintage. Median Size is the median of initial deal balance in millions of dollars. Median Debt is the median 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.

Vintage	Issuance Amount ($ Bil.)	Mean Deal Size ($ Mil.)	Mean Leverage Ratio	Deal Count	Deals with Nonmissing Distributions	Completed Deals
1997-2002	15.9	420.0	0.921	36	10	9
2003	13.2	424.6	0.903	31	13	12
2004	30.5	462.2	0.903	66	20	20
2005	49.6	490.6	0.901	101	57	55
2006	91.3	507.1	0.905	180	112	108
2007	97.2	568.5	0.904	171	111	106
2008	42.1	1,026	0.906	41	15	9
2009	5.0	552.9	0.902	9	1	0
2010	5.1	337.6	0.900	15	7	6
2011	15.3	478.3	0.897	32	23	23
2012	55.0	466.0	0.895	118	95	76
2013	84.8	496.0	0.893	171	150	50
2014	128.4	537.2	0.891	239	187	49
2015	104.7	537.0	0.892	195	175	10
2016	83.9	482.3	0.892	174	156	4
2017	112.9	535.2	0.891	211	204	1
2018	172.4	527.2	0.892	327	321	0
2019	129.4	493.9	0.892	262	175	0
1997-2019	1,236.6	519.8	0.891	2,379	1,832	538

Table 2: Debt Performance of Completed Deals

This table reports statistics on the performance of CLO debt by initial rating category. The sample contains completed deals that paid down 99% of their senior debt by March 2020. 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).

Panel A: Internal Rate of Return (%)

Vintage	Mean	StDev	p10	p25	p50	p75	p90	Obs.
CLO 1.0 (1997-2009)								
AAA-Rated	2.21	0.86	1.36	1.56	2.03	2.69	3.28	318
AA-Rated	2.15	0.69	1.53	1.62	1.94	2.49	3.11	285
A-Rated	2.73	0.97	1.89	2.05	2.41	3.02	4.08	315
BBB-Rated	3.80	1.09	2.67	3.02	3.58	4.35	5.33	315
BB-Rated	6.19	2.54	4.59	5.10	5.68	7.20	9.03	248
CLO 2.0 (2010-2016)								
AAA-Rated	2.08	0.34	1.71	1.83	2.03	2.32	2.50	219
AA-Rated	3.03	0.93	2.47	2.69	2.94	3.21	3.45	217
A-Rated	3.82	0.52	3.27	3.48	3.73	4.03	4.41	216
BBB-Rated	4.78	0.70	4.03	4.34	4.72	5.10	5.67	217
BB-Rated	6.22	1.42	5.25	5.71	6.15	6.68	7.38	214
B-Rated	6.91	0.75	6.13	6.37	6.73	7.35	7.83	75
Full Sample (1997-2016)								
AAA-Rated	2.16	0.70	1.45	1.74	2.03	2.45	3.01	537
AA-Rated	2.53	0.92	1.58	1.86	2.54	3.01	3.34	502
A-Rated	3.17	0.98	1.97	2.27	3.20	3.84	4.27	531
BBB-Rated	4.20	1.06	2.85	3.41	4.22	4.90	5.40	532
BB-Rated	6.20	2.09	4.83	5.37	6.05	6.87	8.32	462
B-Rated	6.91	0.75	6.13	6.37	6.73	7.35	7.83	75

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

Vintage	Mean	StDev	p10	p25	p50	p75	p90	Obs.
CLO 1.0 (1997-2009)								
AAA-Rated	1.05	0.04	1.02	1.03	1.05	1.06	1.08	318
AA-Rated	1.02	0.03	0.99	1.00	1.02	1.04	1.06	285
A-Rated	1.02	0.05	0.97	0.99	1.01	1.04	1.08	315
BBB-Rated	1.07	0.08	0.99	1.02	1.05	1.10	1.16	315
BB-Rated	1.22	0.12	1.12	1.16	1.22	1.28	1.35	248
CLO 2.0 (2010-2016)								
AAA-Rated	1.03	0.03	1.00	1.01	1.03	1.04	1.06	219
AA-Rated	1.05	0.05	1.01	1.03	1.05	1.07	1.08	217
A-Rated	1.09	0.04	1.04	1.07	1.08	1.11	1.13	216
BBB-Rated	1.10	0.05	1.03	1.07	1.10	1.12	1.15	217
BB-Rated	1.06	0.07	1.01	1.04	1.06	1.09	1.13	214
B-Rated	1.11	0.05	1.06	1.09	1.11	1.13	1.15	75
Full Sample (1997-2016)								
AAA-Rated	1.04	0.03	1.01	1.03	1.04	1.06	1.07	537
AA-Rated	1.03	0.04	0.99	1.01	1.03	1.05	1.07	502
A-Rated	1.05	0.06	0.98	1.00	1.04	1.09	1.12	531
BBB-Rated	1.08	0.07	1.00	1.03	1.08	1.11	1.16	532
BB-Rated	1.15	0.13	1.03	1.06	1.14	1.23	1.31	462
B-Rated	1.11	0.05	1.06	1.09	1.11	1.13	1.15	75

Table 3: Equity Performance of Completed Deals

This table reports statistics on the performance of CLO equity by vintage. The sample contains completed deals that paid down 99% of their senior debt by March 2020. Panel A reports internal rates of return and Panel B reports multiples on invested capital, Panel C reports the public market equivalent (PME) versus the S&P 500 index, and Panel D reports the PME versus the S&P 500 Banks sub-index.

Panel A: Internal Rate of Return (%)

Vintage	Mean	StDev	p10	p25	p50	p75	p90	Obs.
1997-2002	13.31	9.06	1.06	5.65	14.32	21.69	23.53	8
2003	4.41	6.90	-4.47	-1.35	3.22	10.87	13.08	12
2004	5.21	8.06	-6.50	-0.64	6.49	10.72	15.10	20
2005	13.21	6.09	4.87	9.32	13.24	16.38	21.49	55
2006	16.23	5.57	9.26	13.30	16.83	20.02	22.38	108
2007	19.08	6.01	12.59	16.26	18.57	22.75	26.44	106
2008	10.09	6.03	2.36	5.04	10.71	13.28	18.77	9
2010	8.24	7.83	0.31	0.61	7.72	14.54	18.15	6
2011	15.66	6.64	7.54	10.93	15.15	20.32	23.85	23
2012	9.11	5.78	2.59	6.11	9.36	12.87	15.84	76
2013	6.94	7.91	-1.60	2.30	5.70	9.42	19.14	50
2014	4.51	8.44	-9.00	3.04	5.95	8.85	13.05	49
2015	9.15	3.53	4.58	6.68	9.42	10.44	13.73	10
2016	9.20	6.87	2.19	3.36	9.25	15.04	16.10	4
1997-2016	12.41	8.23	2.80	7.00	13.13	17.88	21.96	537

Panel B: Multiple on Invested Capital

Vintage	Mean	StDev	p10	p25	p50	p75	p90	Obs.
1997-2002	2.01	0.83	1.04	1.28	1.88	2.90	2.96	8
2003	1.34	0.47	0.84	0.96	1.19	1.73	1.96	12
2004	1.34	0.50	0.76	0.97	1.31	1.68	1.97	20
2005	1.98	0.59	1.28	1.58	1.90	2.25	2.62	55
2006	2.21	0.56	1.51	1.87	2.21	2.47	2.87	108
2007	2.46	0.61	1.75	2.12	2.40	2.78	3.32	106
2008	1.55	0.34	1.13	1.26	1.56	1.75	2.05	9
2010	1.21	0.21	1.01	1.02	1.17	1.37	1.52	6
2011	1.54	0.24	1.22	1.35	1.51	1.78	1.87	23
2012	1.34	0.22	1.08	1.20	1.33	1.48	1.61	76
2013	1.24	0.27	0.95	1.08	1.19	1.30	1.68	50
2014	1.15	0.23	0.78	1.08	1.18	1.25	1.44	49
2015	1.24	0.10	1.12	1.18	1.23	1.32	1.38	10
2016	1.08	0.05	1.03	1.04	1.08	1.13	1.15	4
1997-2016	1.79	0.69	1.09	1.23	1.63	2.25	2.67	537

Panel C: Public Market Equivalent versus S&P 500

Vintage	Mean	StDev	p10	p25	p50	p75	p90	Obs.
1997-2002	1.72	0.57	0.87	1.43	1.80	2.07	2.41	8
2003	0.93	0.27	0.64	0.75	0.84	1.11	1.31	12
2004	1.03	0.35	0.59	0.76	1.01	1.24	1.45	20
2005	1.50	0.42	1.02	1.20	1.45	1.72	2.05	55
2006	1.78	0.43	1.22	1.51	1.78	2.08	2.23	108
2007	2.13	0.50	1.55	1.84	2.09	2.37	2.84	106
2008	1.23	0.33	0.80	0.94	1.19	1.46	1.67	9
2010	0.83	0.22	0.55	0.63	0.85	1.03	1.08	6
2011	1.00	0.18	0.76	0.83	1.00	1.15	1.28	23
2012	0.84	0.13	0.68	0.76	0.84	0.93	1.01	76
2013	0.86	0.18	0.65	0.75	0.83	0.94	1.12	50
2014	0.88	0.17	0.62	0.85	0.90	0.96	1.09	49
2015	0.94	0.09	0.86	0.87	0.91	0.99	1.08	10
2016	0.92	0.07	0.85	0.86	0.92	0.98	0.99	4
1997-2016	1.40	0.62	0.75	0.88	1.20	1.86	2.21	537

Panel D: Public Market Equivalent versus Bank Stocks

Vintage	Mean	StDev	p10	p25	p50	p75	p90	Obs.
1997-2002	2.14	1.13	0.79	1.11	2.08	3.19	3.48	8
2003	1.58	0.63	0.85	1.00	1.47	2.05	2.44	12
2004	1.91	0.81	0.88	1.27	1.94	2.35	2.73	20
2005	3.13	1.02	1.90	2.41	3.07	3.65	4.39	55
2006	4.07	1.06	2.71	3.37	4.08	4.72	5.21	108
2007	4.61	1.19	3.23	4.05	4.64	5.26	6.34	106
2008	1.80	0.57	1.15	1.30	1.91	2.15	2.58	9
2010	0.88	0.24	0.60	0.65	0.91	1.11	1.12	6
2011	0.92	0.19	0.65	0.76	0.89	1.09	1.20	23
2012	0.82	0.13	0.66	0.73	0.81	0.90	0.98	76
2013	0.84	0.18	0.64	0.74	0.81	0.92	1.09	50
2014	0.87	0.16	0.63	0.83	0.88	0.95	1.07	49
2015	0.90	0.07	0.82	0.84	0.88	0.98	1.00	10
2016	0.81	0.09	0.68	0.74	0.83	0.88	0.89	4
1997-2016	2.56	1.80	0.75	0.87	2.06	4.12	4.94	537

Table 4: Correlations among Measures of Performance

This table presents the correlation matrix of the performance measures in Table 3.

	IRR	MOIC	PME Market	PME Bank
IRR	1			
MOIC	0.881	1		
PME Market	0.845	0.962	1	
PME Bank	0.752	0.924	0.967	1

Table 5: Manager Fixed Effects in Equity Performance

This table presents estimates of manager fixed effects in performance following equation (5.3). Each column is based on a different measure of CLO equity performance as the regression's dependent variable. The performance metrics are winsorized at the 1% level to mitigate the influence of outliers. The first panel reports the number of observations and fixed effects in each regression. The second panel contains statistics including the adjusted R^2 of a regression with manager and vintage fixed effects, the incremental adjusted R^2 from adding manager fixed effects to a regression containing only quarterly vintage fixed effects, an F-test of the joint significance of the manager fixed effects, and the associated p-value. The bottom panel summarizes the distribution of manager fixed effects.

	IRR (%)	MOIC	PME Market	PME Bank
Number of CLOs	536	536	536	536
Number of Managers	154	154	154	154
Statistics on Manager FEs				
Overall Adj. R^2	0.727	0.798	0.853	0.905
Incremental Adj. R^2	0.325	0.242	0.160	0.088
Joint F-Test	4.733	4.757	4.435	3.908
p-Value	0.000	0.000	0.000	0.000
Distribution of Manager FEs				
p90	4.962	0.368	0.291	0.520
p75	2.291	0.148	0.117	0.267
p50	−0.801	−0.052	−0.014	0.040
p25	−4.473	−0.320	−0.223	−0.425
p10	−7.774	−0.674	−0.509	−1.168

Table 6: Persistence in CLO Manager Performance

This table presents transition probabilities for CLO manager performance across funds. We sort completed deals into terciles in each annual vintage based on PME relative to the S&P 500 Banks sub-index (in the columns) and calculate the conditional probability that the manager's next fund (in the rows) is in the same relative performance tercile or moves to one of the other two terciles. Panel A is based on the next deal issued by the manager, Panel B is based on the first deal issued at least one year after the current deal's closing date, and Panel C is based on the first deal issued at least seven years after the current deal's closing date. Observation counts are based on the number of deals with a completed follow-on deal. *, **, and *** denote p-values less than 0.10, 0.05, and 0.01, respectively, for a statistical test of equality between the estimated transition probability and the baseline transition probability of 0.33 using standard errors clustered by manager.

Panel A: Next Deal in Sequence (379 observations)

	Lower tercile	Middle tercile	Upper tercile
Lower tercile	0.538***	0.283	0.134***
Middle tercile	0.342	0.350	0.275
Upper tercile	0.120***	0.367	0.592***

Panel B: One-Year Minimum Gap (290 observations)

	Lower tercile	Middle tercile	Upper tercile
Lower tercile	0.524***	0.299	0.162***
Middle tercile	0.293	0.351	0.279
Upper tercile	0.183***	0.351	0.559***

Panel C: Seven-Year Minimum Gap (95 observations)

	Lower tercile	Middle tercile	Upper tercile
Lower tercile	0.500	0.333	0.205
Middle tercile	0.150*	0.389	0.231
Upper tercile	0.350	0.278	0.564*

Table 7: Determinants of CLO Performance

This table presents regressions of CLO performance on liability structure and collateral attributes. Initial leverage is the initial ratio of debt to deal balance. Debt Tranche Coupon is the value-weighted coupon rate for debt tranches in percentage terms. Avg. Loan Coupon is the value-weighted average coupon rate of loans in the collateral pool over the observed life of the deal. Turnover is the ratio of absolute transaction volume after closing to the original deal balance. Par Build is the total collateral value gained by purchasing loans at a discount, accounting for discounted sales and the discounted treatment of purchases below 80 (or 85 for CCC+ and below ratings), scaled by the original deal balance. Vintage fixed effects are based on the calendar quarter in which the deal closed. t-statistics based on standard errors clustered by manager are reported in parentheses. *, **, and *** denote p-values less than 0.10, 0.05, and 0.01, respectively.

Dependent Variable	IRR (%)	MOIC	PME Market	PME Bank
Initial Leverage (%)	0.792***	0.063***	0.049***	0.101***
	(3.59)	(3.95)	(4.03)	(3.46)
Debt Tranche Coupon (%)	-3.408***	-0.298***	-0.213***	-0.504***
	(-3.67)	(-4.76)	(-4.45)	(-4.58)
Avg. Loan Coupon (%)	2.839***	0.205***	0.167***	0.329***
	(3.26)	(2.87)	(3.20)	(2.71)
Turnover	0.504***	0.060***	0.035***	0.078***
	(3.48)	(3.96)	(3.02)	(3.00)
Par Build (%)	1.197***	0.087***	0.070***	0.145***
	(8.25)	(8.14)	(7.44)	(6.93)
Quarterly Vintage FE	X	X	X	X
Adj. R^2	0.608	0.720	0.811	0.881
Adj. Within R^2	0.274	0.315	0.313	0.271
Observations	470	470	470	470

Table 8: Manager-Driven Determinants of CLO Performance

This table presents instrumental variables regressions of CLO performance on liability structure and collateral attributes. The five explanatory variables in the second stage are defined as in Table 7. We instrument these variables using fixed effects for each of the 142 managers in the regression sample. The performance metrics and explanatory variables are winsorized at the 1% level to mitigate the influence of outliers. Panel A reports the second-stage regression estimates. t-statistics are reported in parentheses and based on two-stage least squares standard errors clustered by manager. *, **, and *** denote p-values less than 0.10, 0.05, and 0.01, respectively. Panel B reports statistics on the first-stage regressions including the adjusted R^2 of a regression with manager and vintage fixed effects, the incremental adjusted R^2 from adding manager fixed effects to a regression containing only quarterly vintage fixed effects, an F-test of the joint significance of the manager fixed effects and its p-value, and the distribution of manager fixed effects in the explanatory variables.

Panel A: Second-Stage Regression Estimates

Dependent Variable	IRR (%)	MOIC	PME Market	PME Bank
Initial Leverage (%)	0.899***	0.070***	0.048***	0.103**
	(2.94)	(2.96)	(2.69)	(2.41)
Debt Tranche Coupon (%)	-4.947**	-0.445***	-0.335***	-0.744**
	(-2.40)	(-2.84)	(-2.71)	(-2.45)
Avg. Loan Coupon (%)	4.483***	0.316***	0.241***	0.474***
	(3.46)	(3.09)	(3.26)	(2.83)
Turnover	0.686***	0.069***	0.039**	0.083**
	(2.86)	(3.00)	(2.24)	(2.14)
Par Build (%)	1.402***	0.105***	0.081***	0.170***
	(6.28)	(6.15)	(6.11)	(5.97)
Quarterly Vintage FE	X	X	X	X
Observations	470	470	470	470

Panel B: Summary of First-Stage Regression

	Leverage	Debt Cpn.	Loan Cpn.	Turnover	Par Build
Statistics on Manager FEs					
Overall Adj. R^2	0.609	0.730	0.628	0.445	0.511
Incremental Adj. R^2	0.202	0.020	0.324	0.384	0.258
Joint F-Test	2.571	1.226	3.650	3.106	2.606
p-Value	0.000	0.076	0.000	0.000	0.000
Distribution of Manager FEs					
p90	1.229	0.318	0.644	1.704	1.799
p75	0.655	0.129	0.132	0.872	1.018
p50	0.304	−0.016	−0.116	−0.218	0.060
p25	−0.539	−0.111	−0.300	−1.336	−1.201
p10	−1.724	−0.221	−0.465	−2.660	−1.868