Consequences of CLO portfolio constraints*

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ABSTRACT

We examine the effect of portfolio restrictions in Collateralized Loan Obligations (CLOs) on their trading strategy and performance. These restrictions involve tests on loan portfolio characteristics and quality that CLOs have to pass monthly. We find that CLOs with restrictive tests have higher portfolio turnover, rebalancing and diversification, and hold loans for shorter periods, suggesting that managers of constrained CLOs actively administer loan portfolios to alleviate credit losses and costly test violations. We further document that managers of constrained CLOs respond to borrower news differently by trading loans to avoid reporting credit losses and to comply with the CLO tests rather than to generate profits from trading. Last, we examine the economic effects of restrictive portfolio tests and find that these constraints are associated with lower CLO equity returns. Our evidence indicates that portfolio constraints lead to divergent trading choices and to different levels of CLO performance.

Keywords: CLOs, securitization, portfolio tests, equity returns, credit risk, asset management
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1. Introduction

Collateralized loan obligations (CLOs, i.e., collateralized debt obligations backed by corporate loans) have largely promoted the growth of the private debt market, raising about $1.2 trillion of capital over the period 2006-2017 and holding over 70% of the leveraged loans outstanding (Standard and Poor's 2015; JP Morgan 2018). CLOs have consistently exhibited strong performance in terms of low default rates on their senior and junior notes and double-digit equity returns.[1] Financial industry commentators attribute this performance to the active management of CLO portfolios by asset management firms (CLO managers) and to the constraints (tests) that monitor the portfolios' credit risk and quality (e.g., Prudential Fixed Income Perspectives 2015; Ares Market Insights 2018). While portfolio tests are standardized, their restrictiveness varies significantly across CLOs, imposing different constraints on CLO managers and potentially leading to divergent trading choices and different levels of CLO performance. Despite the economic importance of CLOs in the private debt market, there is surprisingly little systematic evidence on the interplay between CLO portfolio constraints, trading strategies and performance.

In this paper, we examine the effect of CLO test restrictiveness on CLO managers' loan trading choices and CLOs' equity returns. For a CLO to generate equity returns, loans' interest payments must be substantially higher than the CLO's cost of debt financing, realized portfolio credit losses and other costs (e.g., management fees, administrative costs). Thus, the CLO manager's role is to purchase high yielding loans and actively rebalance the portfolio to mitigate credit losses. Loan trading is facilitated by access to borrowers' private information as CLO managers are members of loan syndicates and perform borrower due diligence that involves the collection of proprietary

[1] The average default rate of BBB-rated CLO notes (corporate bonds) is 0.47% (5.27%), and no defaults of AAA- or AA-rated CLO notes have ever been recorded (Loan Syndications and Trading Association [LSTA] 2015). CLOs' annualized equity returns on a cash-flow basis averaged about 16% over the period 2012-2017 (JP Morgan 2018).

information (e.g., Liebscher and Mahlmann 2017a). However, the CLO loan portfolio and managers' trading choices must align with certain portfolio constraints set at a CLO's inception, which aim to control risk-taking and protect the senior and junior noteholders from credit losses.

The most prominent CLO portfolio constraint is the *capital coverage* or *overcollateralization* test, which requires the ratio of the CLO's loan portfolio balance, scaled by the CLO notes' principal balance, to exceed a certain minimum threshold. Another constraint is the *interest coverage* test, which requires the ratio of the interest generated by the loan portfolio to the interest payable on the CLO notes to be above a certain threshold. These coverage tests ensure that a CLO holds sufficient loan assets and receives sufficient loan interest income to cover the CLO notes' principal and interest payments, respectively.[2] Other than the coverage tests, additional CLO constraints aim to ensure that a certain level of portfolio quality is maintained. The *weighted average rating factor* or the *WARF test* measures the credit riskiness of the loans in the portfolio and requires that the weighted average portfolio loan rating does not exceed a certain threshold. Also, the *weighted average spread* or *WAS test* ensures that the average spread of a CLO's portfolio loans is above a certain threshold, thus, the portfolio generates a minimum level of interest spread.

The CLO setting is relevant for studying the relation between portfolio investment constraints, managers' trading choices and investors' returns for several reasons. First, CLOs are required to report monthly loan-level information on their portfolio structure, performance and trading activity. We can thus observe the specific loans traded and retained in a CLO portfolio over a reporting period, as well as the timing and pricing of loan trades. Also, all CLOs have to meet the same set of portfolio tests monthly, thus, we are able to develop a common model-free estimate of

[2] Violation of these tests triggers a diversion of the portfolio's cash flows from the junior CLO note and equity tranches and manager's performance-linked fees towards repaying the senior CLO notes until the tests are satisfied.

investment constraints across CLOs. While portfolio restrictions may also apply in other private fund settings (e.g., hedge funds), granular detailed data on fund portfolio holdings and trading that is not affected by self-reporting bias is largely unavailable (e.g., Agarwal et al. 2013). Second, given that test restrictiveness is determined upon a CLO's origination and is not renegotiated, we believe that our measure of portfolio constraints is likely not endogenous to managers' loan trading choices over the life of a CLO. Therefore, this measure potentially allows us to examine features of the investment strategy that CLO managers develop under these constraints to enhance their portfolio performance. Third, prior studies find that equity mutual funds' portfolio investment constraints have no material effect on investors' returns (Almazan et al. 2004). However, the nature of CLO portfolio tests differs and their underlying assets (i.e., corporate loans) are more informationally opaque, suggesting that portfolio constraints may play a more important role in private debt funds. A study on the effects of CLO test restrictiveness can thus potentially provide significant novel insights.

We examine our research question using a sample of 15,621 CLO-quarter observations of 1,226 CLOs over the 2008–2017 period. We obtain data on CLO portfolio holdings, loan trades, equity returns on a cash-flow basis and CLO test triggers from CLO-i, a database provided by Creditflux. To measure a CLO's portfolio constraints, we first estimate the relative restrictiveness score for each of the four tests —overcollateralization, interest coverage, WARF, WAS— by using the distribution of the test thresholds in our CLO sample. More specifically, for the overcollateralization, interest coverage and WAS tests, we compute the difference between a CLO's test threshold and the minimum threshold of that test category in our CLO sample, scaled by the difference between the sample maximum and minimum test thresholds. For the WARF test, we compute the difference between the maximum WARF threshold across the CLOs in our sample

and a CLO's WARF test threshold, scaled by the difference between the sample maximum and minimum WARF test thresholds. Thus, each restrictiveness measure takes a value from zero (least restrictive) to one (most restrictive). Finally, we compute a CLO constraint index by averaging the four test restrictiveness measures defined above at the CLO level. These variable measurement choices allow us to capture the cross-sectional variation in a CLO's test restrictiveness relative to other CLOs in the sample.

We first validate our CLO test restrictiveness measure and find that it is positively (negatively) associated with the size of CLO junior notes (the interest premium paid to junior noteholders), suggesting that —as one would expect— junior noteholders trade off cash flow with control rights that offer greater protection against credit losses. We also find that CLO test restrictiveness is significantly lower in periods when CLO investor demand is strong given that during these periods CLO noteholders are likely less concerned about tight control rights. We further document that recent CLO vintages have stricter tests on average, which reflects the greater regulatory pressure on loan securitizations after the credit crisis.

We next examine the relation between CLO test restrictiveness and managers' loan trading and investment choices and show that CLOs with more restrictive tests have higher portfolio turnover and diversification and hold loans for fewer quarters. Economically, an increase in the restrictiveness of the portfolio tests by one standard deviation increases (decreases) the probability of a CLO's having high portfolio turnover and diversification (the average loan holding period) by about 6.83% and 8.96% (5.07%) of the mean values of the dependent variables, respectively. These CLOs are also more likely to rebalance their portfolios, i.e., they tend to purchase a greater number of loans to alleviate the adverse effects of potential credit losses. To exemplify, an increase in CLO test restrictiveness by one standard deviation increases the probability of high portfolio rebalancing

by about 7.84% of the mean value of the dependent variable. These findings support our argument that managers of CLOs with restrictive tests are more likely to actively rebalance and diversify loan portfolios potentially to mitigate credit losses and avoid test violations.

To provide further insights into the effect of test restrictiveness on managers' trading strategies, we examine how constrained managers' trading choices are influenced by the arrival of new information about portfolio borrowers' credit risk. We first investigate loan sale activity in response to bad credit news experienced by their portfolio borrowers over the prior two quarters. We find that although CLO managers on average sell loans of borrowers with bad credit news, managers of CLOs with restrictive tests are more reluctant to unload such loans from their portfolios, suggesting that constrained managers are more likely to delay the realization of credit losses generated by the sale of low-quality loans as these losses can lead to a test violation. Second, we show that when these managers do decide to sell bad-credit-news loans, they accept substantially larger price discounts. Thus, when forced to sell (presumably because a loan default is imminent), managers of constrained CLOs sell these loans at steeper discounts.[3] Third, we document that managers of CLOs with restrictive tests pay a larger price premium to purchase loans of borrowers experiencing positive credit news than managers of CLOs with less restrictive tests. These loans are unlikely to default, thus mitigating the risk of future test violations. Overall, these results are consistent with the interpretation that the trading choices made by managers of CLOs with restrictive tests likely reflect the pressure to comply with CLO tests rather than to generate trading profits.

Next, we examine the relation between CLO test restrictiveness and equity returns. We document

[3] In additional robustness analyses (untabulated), we show that CLOs with restrictive tests hold underperforming loans for longer periods than well-performing loans (i.e., CLOs retain loans whose price has decreased over the holding period, and dispose loans for which market price has increased).

that CLOs with stringent tests generate lower equity returns on a cash-flow basis. Economically, an increase in CLO test restrictiveness by one standard deviation decreases CLO equity returns by about 4.00%. Importantly, we show that while CLO portfolio turnover, rebalancing and diversification on average increase equity returns, these trading choices actually lower equity returns in the case of constrained CLOs. This evidence suggests that restrictive CLO tests may place a higher hurdle on managers who need to achieve the necessary short-term portfolio performance to pass these tests. To do so, as we note above, CLO managers likely pursue trading strategies that sacrifice the returns of the equity tranche.

In supplemental analyses, we examine the relation between CLO test restrictiveness and the performance of CLO notes to further assess the economic implications of CLO constraints. We find that CLO test restrictiveness is negatively associated with the probability of (1) junior notes' credit rating downgrade, (2) CLO notes receiving a low credit rating, and (3) a CLO making early principal repayments to its noteholders. Consistent with our primary findings that junior noteholders trade off cash flow rights with tighter control rights upon a CLO's inception, we show that more restrictive CLO tests incentivize managers to engage in compliance trading to avoid a test violation, benefiting noteholders at the expense of equity holders. Last, we document a significant relation between CLO test restrictiveness and CLO note and equity pricing in the secondary market, suggesting that the effects of CLO test restrictiveness on note and equity tranche performance are, to some extent, understood by CLO investors.

Several caveats are in order. First, our findings preclude us from drawing conclusions on the optimality of CLO managers' trading strategies under restrictive tests, since CLO equity returns might be even lower if managers adopted different trading choices or in the absence of restrictive tests. Second, our objective is not to investigate why these portfolio tests are commonly used in

the CLO setting, or delineate a causal link between CLO test restrictiveness and other structural features. Instead, we are simply interested in examining the cross-sectional variation in CLO test restrictiveness and its effect on subsequent CLO trading strategy and investors' returns. Third, data availability restricts us from examining whether CLO managers' equity ownership can mitigate the adverse effects of CLO constraints on equity returns.

Our paper contributes to the literature in several important ways. First, our findings provide broader new insights on the performance of structured finance products. While recent studies have identified poor loan screening practices and information misrepresentation as the main drivers of the underperformance of mortgage securitizations (e.g., Keys et al. 2010; Garmaise 2015; Piskorski et al. 2015; Griffin and Maturana 2016; Kruger and Maturana 2017), other papers find no evidence that corporate loan securitizations triggered riskier corporate lending (e.g. Shivdasani and Wang 2011; Benmelech et al. 2012), consistent with industry reports documenting CLOs' strong investment performance (LSTA 2015). One potential explanation for the different findings across CLOs and mortgage securitizations may be related to the presence of strict portfolio performance tests and the active management of CLOs by third-party managers —two factors widely overlooked in the literature (mortgage securitizations are static loan pools; see Fitch Ratings 2015). Our results show that, in the presence of tight CLO tests, active portfolio turnover improves CLO junior note performance at the expense of CLO equity returns, suggesting that stringent constraints incentivize managers to screen and closely monitor their underlying portfolios to alleviate losses on CLO notes. Relatedly, Loumioti and Vasvari (2019) focus on only one portfolio constraint —the capital coverage test— and examine the CLO characteristics that influence how CLO managers mitigate the risk of test violations, without investigating the effect of these actions on investors' returns. We extend this paper by exploring how the design of portfolio constraints at a CLO's inception leads

to divergent trading choices and to different levels of CLO equity and note performance.

Second, we add to prior studies that examine how lenders employ borrower-specific information when pricing and trading loans (e.g., Sufi 2007; Wittenberg-Moerman 2008; Bushman et al. 2010). This literature did not assess the extent to which lenders' own portfolio constraints can influence their loan selection and pricing decisions in response to new borrower-specific information. We extend this literature by focusing on the largest investor type in the leveraged loan market — CLOs— and documenting that the restrictiveness of CLO portfolio constraints determines how these lenders react to borrower information signals. Relatedly, Liebscher and Mahlmann (2017b) find substantial heterogeneity in CLO equity returns, suggesting that managers' skills in collecting and processing borrower information largely differ. We add to this study by showing that CLO test restrictiveness can affect how CLO managers use and process news about their portfolio borrowers.

Finally, we offer new insights to the asset management literature that examines the relation between active portfolio management and fund performance (e.g., Wermers 2000; Chen et al. 2000; Cremers and Petajisto 2009). We show that while more actively rebalanced CLO portfolios generate higher equity returns on average, this association reverses in the presence of restrictive tests, suggesting that portfolio constraints determined at a CLO's origination are instrumental to the association between active management and portfolio returns. We thus complement analytical models that examine benefits of funds' tight portfolio investment constraints (e.g., He and Xiong 2013; Liu 2015).

2. Institutional background and CLO portfolio constraints

2.1. The CLO structure

CLOs are bankruptcy-remote special-purpose vehicles that facilitate the securitization of corporate loans by purchasing tranches of primarily senior secured leveraged loans and using these

loans' cash flows as collateral to back the issuance of new securities (CLO senior and junior notes; equity tranche) that are purchased by institutional investors.[4] The average CLO acquires 200–250 loans issued by borrowers in 20–25 industries, with a portfolio allocation to an individual borrower of about 2%.[5] Thus, despite the significant credit risk of the loans in the underlying portfolio (a typical CLO loan is B-rated), 70%–80% of the CLO notes are investment-grade due to the high portfolio diversification and the portfolio credit enhancements set at the CLO's origination.

These credit enhancements refer to certain tests (or constraints) on loan portfolio quality and characteristics (e.g., minimum loan interest rate, maximum loan portfolio rating, maximum allocation across borrowers and industries) as well as on the coverage of the CLO's liabilities (i.e., whether the CLO loans' principal value and interest payments suffice to cover the principal balance and interest payments of the CLO notes). These tests determine the portfolio structure and credit risk over the life of the CLO with the aim of protecting senior and junior noteholders against credit losses. They are typically standardized across CLOs and are strongly influenced by credit rating agencies that require portfolio constraints in order to provide certain target ratings for the CLO notes.[6] CLOs are required to meet these tests monthly over their life (about 10-12 years), and a test violation can adversely affect payments to CLO investors or lead to the early redemption of the notes. A detailed discussion of CLO constraints is included in section 2.2.

The structuring of a new CLO typically begins with negotiations between a CLO manager (i.e., an independent large investment manager that administers the loan portfolio over the CLO's life), an arranging bank (i.e., an investment bank that provides short-term financing to help structure the

[4] Subordination is a central component of the CLO structure: payments to junior CLO noteholders can be made only after a CLO's obligations to senior noteholders are satisfied and the CLO coverage tests (discussed in detail below) are passed. This feature provides additional credit protection to the more senior CLO noteholders.

[5] The average CLO has a size of about $500 million, and the average loan tranche size is $2.5 million. The CLO-specific statistics in this section are based on the characteristics of CLOs covered by Creditflux CLO-i.

[6] CLO notes and portfolio loans are rated by two credit rating agencies, although this requirement has been relaxed for more recent CLO vintages (Ares Market Insights 2018). We control for CLO vintage across our empirical analyses.

CLO portfolio) and a sponsoring equity investor (e.g., the CLO manager, hedge funds, insurers and business development companies).[7] The initial negotiations among these stakeholders involve the desired portfolio characteristics and the design of CLO constraints, with equity investors usually leading the conversations at this stage. The next round of negotiations takes place between the equity tranche investors and the senior noteholders of the AAA-rated notes (e.g., banks, pension funds, hedge funds, insurers and asset managers) that usually propose changes to the initial CLO structure and tests, with the arranging bank typically mediating the discussions. Thus, while portfolio constraints are standardized across CLOs, their restrictiveness highly varies with riskier loan portfolios requiring tighter CLO tests to achieve targeted ratings for each CLO tranche. After these stakeholders agree upon the preliminary CLO characteristics, terms and tests, the equity investors provide capital and the arranging bank issues a short-term loan to warehouse the CLO (i.e., the manager starts purchasing and pulling loans in the CLO portfolio).

At the end of the warehousing period, the CLO arranger and the CLO manager initiate roadshow meetings with prospective senior and junior investors who receive the CLO book with the preliminary portfolio structure criteria, terms and tests (CLO junior notes are usually purchased by hedge funds and CLO managers). Based on investors' feedback, the CLO terms, tests and size of the notes with various credit ratings are finalized in the offering prospectus, and the CLO notes are then priced.[8] Given the portfolio diversification, triggers and tests that provide credit enhancements, the average CLO note coupon rate is substantially lower than the average interest rate of the portfolio loans (i.e., the average CLO note coupon rate is about 2.5%, while the average

[7] CLO managers are not required to own equity in the CLO. The Volcker rule of The Dodd-Frank Act, under which recent CLOs are originated, required by CLO managers to retain 5% of the CLO tranches (5% of CLO equity or 5% on average vertically across all tranches) (e.g., Coffey 2015). This retention rule was challenged by LSTA given its repercussions on the CLO industry growth. The U.S. Court of Appeals ruled in favor of LSTA allowing CLO managers not to comply with the risk retention rules (LSTA, "DC Court of Appeals Ruled in Favor of LSTA in Risk Retention Lawsuit," February 9 2018).

[8] CLO liabilities are fixed over the life of a CLO, and the CLO terms and tests are not typically renegotiated.

CLO portfolio loan interest rate is about 4.9%). This excess spread, commonly referred to as "CLO arbitrage," allows CLOs to cover their running costs and generate profits for the equity tranche investors. Equity investors' profits reflect the difference between the portfolio loan yield (the interest payments by portfolio loans) and: (1) the CLO's cost of debt (average coupon rate on the notes); (2) management and administrative fees;[9, 10] and (3) the CLO's credit losses. The CLO structuring period lasts for about six months. After the CLO becomes effective, credit rating agencies confirm that the CLO portfolio structure meets the requirements set in the prospectus, and the CLO tests start to apply.

2.2. CLO management and portfolio constraints

Perhaps the most important feature that differentiates CLOs from other types of loan securitizations is the active management of the underlying loan portfolio by the CLO manager (e.g., Keys et al. 2010; Ertan et al. 2017). Based on the terms in CLO prospectuses, managers can sell loans to mitigate adverse credit events, as well as discretionarily rebalance up to 25% of the CLO portfolio value annually (Benmelech and Dlugosz 2009).[11] Thus, over the life of a CLO, the portfolio composition is in a continual state of flux, with CLO managers purchasing and selling loan tranches in order to enhance the excess spread as well as monitor portfolio's credit risk and comply with the CLO tests. To that end, CLO managers take advantage of the private information they receive as members of the loan syndicates, as well as the information they collect from their

[9] CLO managers receive a senior fixed fee of about 15–20 basis points of the CLO's par value, a junior fee of 30–40 basis points if CLO tests are met and payments to junior noteholders are made, and a performance fee that is paid if the CLO achieves a minimum internal rate of return, commonly set at 12% (e.g., Yan 2012).

[10] The administrative fees include operating costs paid to (1) credit rating agencies that rate the CLO notes, (2) an accounting firm that verifies the accuracy of the test calculations, and (3) noteholders' trustee. CLO administrative costs are about 1% of a CLO's total interest income (Ares Market Insights, 2018).

[11] This evidence is consistent with additional empirical findings on CLOs' trading activity. Peristiani and Santos (2015) document that, during the two-year period after their origination, CLOs sell 30% of their initial loan investments, while their monthly loan purchase activity is about 5.5% of their portfolio balance. Similarly, using CLO loan trading data from Creditflux, Bozanic et al. (2018) show that the mean CLO portfolio turnover is about 18%, and tranches of securitized corporate loans are traded about 40 times per quarter.

own due diligence on the underlying portfolio borrowers. For instance, Liebscher and Mahlmann (2017a) show that private equity firms that serve as CLO managers often pull into CLO portfolios the loans of borrowers they own in their funds. Moreover, the CLO tests that a manager is required to comply with on a monthly basis provide some guidance regarding the level of portfolio credit losses that a CLO can withstand without impairing CLO notes.

The most prominent CLO tests are the *capital coverage tests* (or *overcollateralization tests*), which require that the ratio of a CLO's loan portfolio value, scaled by CLO notes' principal balance, exceeds a certain minimum threshold. A CLO's portfolio value is measured as the sum of five components: (1) the principal balance of performing portfolio loans; (2) the cash generated from trading activities and loan payments; (3) the aggregate expected recovery of loans in default (i.e., loans that do not pay principal and/or interest, are D-rated or have been issued by borrowers who filed for bankruptcy); (4) the aggregate fair value of CCC-rated loans above the maximum CCC-rated loan balance that a CLO is allowed to hold; and (5) the aggregate purchase price of portfolio loans purchased at 80%-85% of par value or below (deep-discount loans).[12] Given their capital structure, CLOs must comply with a senior overcollateralization test (i.e., a CLO's loan portfolio value scaled by the senior notes' principal balance) and a junior overcollateralization test (i.e., a CLO's loan portfolio value scaled by the sum of senior and junior notes' principal balance). Importantly, since portfolio loans are not marked-to-market, and unless they are in the default or the excess CCC-rated loan bucket, credit losses are only recognized when loans are sold by the manager (see Loumioti and Vasvari (2019) for detailed description of these tests).

[12] More than 90% of CLO loans are usually classified as performing. Defaulted and excess CCC-rated loans account for about 3% and 4% of a CLO's principal balance, respectively. The recovery values of defaulted loans are computed as the lower of their fair values or recovery values provided by credit rating agencies such as S&P and Moody's. Moreover, CLOs typically avoid purchasing deep-discount loans, since they permanently erode the overcollateralization test score.

A second important category of CLO tests are the *interest coverage tests*, which ensure that the loan portfolio generates sufficient interest income to service the interest on CLO notes. These tests require the ratio of the net loan interest amount to the interest due and payable on the CLO notes to exceed a certain threshold. The net loan interest amount is estimated as the difference between the aggregate amount of loan interest proceeds that has been received or is expected to be received and (1) the defaulted loans' interest income receivable (other than interest proceeds indeed received from defaulted loans); (2) interest income accrued that the CLO manager in his commercially reasonable judgment does not expect to be paid; and (3) senior management and administrative fees.

Violation of these CLO tests can have significant implications for the CLO structure. Specifically, if test violations are not resolved within a certain period, interest and principal cash flows are diverted from more junior CLO notes and equity tranches to pay down the CLO's liabilities in order of their seniority. Relatedly, interest payments to the CLO junior noteholders as well as to the equity investors are suspended until the CLO complies with the tests. Also, CLO note ratings can be downgraded, and managers do not receive performance-linked fees.

Other than the overcollateralization and the interest coverage tests, additional CLO tests aim to monitor the quality of the loans in the portfolio. More specifically, the *weighted average rating factor* or *WARF test* measures the credit riskiness of the loans in a CLO portfolio. The test requires that the ratio of the aggregate value of each CLO portfolio loan's principal balance (excluding defaulted loans) multiplied by Moody's rating factor scaled by the total CLO portfolio principal balance is below a certain threshold. Moody's rating factors (the 10-year loan default probability) are standardized and explicitly disclosed in the CLO offering prospectus. An additional test, the *weighted average spread* or *WAS test*, ensures that the portfolio generates a minimum level of

interest spread. The test requires that portfolio loans' par-weighted average LIBOR-spread exceeds a certain threshold (defaulted loans are excluded from the WAS score calculations).[13]

The CLO noteholders' trustee (an investment bank) is responsible for calculating the monthly compliance test scores as well as preparing and distributing the CLO monthly reports to the investors. These reports include loan-level data on the CLO portfolio structure and trading activity, as well as granular information about the calculations used to estimate the CLO test compliance.

Many financial industry commentators argue that although investors often overlook important structural features in the legal documents that govern a CLO, the design of the portfolio constraints upon a CLO's origination can create trading challenges for CLO managers, often leading to divergent trading decisions and consequently to different levels of performance for CLO tranches (e.g., Prudential Fixed Income Perspectives 2015; Ares Market Insights 2018). Despite the inherent importance of CLOs' portfolio tests, the economic consequences of these constraints have been largely unexplored. We attempt to provide initial large-scale evidence by examining the effect of portfolio constraints on CLO managers' trading strategies and on CLO equity returns.

3. Data methodology

We obtain data on the terms, performance, portfolio holdings and trades of CLOs originated in the U.S. over the period 1999-2017 from Creditflux CLO-i. This database has been widely used by prior studies on CLO loan portfolio characteristics, quality and reporting (e.g., Benmelech et al. 2012; Liebscher and Mahlmann 2017b; Bozanic et al. 2018; Loumioti and Vasvari 2019). CLO-

[13] CLOs must also comply with tests that describe portfolio characteristics. For instance, CLOs must maintain a minimum diversity score (across industries, borrowers, and geographies), a maximum average maturity of portfolio loans and a maximum portfolio allocation across different loan ratings. We do not investigate these tests given that an assessment of their level of restrictiveness is ambiguous (i.e., it is unclear whether a higher diversity test threshold imposes greater constraints on CLO managers compared to a lower portfolio diversification, thus higher concentration requirements).

i retrieves data on CLO terms from the offering prospectuses, including information on the CLO origination date, maturity, size (par value) and type of CLO notes, the coupon rate and credit rating of each CLO tranche, the CLO arranger and manager names, and the CLO managers' (senior and junior) fees. CLO-i also provides data on the thresholds of the overcollateralization (OC) and interest coverage (IC) tests, as well as the weighted average rating factor (WARF) and weighted average spread (WAS) tests.

Moreover, CLO-i provides data on portfolio performance, holdings and trades extracted from CLOs' monthly trustee reports starting from January 2008. Thus, while CLO-i includes data on the terms of the CLOs originated post-1999 and outstanding as of 2008, the coverage of their portfolio structure and performance starts in 2008. The monthly performance data covered by CLO-i includes the CLO test scores, the percentage of underperforming portfolio loans (i.e., CCC-rated and defaulted loans), CLO notes' credit ratings, and the principal balance outstanding by CLO tranche. Moreover, CLO-i retrieves data on the distributions to equity investors from quarterly CLO payment reports (CLO payments to note- and equity-holders are made quarterly).[14] To match the different reporting frequency of CLO performance and payment data, we average portfolio and performance characteristics at the CLO-quarter level. This sample design choice is unlikely to affect the results of our analyses on loan portfolio structure and rebalancing, since the average loan holding period by a CLO is about one year (Table 1). Our sample covers complete data on the performance and payments of 1,226 U.S. CLOs and 15,621 observations at the CLO-quarter level over the period 2008-2017.[15] We note that CLO-i does not always cover CLO reporting across consecutive periods. However, these lapses in CLO data coverage are not

[14] In periods when a CLO generates no excess returns, the distributions to equity holders are zero. We randomly downloaded from the Creditflux website and manually checked 50 CLO payment reports to verify data accuracy.

[15] To alleviate the concern that the initiation of data coverage on CLO performance/structure in 2008 affects our results, we replicate our analyses using only CLOs originated post-2008, and our results continue to hold (untabulated).

associated with CLO performance (Liebscher and Mahlmann 2017b).

The monthly CLO loan portfolio holdings dataset provided by CLO-i includes granular information on borrower name and industry (Moody's classification), loan type, interest rate, maturity, credit rating and principal balance held. The dataset covers 13,977,546 observations at the CLO-month-loan tranche level. We note that CLO-i covers the complete loan portfolio structure of CLOs, as reported in trustee reports. To retrieve information on borrowers' financial and stock price performance, we match the borrower names in CLO-i with company names in Compustat. This process yields a sample of 1,736 unique public companies whose loan tranches are held in CLO portfolios (5,376,834 observations at the CLO-month-loan tranche level, or 189,151 observations at CLO-quarter-borrower level). Loans of the same borrower are held by about 100 CLOs monthly (untabulated summary statistic). Our matched borrower sample is significantly larger than those used in prior studies (e.g., Benmelech et al. 2012; Bozanic et al. 2018) and covers a monthly CLO portfolio balance of about $200 million, i.e., 41% of the monthly average CLO portfolio balance outstanding.

Lastly, data on individual loan trades includes the specific loans traded by a CLO (borrower name and loan type), the direction of the trades (sale or purchase), the trade price and the face amount traded. There are 1,162,794 unique loan trades over the 2008-2017 period, and all CLOs in our sample are actively managed. Data on CLO tranche trades includes 12,641 bids with complete information on the date of the transaction as well as CLO tranche price, type, credit rating and amount traded (7,348 observations at the CLO tranche-quarter level).[16]

4. Research design and empirical results

[16] An institutional investor submits a list of CLO tranches to be sold to different dealers. The dealers then make bids, and those with the highest bids likely purchase the CLO tranches. CLO-i does not provide information on the names of the institutional investors that purchase or sell CLO tranches.

4.1. Determinants of CLO test restrictiveness

We first examine CLO characteristics that are related to CLO test restrictiveness, which we measure by using the mean value of the standardized measures of the coverage (overcollateralization and interest coverage) and asset quality tests (WARF and WAS) (*CLO test restrictiveness*). For each CLO test, we estimate a standardized score of how restrictive its threshold is relative to the distribution of this test threshold across sample CLOs. To exemplify, for the overcollateralization, interest coverage and WAS tests, we measure a CLO's test restrictiveness by taking the difference between the test threshold in this CLO and the minimum threshold of the test across sample CLOs, scaled by the difference between the maximum and minimum test thresholds. For the WARF test, we compute the difference between the maximum WARF threshold across the CLOs in our sample and a CLO's WARF test threshold, scaled by the difference between the sample maximum and minimum WARF test thresholds. Thus, each restrictiveness measure takes a value from zero (least restrictive) to one (most restrictive). This measurement approach allows us to estimate a standardized average restrictiveness variable of a CLO's tests, despite the fact that the measurement unit of these tests and their distribution differ significantly. We test the association between CLO test restrictiveness and CLO terms using an ordinary least squares (OLS) model, where the dependent variable is *CLO test restrictiveness*.

$$\begin{aligned}\textit{CLO test restrictiveness} = \quad & \alpha + \beta_1 \textit{Junior to senior CLO note par value} \\ & + \beta_2 \textit{Junior CLO note coupon premium} + \beta_3 \textit{CLO note coupon rate} \\ & + \beta_4 \textit{CLO note rating at origination} \\ & + \beta_5 \textit{CLO size} + \beta_6 \textit{CLO tranche slicing} + \beta_7 \textit{CLO maturity} \\ & + \beta_8 \textit{CLO vintage} + \beta_9 \textit{Quarterly CLO issuance} \\ & + \beta_{10} \textit{CLO manager AUM} + \beta_{11} \textit{CLO manager tenure} \\ & + \beta_{12} \textit{CLO manager-arranger prior relation} \\ & + \beta_{13} \textit{CLO manager fees} + \textit{CLO manager FE} + \textit{CLO arranger FE.}\end{aligned}$$

(Model 1)

The analysis is at the CLO level, and CLO terms are measured at CLO origination. The

variables are described in detail in the Appendix, and Table 1 reports their summary statistics. We further include in our tests CLO manager (145 unique managers) and arranging bank fixed effects (38 unique arrangers) to control for their unique features (e.g., style, sophistication) that may determine CLO test restrictiveness.[17] Standard errors are clustered at the CLO arranger level.

We report the results of the analyses in Table 2. We find that CLO test restrictiveness is positively related to the size of CLO junior notes (*Junior to senior CLO note par value*) and negatively associated to the interest premium paid to junior noteholders (the percentage difference between a CLO's junior minus senior coupon rate; *Junior CLO note coupon premium*). Economically, an increase in *Junior to senior CLO note par value* (*Junior CLO note coupon premium*) by one standard deviation increases (decreases) test restrictiveness by about 0.02 (0.01), which represents 3.73% (2.36%) of the mean value of the dependent variable. Further, we show that CLO test restrictiveness is greater in periods of weak CLO issuance and for more recent CLO vintages. For instance, CLOs structured under the Volcker rule of the Dodd-Franck Act (CLO 3.0) have about 36.67% higher test restrictiveness than earlier CLO vintages do. Also, a one standard deviation increase in *Quarterly CLO issuance* decreases *CLO test restrictiveness* by about 2.53% of the mean value of the dependent variable.

We also find some evidence that CLO test restrictiveness is related to CLO manager's reputation. Although test restrictiveness is unrelated to CLO manager tenure, size (assets under management) or prior relations with the arranging bank, we show that CLO manager's compensation (senior and junior fees) is negatively related to CLO test restrictiveness.[18]

[17] Our discussions with CLO managers suggest that the percentage of the CLO equity tranche they retain is largely fixed across all CLOs they manage. Thus, CLO manager fixed effects also help us control for incentives to monitor the portfolio given managers' own exposure.

[18] The findings do not change when we exclude CLO manager fixed effects (untabulated). Consistent with our discussions with CLO managers, the CLO structuring process is significantly driven by the noteholders.

Economically, an increase by one standard deviation in *CLO manager fees* decreases *CLO test restrictiveness* by about 0.01, i.e., 1.4% of the mean value of the dependent variable.

We find very weak evidence of the association between CLO test restrictiveness and credit risk. To exemplify, while CLO test restrictiveness is positively related to CLO tranche credit risk, i.e., the initial average rating of CLO notes (*CLO note rating at origination*), this association is economically insignificant: a one standard deviation increase in *CLO note rating at origination* increases *CLO test restrictiveness* by about 0.40% of the mean value of the dependent variable.[19,20] Also, the interest rate on CLO tranches (i.e., the average CLO note coupon rate) is unrelated to CLO test restrictiveness.

Overall, these results validate our measure of CLO test restrictiveness, showing that it is related to the influence of junior noteholders who likely trade off cash flow with control rights that can offer them greater protection against credit losses. We also find that when CLO investor demand is strong CLO test restrictiveness is lower, consistent with investors putting less pressure on requiring tighter constraints. Finally, recent regulatory trends (i.e., the Volcker rule) have generally placed greater constraints on CLO structures.

4.2. CLO test restrictiveness and the CLO trading strategy

We next examine whether CLO test restrictiveness affects managers' subsequent trading choices. To do so, we employ an OLS model where the dependent variables are the following measures of managers' investment decisions: (1) *High portfolio turnover*, defined as an indicator

[19] Data on the loan portfolio structure at origination is unavailable to us for most sample CLOs, thus, we cannot measure the credit risk of the underlying loans at a CLO's inception. However, using a sample of 311 CLOs for which such data is available, we measure CLO credit risk by the average credit rating of the loans in the initial portfolio. We continue to find that the relation between CLO credit risk and test restrictiveness is economically insignificant (untabulated robustness test).

[20] Similarly, the relation between CLO test restrictiveness and CLO complexity measured by CLO par value (*CLO size*) is not economically significant: a one standard deviation increase in *CLO size* increases *CLO test restrictiveness* by about 0.70% of the mean value of the dependent variable.

variable of whether a CLO's quarterly loan trading volume ranks in the upper quartile of CLOs' trading volume; (2) *High portfolio diversification*, defined as an indicator variable of whether a CLO's excess portfolio concentration ranks in the bottom quartile of CLOs' excess portfolio concentration;[21] (3) *High portfolio rebalancing*, defined as an indicator variable of whether a CLO's quarterly portfolio rebalancing ranks in the upper quartile of the variable (portfolio rebalancing is the number of loan tranches purchased minus the number of loan tranches sold by a CLO over a quarter, divided by the average number of loan tranches held by the CLO over the prior quarter); and (4) *Loan holding period*, defined as the number of quarters a CLO holds a loan in the portfolio, averaged at the CLO-quarter of sale level. Detailed variable descriptions are included in the Appendix.

$$\begin{aligned} \textit{CLO trading} = \quad & \alpha + \beta_1 \textit{CLO test restrictiveness} + \beta_2 \textit{CCC-rated loan bucket} \\ & + \beta_3 \textit{Defaulted loan bucket} + \beta_4 \textit{CLO quarterly note rating} \\ & + \beta_5 \textit{CLO test violation} + \beta_6 \textit{CLO time to maturity} \\ & + \beta_7 \textit{CLO principal balance outstanding} \\ & + \beta_8 \textit{Junior to senior CLO note principal balance outstanding} \\ & + \beta_9 \textit{CLO quarterly coupon payments} + \beta_{10} \textit{CLO tranche slicing} \\ & + \beta_{11} \textit{CLO vintage} + \textit{CLO manager FE} + \textit{CLO arranger FE} + \textit{Year FE.} \end{aligned}$$

(Model 2)

The analysis is at the CLO-quarter level. The independent variable of interest is *CLO test restrictiveness*. We control for CLO portfolio quality, measured by the percentage of defaulted (*Default loan bucket*) and CCC-rated (*CCC-rated loan bucket*) loans in a CLO portfolio; the average quarterly credit rating of the CLO notes (*CLO quarterly note rating*); and an indicator variable of whether a CLO violates a test during a quarter (*CLO test violation*).[22] We also control

[21] To alleviate the concern that our measure is driven by portfolio diversification criteria set for a CLO upon its origination, excess portfolio concentration is the residual of the regression of a CLO's average quarterly portfolio allocation to different borrowers on CLO fixed effects.

[22] The probability of a CLO violating the WARF test over a quarter is about 22%, which explains the high probability of a CLO test violation (Table 1). Since the WARF test seems not to be binding, in untabulated robustness tests, we

for a CLO's investment horizon, measured by the natural logarithm of days to maturity (*CLO time to maturity*), the total principal balance outstanding (*CLO principal balance outstanding*) and junior to senior note principal balance outstanding (*Junior to senior CLO note principal balance outstanding*). We control for CLO quarterly note payments using the weighted average CLO note coupon rate (*CLO quarterly coupon payments*). We further include in our analyses measures of CLO characteristics, such as whether a CLO is structured under the Volcker rule (*CLO vintage*) and the number of different tranches in a CLO's capital structure (*CLO tranche slicing*). Finally, we include CLO manager (145 unique managers) and arranging bank fixed effects (38 unique arrangers) in the analyses to control for CLO managers' and arranging banks' unique features (e.g., style, sophistication) that likely determine CLO trading activity, as well as year fixed effects to control for changes in trading activity over time. Standard errors are clustered at the CLO level.

We report the results of the analyses in Table 3. Across all specifications, we show that test restrictiveness determined upon a CLO's origination is related to managers' subsequent trading choices. Specifically, we find that CLOs with more restrictive tests have higher portfolio turnover and diversification and hold loans for fewer quarters. These CLOs are also more likely to rebalance their portfolios, i.e., their net purchased loan volume is higher, which likely allows CLOs to alleviate the adverse effects of potential credit losses. Economically, an increase in *CLO test restrictiveness* by one standard deviation increases *High portfolio turnover*, *High portfolio diversification* and *High portfolio rebalancing* by about 0.017, 0.022 and 0.019, respectively, i.e., 6.83%, 8.96% and 7.84% of the mean values of the dependent variables. Further, an increase in *CLO test restrictiveness* by one standard deviation decreases *Loan holding period* by 0.210, i.e., about 5.07% of the mean value of the dependent variable. These results are consistent with the

exclude the WARF test restrictiveness from estimating *CLO test restrictiveness*, and the results across our empirical analyses continue to hold.

view that managers of CLOs with restrictive tests are more likely to actively manage, rebalance and diversify loan portfolios potentially to mitigate credit losses and avoid test violations.[23]

4.3. CLO test restrictiveness, borrower information and loan trading

We provide further insights into the effect of test restrictiveness on CLOs' trading strategy by examining how CLO managers facing stringent constraints respond to new information arrival about the credit risk of portfolio borrowers. We first investigate CLOs' loan sale activity in response to bad credit news regarding their portfolio borrowers over the prior two quarters. We employ a sample of CLO quarterly holdings of borrowers (the data are at the CLO-quarter-borrower level) and an OLS model, where the dependent variable is a borrower's principal balance sold by a CLO over a quarter, divided by the total borrower's principal balance held by the CLO over the prior quarter (*Loan sale intensity*).

$$\begin{aligned} \textit{Loan sale intensity} = \; & \alpha + \beta_1 \textit{Bad news} + \beta_2 \textit{CLO test restrictiveness} \\ & + \beta_3 \textit{Bad news} \times \textit{CLO test restrictiveness} + \beta_4 \textit{Loan rating} \\ & + \textit{Borrower accounting performance} + \textit{CLO manager FE} \\ & + \textit{CLO arranger FE} + \textit{Quarter FE} + \textit{Borrower industry FE.} \end{aligned}$$

(Model 3)

The independent variable of interest is the interaction term of *CLO test restrictiveness* and *Bad news.* We use the following measures of bad news about a borrower's credit risk over the prior two quarters: (1) an indicator variable of whether a borrower experiences negative stock returns (*Negative stock returns*); (2) an indicator variable of whether a borrower reported negative earnings (i.e., negative return on assets) (*Negative earnings*); (3) an indicator variable of whether a borrower's loan rating was downgraded (*Loan rating downgrade*); and (4) an indicator variable that equals one if a borrower experiences negative stock returns or negative earnings or a loan

[23] Our results hold when controlling for *CLO manager fees*, despite the significant sample size decrease (untabulated).

rating downgrade, and zero otherwise (*Aggregate bad news*). We control for the average quarterly credit rating of a borrower's loans held by a CLO (*Loan rating*).[24] We include CLO manager, arranging bank, quarter and borrower's industry (2-digit SIC) fixed effects.[25] We eliminate CLOs that rarely trade and illiquid loans (for which trading activity over our sample period ranks in the bottom 1%, i.e. have fewer than twenty and two trades, respectively). Standard errors are clustered at the borrower level.

We report the results of the analyses in Panel A of Table 4. We find that CLO managers are likely to sell loans of borrowers with negative stock returns and those that experience a loan rating downgrade, suggesting that CLO managers on average try to unload from their portfolios loans of borrowers with greater credit risk. Economically, CLOs are likely to increase the loan sale volume of borrowers who experience negative stock returns (column II) or a loan rating downgrade (column IV) by about 18.18% and 9.09% of the mean value of the dependent variable, respectively. However, these results are significantly weaker for CLOs with restrictive tests. Specifically, when a portfolio borrower experiences negative credit news such as negative stock returns (column II), negative earnings (column III) or a loan rating downgrade (column IV), an increase in *CLO test restrictiveness* by one standard deviation decreases *Loan sale intensity* by about 17.51%, 11.12% and 7.77% of the mean value of the dependent variable, respectively. Our results are similar when we examine the effect of aggregate negative credit news (Column I).[26] The mean probability of a borrower experiencing negative stock returns, negative earnings and a loan rating downgrade is

[24] We further control for a borrower's quarterly accounting information that may affect a CLO's loan sale decision, such as the natural logarithm of total assets (*Total assets*); the ratio of total liabilities to total assets (*Leverage*); the ratio of current assets to current liabilities (*Liquidity*); an indicator variable of whether a borrower reports negative quarterly earnings (*Loss*); the ratio of market to book value of equity (*Market to book value of equity*); and the natural logarithm of operating cash flow volatility over the prior five years (*Cash flow volatility*).

[25] Our results are overall robust when we control for CLO fixed effects (untabulated robustness tests).

[26] We further examine whether CLOs with restrictive tests are more likely to sell loans of borrowers who experience good news. We find no evidence of such trading choices, thus, CLOs with restrictive tests are not more likely to sell well-performing portfolio loans compared to CLOs with laxer test thresholds (untabulated tests).

about 21.01%, 21.60% and 13.82%, respectively (untabulated). These results are further supported by supplemental robustness analyses (untabulated) which indicate that CLOs with restrictive tests hold underperforming loans for longer periods than well-performing loans (i.e., CLOs retain in their portfolios loans whose price has decreased over the holding period, and quickly sell loans whose price has increased).

Although CLO constraints typically aim to incentivize managers to mitigate credit risks —and we would thus expect that managers of CLOs with restrictive tests to be more likely to sell loans of borrowers with negative credit news— our findings suggest that CLO test restrictiveness is associated with the opposite trading strategy. Several reasons may explain this association. First, selling off loans related to negative credit news can lead to CLOs realizing credit losses.[27] Managers of CLOs with restrictive tests are likely reluctant to realize portfolio losses that may adversely affect their ability to pass the tests and make quarterly principal and interest payments to their junior noteholders. Relatedly, selling off loans with negative credit news likely involves greater transaction costs, which may further lower noteholders' returns in the presence of restrictive CLO tests. Second, as we document in Table 3, CLOs with restrictive tests have more diversified and rebalanced loan portfolios, potentially suggesting that high portfolio turnover and diversification offset the impact of retaining low-quality loans in the portfolios. Note that throughout our tests we control for CLO manager fixed effects, thus, our findings are unlikely to be driven by managers' inherent characteristics.

Next, we investigate the pricing of negative-credit-news loans sold by CLOs with restrictive tests. We use a sample of loan sale transactions (the data are at the CLO-quarter-borrower level)

[27] Unless a portfolio loan is listed as defaulted, deep-discounted or in the excess CCC-rated bucket, it is recognized at its principal value, not market value. Thus, credit losses on this loan are only recognized if this loan is sold. A detailed discussion of the CLO reporting rules is included in Section 2 and in Loumioti and Vasvari (2019).

and Model 3, where the dependent variable is the difference between the average sale price of a borrower's loans by a CLO over a quarter minus the average price of same-rated loans traded in the same period (*Loan sale price*). We further control for the natural logarithm of a borrower's loan balance sold by a CLO over a quarter (*Loan balance sold*). All other control variables and specifications are the same as in Model 3. We report the results of these tests in Panel B of Table 4. We show that bad credit news is associated with a decrease in the loan sale price relative to the average sale price of same-rated loans, presumably because loan ratings are often adjusted slowly by rating agencies and do not immediately capture the advent of new information (e.g., Norden and Weber 2004). Interestingly, this discount is greater when loan sales are initiated by CLOs with restrictive tests. Economically, when a borrower experiences negative credit news such as negative stock returns (column II) or negative earnings (column III), an increase in *CLO test restrictiveness* by one standard deviation further decreases *Loan sale price* by about 24.66% and 29.73% of the mean value of the dependent variable, respectively. These results hold when we examine the effect of aggregate negative credit news (Column I). Thus, when CLOs with restrictive tests sell loans of borrowers with bad credit news, they do so at large price discounts, presumably because an adverse credit event may be imminent and can trigger test violations, forcing the managers to unload these loans quickly. We further support this argument by showing that CLOs with restrictive tests are more likely to increase their loan sale activity over the five-day period prior to the reporting date relative to CLOs with lax tests (Figure 1).

Last, we complement our analyses by examining the pricing of loans issued by borrowers who experience positive credit news and which are purchased by CLOs with restrictive tests. We use a sample of loan purchase transactions (the data are at the CLO-quarter-borrower level) and Model 3, where the dependent variable is the difference between the average purchase price of a

borrower's loans by a CLO over a quarter and the average price of same-rated loans traded in the same period (*Loan purchase price*). We use the following measures of positive news about a borrower's credit quality over the prior two quarters: (1) an indicator variable of whether a borrower experiences positive stock returns (*Positive stock returns*); (2) an indicator variable of whether a borrower reported gains (i.e., positive return on assets) (*Positive earnings*); (3) an indicator variable of whether a borrower's loan rating was upgraded (*Loan rating upgrade*); and (4) an indicator variable that equals one if a borrower experiences positive stock returns or positive earnings or a loan rating upgrade, and zero otherwise (*Aggregate good news*). We further control for the natural logarithm of a borrower's loan balance purchased by a CLO over a quarter (*Loan balance purchased*). All other control variables and specifications are the same as in Model 3.

We report the results of these tests in Panel C of Table 4. We find that CLOs with restrictive tests pay a larger price premium to purchase loans of borrowers with positive credit news (the results are significant at the 10% level). When a borrower experiences positive credit news measured by positive stock returns (column II) or a loan rating upgrade (column IV), an increase in *CLO test restrictiveness* by one standard deviation further increases *Loan purchase price* by about 17.76 % and 20.10% of the mean value of the dependent variable, respectively. These results hold when we examine the effect of aggregate good credit news (Column I). Our findings indicate that CLO managers who face stringent tests pay a price premium to acquire loans of borrowers with positive credit-quality information, presumably because they seek to pull in their portfolio loans that are less likely to default and experience credit losses, thus, adversely affect CLO test compliance.[28]

[28] In untabulated analyses, we find that CLO portfolio constraints do not impact the purchase volume of loans issued by borrowers who experience good news, presumably because loan trade volumes are determined by broker dealers and loan sellers, not by loan buyers.

Collectively, we show that the design of CLO tests is related to CLOs' trading strategy. CLOs with more restrictive tests have higher portfolio diversification and turnover potentially to mitigate credit losses and test violations. Further, CLO managers under the pressure of restrictive tests react to borrower news by trading loans to alleviate the reporting of credit losses that can lead to test violations. Therefore, trading choices by managers of constrained CLOs likely reflect their need to comply with the CLO tests rather than to generate trading profits.

4.4. CLO test restrictiveness and CLO equity returns

We next examine the performance implications of CLO test restrictiveness for CLO equity holders, the most junior CLO investor class, whose returns are the first to be affected by managers' investment and trading decisions. We test the association between CLO test restrictiveness and equity returns using an OLS model, where the dependent variable is the annualized CLO equity returns on a cash-flow basis (*CLO equity returns*).

$$\begin{aligned} \textit{CLO equity returns} = \quad & \alpha + \beta_1 \textit{CLO test restrictiveness} + \beta_2 \textit{CCC-rated loan bucket} \\ & + \beta_3 \textit{Defaulted loan bucket} + \beta_4 \textit{CLO quarterly note rating} \\ & + \beta_5 \textit{CLO test violation} + \beta_6 \textit{CLO time to maturity} \\ & + \beta_7 \textit{CLO principal balance outstanding} \\ & + \beta_8 \textit{Junior to senior CLO note principal balance outstanding} \\ & + \beta_9 \textit{CLO quarterly coupon payments} + \beta_{10} \textit{CLO tranche slicing} \\ & + \beta_{11} \textit{CLO vintage} + \textit{CLO manager FE} + \textit{CLO arranger FE} \\ & + \textit{Year FE.} \end{aligned}$$

(Model 4)

The independent variable of interest is *CLO test restrictiveness*. The analysis is at the CLO-quarter level. The control variables and specifications are the same as in Model 2. In Table 5, we report a negative and statistically significant coefficient on *CLO test restrictiveness* (column I), suggesting that CLOs with more restrictive tests generate, on average, lower quarterly returns to their equity investors. Economically, an increase in *CLO test restrictiveness* by one standard

deviation decreases *CLO equity returns* by about 4.00% of the mean value of the dependent variable. Our findings are robust when using a Fama-MacBeth cross-sectional regression and when truncating the values of *CLO equity returns* at 1% and 99% (untabulated robustness tests).

These results hold when we restrict the sample to managers that administer both CLOs with high and low test restrictiveness (i.e., CLOs with test restrictiveness ranked in the upper or lower quintile of CLOs' test restrictiveness, respectively) (Column II). These tests further indicate that our results are unlikely to be driven by CLO managers' characteristics (we also control for CLO manager fixed effects across our tests). In columns III and IV, we restrict our sample to CLOs originated during the period 2008-2014, and examine their equity returns over a three-year period post-origination (in column IV, we estimate the average equity returns of CLOs in this subsample, and the analysis is at the CLO level). Our findings are robust to these specifications, thus, differences in investment horizons do not seem to drive the lower equity returns of CLOs with restrictive tests. These multivariate results are consistent with the evidence presented in Figure 2, where we graphically show that CLO vintages with greater test restrictiveness have on average lower equity returns over their life. We further investigate whether the lower equity returns of constrained CLOs reflect more stable cash flow payments and thus lower risk. We examine the standard deviation of a CLO's annualized equity returns (measured within a calendar year or across the first three years of its life) and find no statistically significant association between a CLO's test restrictiveness and return volatility (untabulated tests).

We next investigate whether the trading strategy of CLOs with restrictive tests is instrumental to the negative relation between CLO test restrictiveness and equity returns. To do so, we augment Model 4 with the measures of CLO trading choices (*High portfolio turnover*, *High portfolio rebalancing*, *High portfolio diversification*, *Loan holding period*) and their interaction term with

CLO test restrictiveness. All other control variables and specifications are the same as in Model 4. We report the results of these tests in Table 6. Consistent with prior studies, we find that portfolio turnover and diversification increases CLO equity returns. To exemplify, CLOs with high portfolio turnover, diversification and rebalancing have about 2.2%, 1.6% and 0.6% higher equity returns, i.e., 12.5%, 9.3% and 3.4% of the mean value of the dependent variable (columns I, II and III, respectively). However, these trading choices actually lead to lower equity returns in the case of CLOs with restrictive tests. Economically, an increase by one standard deviation in *CLO test restrictiveness* for CLOs with high portfolio turnover, diversification and rebalancing decreases *CLO equity returns* by about 2.2%, 4.5% and 5.0% of the mean value of the dependent variable. These findings are consistent with the view that compliance trading guided by the presence of restrictive CLO tests erodes equity returns.

5. Supplemental analyses

5.1. CLO test restrictiveness and CLO note performance

In supplemental tests, we further assess the performance implications of CLO constraints by investigating the relation between CLO test restrictiveness and the quarterly CLO note credit risk. We employ Model 4, where the dependent variable is one of the following performance measures: (1) an indicator variable of whether a CLO junior note's quarterly rating is downgraded (*CLO junior note rating downgrade*); (2) an indicator variable of whether a CLO note's quarterly rating is CCC+ or below (*High CLO note risk*); and (3) an indicator variable of whether a CLO makes early principal repayments to its noteholders (i.e., whether the quarterly percentage decrease in a CLO's note principal balance prior to its maturity ranks in the bottom quartile of this variable) (*CLO early note payments*). Violating a coverage test is the most common cause of the early repayment of the principal of CLO notes (e.g., Barclays Capital 2002).

As we report in Table 7, CLO test restrictiveness is negatively associated with CLO notes' credit risk. Economically, an increase in *CLO test restrictiveness* by one standard deviation decreases the probability of a junior CLO note rating downgrade, a note being rated CCC+ or below and early note principal repayments by 0.4%, 2.1% and 1.2% respectively, representing about 10.4%, 12.3% and 18.4% of the respective mean values of the dependent variables (columns I, II and III, respectively). These results are consistent with our primary findings that junior noteholders trade off cash flow rights with tighter control rights upon a CLO's inception: more restrictive CLO tests incentivize managers to engage in compliance trading to avoid a test violation, benefiting noteholders at the expense of equity holders. Consistent with this argument, in untabulated robustness analyses, we document that while CLOs with restrictive tests report on average a lower quarterly test slack, they are *not* more likely to experience a test violation or very low test slack, suggesting that managers' compliance trading is effective.

An important concern we need to address is that our findings may be driven by the loan portfolio structure of CLOs with restrictive tests rather than by their trading choices. For instance, CLOs with restrictive tests may on average hold fewer risky loans that generally carry higher interest rates. Thus, holding less risky loans with lower interest payments restricts CLOs from generating excess returns. To alleviate this concern, we examine whether CLOs with restrictive tests are likely to hold a smaller CCC-rated portfolio loan bucket or low-interest-rate loans. We employ Model 4, where the dependent variable is the percentage of CCC-rated portfolio loans (*CCC-rated loan bucket*) and the quarterly average CLO portfolio loan interest rate (*Loan coupon rate*). All other specifications and control variables are the same as in Model 4. We find no statistically significant association between *CLO test restrictiveness* and *CCC-rated loan bucket* and *Loan coupon rate* (untabulated tests), suggesting that our findings are unlikely to be driven by the different traits of

portfolio loans of CLOs with restrictive tests.

5.2. CLO test restrictiveness and CLO tranche pricing

We next examine whether CLO test restrictiveness affects CLO tranche pricing in the secondary market, i.e., whether the performance implications of CLO test restrictiveness are unraveled by investors when purchasing CLO notes and equity. We augment Model 4 using as a dependent variable the average trading price of a CLO tranche at the CLO tranche-quarter level (*CLO senior note price*, *CLO junior note price* and *CLO equity price*) and further controlling for the natural logarithm of the CLO tranche principal balance traded averaged at the CLO tranche-quarter level (*CLO tranche amount traded*) and the mean quarterly credit rating of the CLO note traded (*Rating of CLO note traded*) (CLO equity is not rated). All other control variables and specifications are the same as in Model 4.

We report the results of the tests in Table 8. Consistent with the subordination of CLOs' junior and equity tranches providing cushion against credit losses to senior noteholders, we show that CLO senior note pricing is not significantly associated with CLO portfolio constraints. However, we find that CLO test restrictiveness has a material effect on the pricing of junior notes and equity tranches: an increase in *CLO test restrictiveness* by one standard deviation increases (decreases) *CLO junior note price* (*CLO equity price*) by about 1.53% (2.70%) of the mean value of the dependent variable. This evidence suggests that the effects of CLO test restrictiveness on CLO note and equity performance are priced by CLO investors to some extent.

5.3. Sensitivity analyses

We perform several robustness tests to provide additional credibility to our findings. First, we investigate whether the results of our primary analyses change for different CLO test categories. We measure the restrictiveness of the coverage tests (overcollateralization and interest coverage)

using the mean value of the standardized measures of these tests (*CLO coverage test restrictiveness*). We measure the restrictiveness of asset (loan) quality tests (WARF and WAS) using the mean value of the standardized measures of these tests (*CLO asset quality test restrictiveness*). We replicate the analyses in Tables 3 and 5 using the *CLO coverage test restrictiveness* and *CLO asset quality test restrictiveness* as our main independent variables and report the coefficients of these variables in Panel A of Table 9. Although the effect of portfolio constraints on trading choices and equity returns is stronger for coverage tests due to the adverse cash flow implications of a CLO violating these tests, our results are mostly robust across both CLO test categories.

Second, we investigate whether our results are robust to an alternative measure of CLO equity returns. We define *CLO equity returns 2* as the percentage of a CLO's quarterly payments to equity holders divided by a CLO's equity tranche par value. We replicate the analyses in Table 5 using *CLO equity returns 2* as the dependent variable and report the results of the tests in Panel B of Table 9. We document that our findings on the relation between CLO test restrictiveness and CLO equity returns are mostly robust to this variable specification. In untabulated robustness tests, we find that the results across the different model specifications in Table 6 are also overall robust to this alternative measure of CLO equity returns.

6. Conclusion

We explore the effect of CLO portfolio test restrictiveness on CLO managers' trading choices and CLO equity returns. These portfolio tests are determined at CLO origination, and managers are required to pass them on a monthly basis over the life of the CLO. We focus on CLO tests that determine the minimum capital and interest coverage on CLO notes, the minimum interest income of portfolio loans and the maximum portfolio riskiness.

We examine the effect of CLO test restrictiveness on CLO trading strategies and find that CLOs with restrictive tests have greater portfolio turnover, rebalancing and diversification and shorter loan holding periods. This evidence is consistent with the view that managers facing stringent CLO constraints try to mitigate portfolio credit losses and avoid a test violation through greater diversification and turnover. We further document that managers of CLOs with restrictive tests respond to borrower news by trading loans to minimize the realization of credit losses and to comply with the CLO tests rather than to generate trading profits. We show that CLO test restrictiveness is negatively associated with CLO equity returns, and most importantly, the trading choices by CLOs with stringent tests tend to yield lower equity returns. In supplemental tests, we find that CLOs with restrictive tests experience better note performance, supporting the argument that trading choices by managers of constrained CLOs likely benefit noteholders at the expense of equity investors. Last, we document a significant association between CLO test restrictiveness and junior note and equity tranche pricing, suggesting that investors can unravel the performance implications of CLO test restrictiveness to some extent. Overall, our empirical evidence shows that differences in CLO structures, and in particular the design of CLO portfolio constraints, result in divergent trading choices and eventually different levels of CLO performance, highlighting the importance of investors understanding the terms in CLO prospectuses.

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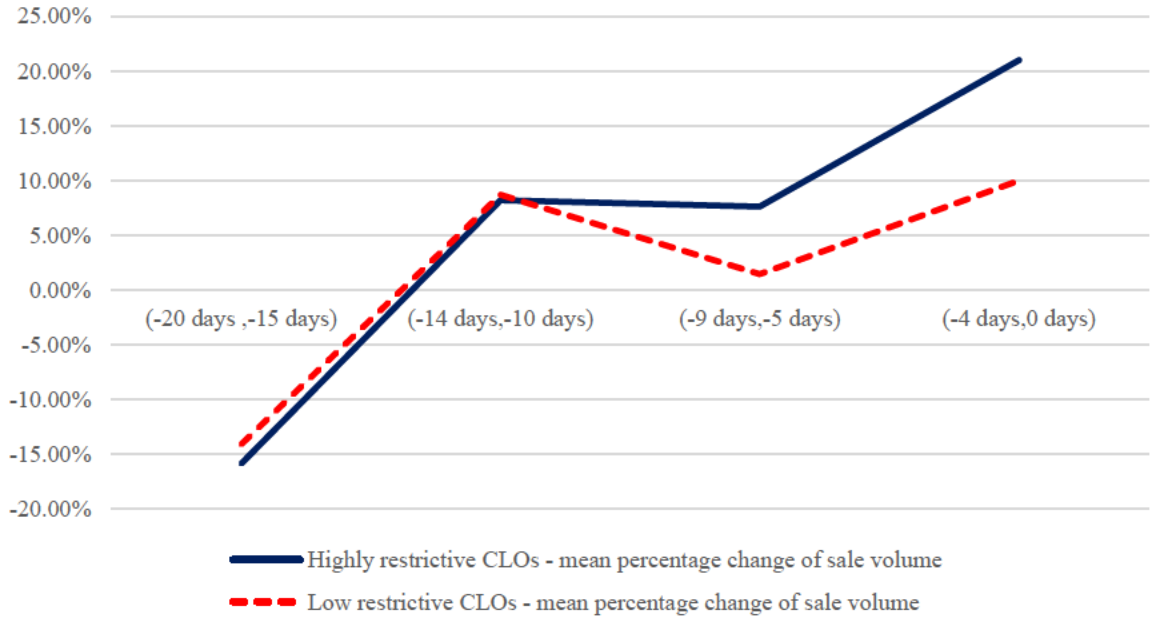
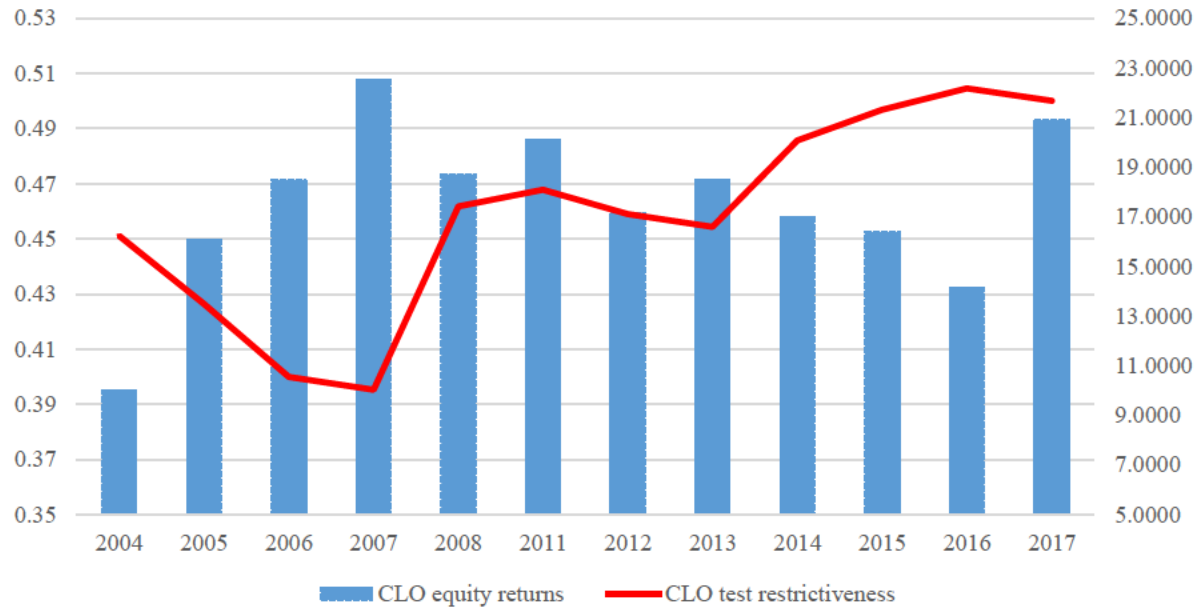
Figure 1. Loan sales by CLOs with restrictive and lax tests before the fiscal period end.



This figure presents the average percentage change of the loan sale volume by CLOs with above- and below-median test restrictiveness (solid and dotted line, respectively) over the 20-day period (using five-day intervals) prior to their reporting period end (x-axis, with zero being the fiscal period-end date). Loan sale activity is estimated using our sample of 1,226 CLOs.

Figure 2. CLO test restrictiveness and CLO equity returns.



This figure presents the average CLO test restrictiveness (primary y-axis) and equity returns (secondary y-axis) by CLO origination year (x-axis) for CLOs issued in 2004-2017. No CLOs were originated in 2009, and only one CLO was issued in 2010, thus, these two years are omitted from the graph. The graphical presentation is similar when we include the full CLO sample (i.e., also CLOs originated in 1999-2004).

APPENDIX
Variable definition

Variable	Definition
CLO characteristics (at origination)	
CLO test restrictiveness	The mean standardized restrictiveness of a CLO's capital coverage, interest coverage, rating and interest income tests. For a CLO's minimum capital coverage, interest coverage and interest income tests, the standardized restrictiveness measures are estimated as: [CLO's test threshold – Min(test threshold)]/[Max(test threshold) – Min(test threshold)]. For a CLO's maximum rating test, the standardized restrictiveness measure is estimated as: [Max(test threshold) – CLO's test threshold/[Max(test threshold) – Min(test threshold)].
CLO note coupon rate	The CLO note coupon rate, averaged across CLO tranches.
CLO note rating at origination	The mean credit rating of CLO notes upon CLO origination. CLO note rating is a scale variable equal to 1 if the rating is AAA, 2 if AA+, and so forth.
CLO manager AUM	The natural logarithm of the total size of CLOs (in $ million) issued by a manager in the past.
CLO manager fees	The natural logarithm of a CLO's senior and junior fees (in basis points).
CLO manager tenure	The natural logarithm of the number of years since a manager's first CLO origination.
CLO manager-arranger prior relation	The number of CLOs the manager raised from an arranger over the past five years, divided by the total number of CLOs that the arranger originated over the same period.
CLO maturity	The natural logarithm of CLO maturity in years.
CLO size	The natural logarithm of total CLO par value.
CLO tranche slicing	The number of CLO tranches issued by the CLO.
CLO vintage	Binary variable that equals one if a CLO was structured under the Volcker, CLO 3.0 rules (i.e., originated in 2014-2017), zero otherwise.
Junior CLO note coupon premium	A CLO's junior note coupon rate minus senior note coupon rate, divided by the senior note coupon rate.
Junior to senior CLO note par value	CLO junior note principal balance to CLO senior note principal balance at CLO origination.
Quarterly CLO issuance	The natural logarithm of the total CLO issuance volume (in $ billion) over the prior quarter.
CLO quarterly portfolio performance	
CCC-rated loan bucket	The principal balance of a CLO's CCC-rated loans to a CLO's portfolio principal balance outstanding.
CLO test violation	Binary variable that equals one if a CLO violated a test during a quarter, zero otherwise.

APPENDIX (continued)

CLO principal balance outstanding	The natural logarithm of a CLO's total principal balance outstanding.
CLO quarterly note rating	The average quarterly credit rating of a CLO's notes. CLO note rating is a scale variable equal to 1 if the rating is AAA, 2 if AA+, and so forth.
CLO quarterly coupon payments	Weighted average coupon rate of a CLO's senior and junior notes.
CLO time to maturity	The natural logarithm of the number of days until a CLO matures.
Defaulted loan bucket	The principal balance of a CLO's defaulted loans to a CLO's portfolio principal balance outstanding.
Junior to senior CLO note principal balance outstanding	CLO junior note principal balance outstanding to CLO senior note principal balance outstanding.
<u>Portfolio management</u>	
Aggregate bad (good) news	Binary variable that equals one if a CLO's portfolio borrower experienced negative (positive) stock returns or negative (positive) earnings or a loan rating downgrade (upgrade) over the prior two quarters, zero otherwise.
High portfolio diversification	Binary variable that equals one if a CLO's excess portfolio concentration ranks in the bottom quartile of CLOs' excess portfolio concentration, zero otherwise. Excess portfolio concentration is the residual of the regression of a CLO's average quarterly portfolio allocation to different borrowers on CLO fixed effects.
High portfolio rebalancing	Binary variable that equals one if a CLO's quarterly portfolio rebalancing ranks in the upper quartile of the variable, zero otherwise. Portfolio rebalancing is the number of loan tranches purchased minus the number of loan tranches sold by a CLO over a quarter, divided by the average number of loan tranches held by the CLO over the prior quarter.
High portfolio turnover	Binary variable that equals one if a CLO's quarterly trading volume ranks in the upper quartile of CLOs' trading volume, zero otherwise. Trading volume is defined as the total balance of loans purchased and sold by a CLO over a quarter, divided by a CLO's total principal balance outstanding.
Loan holding period	The number of quarters a CLO holds a loan in the portfolio, averaged at the CLO-quarter of sale level.
Loan sale intensity	The total borrower's balance sold by a CLO over a quarter, divided by the total borrower's balance held by the CLO over the prior quarter.
Loan sale (purchase) price	The difference between the average sale (purchase) price of a borrower's loans by a CLO over a quarter minus the average price of same-rated loans over the same period.
Negative (Positive) stock returns	Binary variable that equals one if a borrower experiences negative (positive) stock returns over the prior two quarters, zero otherwise.

APPENDIX (continued)

Negative (positive) earnings	Binary variable that equals one if a borrower's ROA (operating income to total assets) is negative (positive) over the prior two quarters, zero otherwise.
Loan rating downgrade (upgrade)	Binary variable that equals one if a borrower's loan rating was downgraded (upgraded) over the prior two quarters, zero otherwise.
CLO equity and note performance	
CLO equity returns	CLO quarterly equity returns based on the cash distributions to equity holders (annualized; source: CLOi).
CLO senior (junior) note price	CLO senior (junior) note tranche price, averaged at the CLO tranche-quarter level.
CLO early note payments	Binary variable that equals one if a CLO made early principal payments to its noteholders (i.e., whether the quarterly percentage decrease in a CLO's note principal balance prior to its maturity ranks in the bottom quartile of this variable), zero otherwise.
CLO equity price	CLO equity tranche price, averaged at the CLO tranche-quarter level.
High CLO note risk	Binary variable that equals one if a CLO note's quarterly rating is CCC+ or below, zero otherwise.
CLO junior note rating downgrade	Binary variable that equals one if a CLO junior note's quarterly rating is downgraded over prior quarter's rating, zero otherwise.

TABLE 1
Summary statistics

Variable	Obs.	Mean	S.D.	Q2	Median	Q3
CLO characteristics (at origination)						
CLO test restrictiveness	1,226	0.457	0.071	0.404	0.454	0.508
CLO note coupon rate	1,226	2.523	1.016	1.510	2.783	3.258
CLO note rating at origination	1,226	5.597	1.627	4.921	5.901	6.600
CLO manager AUM	1,226	7.311	2.824	6.918	8.164	9.037
CLO manager fees	597	3.854	0.210	3.807	3.912	3.912
CLO manager tenure	1,226	1.592	0.887	1.099	1.792	2.398
CLO manager-arranger prior relation	1,226	0.047	0.086	0.000	0.000	0.063
CLO maturity	1,226	2.518	0.169	2.435	2.565	2.639
CLO size	1,226	6.414	0.455	6.028	6.334	6.724
CLO tranche slicing	1,226	8.198	2.107	7.000	8.000	9.000
CLO vintage	1,226	0.428	0.495	0.000	0.000	1.000
Junior CLO note coupon premium	1,226	9.264	5.302	5.964	8.422	11.824
Junior to senior CLO note par value	1,226	0.177	0.069	0.122	0.166	0.235
Quarterly CLO issuance	1,226	3.074	0.762	2.793	3.271	3.562
CLO quarterly portfolio performance						
CCC-rated loan bucket	15,621	0.064	0.046	0.034	0.054	0.080
CLO test violation	15,621	0.304	0.460	0.000	0.000	1.000
CLO principal balance outstanding	15,621	19.733	1.048	19.579	19.875	20.082
CLO quarterly note rating	15,621	5.487	2.127	5.000	5.436	6.000
CLO quarterly coupon payments	15,621	1.217	0.714	0.496	1.233	1.929
CLO time to maturity	15,621	7.986	0.463	7.710	8.002	8.222
Defaulted loan bucket	15,621	0.032	0.085	0.000	0.008	0.023
Junior to senior CLO note principal balance outstanding	15,621	0.267	0.331	0.124	0.180	0.258
Portfolio management						
High portfolio diversification	15,621	0.249	0.432	0.000	0.000	0.000
High portfolio rebalancing	15,621	0.258	0.435	0.000	0.000	1.000
High portfolio turnover	15,621	0.252	0.434	0.000	0.000	1.000
Loan holding period	14,219	4.122	3.432	1.867	4.056	4.457
Loan sale intensity	189,151	0.043	0.184	0.000	0.000	0.000
Loan sale price	31,861	0.846	2.769	0.141	0.721	1.435
Loan purchase price	58,916	0.303	1.532	-0.254	0.250	1.022

TABLE 1 (continued)

CLO equity and note performance						
CLO equity returns	15,621	17.790	10.702	10.450	17.610	24.420
CLO early note payments	15,621	0.064	0.245	0.000	0.000	0.000
CLO junior note price	1,875	86.558	14.420	80	92.27	97.26
CLO senior note price	2,358	94.386	9.377	94	98.672	99.85
CLO equity price	850	69.670	17..539	51.105	70.000	82.000
High CLO note risk	15,621	0.170	0.375	0.000	0.000	0.000
CLO junior note rating downgrade	15,621	0.040	0.195	0.000	0.000	0.000

This table presents summary statistics for the variables used in our primary analyses. The values of the continuous variables are winsorized at 1% and 99%. Detailed variable definitions are reported in the Appendix.

TABLE 2
Determinants of CLO test restrictiveness

	CLO test restrictiveness		
Variable	(I)	(II)	(III)
Junior to senior CLO note par value	0.236***	0.242***	0.255***
	(4.480)	(5.139)	(4.734)
Junior CLO note coupon premium	-0.002***	-0.002***	-0.003***
	(-4.053)	(-4.330)	(-3.779)
CLO note coupon rate	0.002	0.002	-0.002
	(0.511)	(0.905)	(-0.472)
CLO note rating at origination	0.001***	0.001***	0.001***
	(3.069)	(3.123)	(3.313)
CLO size	0.007*	0.008*	0.004
	(1.917)	(2.010)	(0.606)
CLO tranche slicing	-0.001	-0.001	-0.000
	(-0.707)	(-0.901)	(-0.312)
CLO maturity	-0.005	-0.006	-0.011
	(-0.318)	(-0.363)	(-0.558)
CLO vintage	0.031***	0.033***	0.041***
	(5.190)	(5.091)	(4.692)
Quarterly CLO issuance	-0.015***	-0.013***	-0.021***
	(-5.356)	(-3.843)	(-4.620)
CLO manager AUM		-0.002	-0.004
		(-1.012)	(-1.264)
CLO manager tenure		0.000	0.002
		(0.044)	(0.177)
CLO manager-arranger prior relation		0.012	-0.001
		(0.497)	(-0.026)
CLO manager fees			-0.029**
			(-2.224)
Fixed Effects	Yes	Yes	Yes
Obs.	1,226	1,226	597
R^2	60.78%	61.09%	64.41%

This table reports the results of the analyses on the relation between CLO test restrictiveness and CLO characteristics. Across all models, the dependent variable is *CLO test restrictiveness*, defined as the mean standardized restrictiveness of a CLO's capital coverage, interest coverage, rating and interest income tests. In specification (III), sample size drops due to limited data availability on CLO manager fees. All variables are defined in the Appendix. The values of the continuous variables are winsorized at 1% and 99%. OLS regressions are used to estimate the models, with t-statistics reported in parentheses. CLO manager and arranger fixed effects are included but not tabulated. Standard errors are corrected for heteroskedasticity and clustered at the CLO arranger level. ∗∗∗, ∗∗ and ∗ denote significance at the 1%, 5% and 10% (two-sided) levels, respectively.

TABLE 3
CLO test restrictiveness and trading strategy

Variable	(I) *High portfolio turnover*	(II) *High portfolio diversification*	(III) *High portfolio rebalancing*	(IV) *Loan holding period*
CLO test restrictiveness	**0.244****	**0.320****	**0.280*****	**-2.984*****
	(2.090)	**(2.052)**	**(3.327)**	**(-3.416)**
CCC-rated loan bucket	0.094	-0.150	-0.285**	1.186
	(0.630)	(-0.882)	(-2.413)	(1.017)
Defaulted loan bucket	-0.317***	0.137*	-0.044	-1.865**
	(-6.071)	(1.894)	(-0.955)	(-2.561)
CLO quarterly note rating	0.003	0.009***	0.010***	-0.055**
	(1.035)	(2.650)	(4.920)	(-2.156)
CLO test violation	-0.062***	-0.035**	-0.042***	0.238***
	(-4.958)	(-2.551)	(-4.061)	(2.624)
CLO time to maturity	-0.032***	-0.092***	-0.063***	-1.008***
	(-3.367)	(-15.240)	(-7.333)	(-9.302)
CLO principal balance outstanding	-0.019*	0.012*	0.015***	-0.158***
	(-1.869)	(1.776)	(2.645)	(-3.192)
Junior to senior CLO note principal balance outstanding	-0.025	-0.114***	-0.079***	1.792***
	(-1.392)	(-5.849)	(-6.020)	(7.482)
CLO quarterly coupon payments	0.047***	-0.130***	-0.018**	-2.126***
	(4.396)	(-8.434)	(-2.081)	(-15.683)
CLO tranche slicing	0.010***	-0.001	0.002	-0.043**
	(3.296)	(-0.293)	(0.825)	(-2.021)
CLO vintage	0.106***	0.042***	0.071***	-0.935***
	(5.828)	(2.725)	(5.140)	(-7.295)
Fixed Effects	Yes	Yes	Yes	Yes
Obs.	15,621	15,621	15,621	14,219
R^2	17.44%	36.18%	32.27%	37.74%

This table reports the results of the analyses on the relation between CLO test restrictiveness and the CLOs' trading strategy. In model (I), the dependent variable is an indicator variable of whether a CLO's quarterly trading volume ranks in the upper quartile of CLOs' trading volume (*High portfolio turnover*). In model (II), the dependent variable is an indicator variable of whether a CLO's portfolio borrower concentration ranks in the bottom quartile of the variable (*High portfolio diversification*). In model (III), the dependent variable is an indicator variable of whether a CLO's quarterly portfolio rebalancing ranks in the upper quartile of the variable (*High portfolio rebalancing).* Portfolio rebalancing is the number of loan tranches purchased minus the number of loan tranches sold by a CLO over a quarter, divided by the average number of loan tranches held by the CLO over the prior quarter. In model (IV), the dependent variable is the number of quarters a CLO holds a loan in the portfolio, averaged at the CLO-quarter of sale level (*Loan holding period*). Across all models, the main independent variable of interest is *CLO test restrictiveness*, defined as the mean standardized restrictiveness of a CLO's capital coverage, interest coverage, rating and interest income tests. All variables are defined in the Appendix. The values of the continuous variables are winsorized at 1% and 99%. OLS regressions are used to estimate the models, with t-statistics reported in parentheses. Year, CLO manager and arranger fixed effects are included but not tabulated. Standard errors are corrected for heteroskedasticity and clustered at the CLO level. ∗∗∗, ∗∗ and ∗ denote significance at the 1%, 5% and 10% (two-sided) levels, respectively. Coefficients of interest are in boldface.

TABLE 4
CLO test restrictiveness, borrower information and loan trading choices

Panel A: CLO test restrictiveness and the sale volume of loans associated with bad news.

	Loan sale intensity			
	(I)	(II)	(III)	(IV)
Variable	*Aggregate bad news*	*Negative stock returns*	*Negative earnings*	*Loan rating downgrade*
Bad news	**0.005****	**0.008*****	**0.002**	**0.004***
	(2.037)	**(2.621)**	**(0.535)**	**(1.696)**
CLO test restrictiveness	0.057***	0.032***	0.019*	0.014
	(4.564)	(3.139)	(1.791)	(1.403)
CLO test restrictiveness × Bad news	**-0.112*****	**-0.115*****	**-0.055****	**-0.051***
	(-5.699)	**(-4.511)**	**(-2.302)**	**(-1.937)**
Loan rating	-0.002	-0.001	-0.001	-0.001
	(-1.637)	(-1.291)	(-1.366)	(-1.550)
Borrower accounting performance and Fixed Effects	Yes	Yes	Yes	Yes
Obs.	189,151	189,151	189,151	189,151
R^2	3.31%	3.31%	3.26%	3.21%

Panel B: CLO test restrictiveness and the sale price of loans associated with bad news.

	Loan sale price			
	(I)	(II)	(III)	(IV)
Variable	*Aggregate bad news*	*Negative stock returns*	*Negative earnings*	*Loan rating downgrade*
Bad news	**-0.255****	**-0.770*****	**-0.444***	**-0.256**
	(-2.426)	**(-5.414)**	**(-1.651)**	**(-1.013)**
CLO test restrictiveness	0.774	0.320	0.572	-0.028
	(1.537)	(0.757)	(1.257)	(-0.073)
CLO test restrictiveness × Bad news	**-2.429*****	**-3.128****	**-3.772****	**-2.488**
	(-2.652)	**(-2.272)**	**(-2.485)**	**(-1.548)**
Loan rating	0.378***	0.365***	0.388***	0.373***
	(2.691)	(2.630)	(2.665)	(2.770)
Loan balance sold	0.211**	0.208**	0.203**	0.207**
	(2.045)	(2.025)	(2.052)	(1.968)
Borrower accounting performance and Fixed Effects	Yes	Yes	Yes	Yes
Obs.	31,861	31,861	31,861	31,861
R^2	21.50%	22.48%	21.70%	21.64%

Panel B: CLO test restrictiveness and the purchase price of loans associated with positive news.

	Loan purchase price			
	(I)	(II)	(III)	(IV)
Variable	*Aggregate good news*	*Positive stock returns*	*Positive earnings*	*Loan rating upgrade*
Good news	**0.233***	**0.105***	**0.092**	**0.230****
	(1.683)	**(1.659)**	**(1.113)**	**(2.333)**
CLO test restrictiveness	-1.171*	-0.413*	-0.204	-0.773*
	(-1.868)	(-1.832)	(-0.857)	(-1.903)
CLO test restrictiveness × Good news	**1.176***	**0.795***	**0.182**	**0.894***
	(1.760)	**(1.835)**	**(0.386)**	**(1.766)**
Loan rating	0.072	0.074	0.077*	0.072
	(1.586)	(1.618)	(1.677)	(1.562)
Loan balance purchased	0.115	0.114	0.115	0.117
	(1.579)	(1.548)	(1.550)	(1.618)
Borrower accounting performance and Fixed Effects	Yes	Yes	Yes	Yes
Obs.	58,916	58,916	58,916	58,916
R^2	15.80%	15.68%	15.62%	15.93%

This table reports the results of the analyses on the relation between CLO test restrictiveness and CLO trading decisions in response to new information about borrowers' credit risk. In Panel A, we use a sample of CLOs' quarterly loan portfolio holdings and examine portfolio divestment decisions related to borrowers with bad news by CLOs with restrictive tests. Across all models, the dependent variable is the total borrower's balance sold by a CLO over a quarter, divided by the total borrower's balance held by the CLO over the prior quarter (*Loan sale intensity*). In Panel B, we use a sample of loan sales and examine the price discount of loans issued by borrowers who experience bad news and are sold by CLOs with restrictive tests. Across all models, the dependent variable is the difference between the average quarterly sale price of a borrower's loans by a CLO and the average price of same-rated loans over the same period (*Loan sale price*). In Panel C, we use a sample of loan purchases and examine the price premium of loans issued by borrowers who experience positive news and purchased by CLOs with restrictive tests. Across all models, the dependent variable is the difference between the average quarterly purchase price of a borrower's loans by a CLO and the average price of same-rated loans over the same period (*Loan purchase price*). Across all panels, *CLO test restrictiveness* is defined as the mean standardized restrictiveness of a CLO's capital coverage, interest coverage, rating and interest income tests. *Loan rating* is the average rating of a borrower's loans. *Loan balance sold (purchased)* is the natural logarithm of a borrower's loan balance sold (purchased) by a CLO over a quarter. We further control for the following proxies of borrower's accounting performance, measured at the borrower-quarter level (untabulated): the natural logarithm of total assets (*Total assets*); the ratio of total liabilities to total assets (*Leverage*); the ratio of current assets to current liabilities (*Liquidity*); an indicator variable of whether a borrower reports negative earnings (*Loss*); the ratio of market to book value of equity (*Market to book value of equity*); and the natural logarithm of operating cash flow volatility over the prior five quarters (*Cash flow volatility*). All other variables are defined in the Appendix. The values of the continuous variables are winsorized at 1% and 99%. OLS regressions are used to estimate the models, with t-statistics reported in parentheses. Borrower industry (2-digit SIC), quarter, CLO manager and arranger fixed effects are included but not tabulated. Standard errors are corrected for heteroskedasticity and clustered at the borrower level. ***, ** and * denote significance at the 1%, 5% and 10% (two-sided) levels, respectively. Coefficients of interest are in bold format.

TABLE 5
CLO test restrictiveness and equity returns

	CLO equity returns			
	(I)	(II)	(III)	(IV)
Variable	Full sample	CLOs by managers who administer CLOs with restrictive and lax tests	3-year quarterly equity returns of CLOs originated in 2008-2014	3-year quarterly equity returns of CLOs originated in 2008-2014, CLO-level analysis
CLO test restrictiveness	**-9.399*** **	**-12.662*** **	**-7.553***	**-9.244***
	(-2.896)	**(-3.375)**	**(-1.766)**	**(-1.826)**
CCC-rated loan bucket	-11.381***	-13.969**	0.631	-13.231
	(-2.566)	(-2.534)	(0.153)	(-1.345)
Defaulted loan bucket	-8.350***	-9.500***	-4.017	-24.845
	(-4.277)	(-3.597)	(-1.220)	(-1.012)
CLO quarterly note rating	0.325***	0.318***	0.264***	0.261**
	(3.817)	(3.351)	(2.646)	(2.306)
CLO test violation	-3.668***	-3.688***	0.102	-0.416
	(-11.014)	(-9.176)	(0.289)	(-0.392)
CLO time to maturity	3.009***	2.724***	0.158	-0.190
	(9.117)	(6.716)	(0.318)	(-0.213)
CLO principal balance outstanding	1.210***	1.174***	0.090	0.127
	(4.845)	(4.530)	(0.830)	(1.442)
Junior to senior CLO note principal balance outstanding	-4.314***	-5.456***	0.095	3.229
	(-7.641)	(-8.174)	(0.087)	(1.409)
CLO quarterly coupon payments	-2.136***	-1.943***	-0.265	-2.458***
	(-6.900)	(-5.125)	(-0.443)	(-3.707)
CLO tranche slicing	0.139*	0.109	-0.066	-0.009
	(1.915)	(1.327)	(-0.992)	(-0.084)
CLO vintage	1.168***	1.606***	-0.064	-1.711***
	(3.098)	(3.525)	(-0.177)	(-3.921)
Fixed Effects	Yes	Yes	Yes	Yes
Obs.	15,621	11,204	3,483	430
R^2	44.15%	42.92%	41.27%	66.59%

This table reports the results of the analyses on the relation between CLO test restrictiveness and equity returns. The dependent variable is the annualized rate of a CLO's quarterly equity returns measured based on the cash distributions to equity holders (*CLO equity returns*). In model (I), we employ the full sample of 1,226 CLOs. In model (II), we restrict the sample to CLOs with managers who administer both CLOs with highly restrictive and lax tests (i.e., CLOs whose test restrictiveness ranks in the upper or lower quintile of the test restrictiveness of CLOs administered by the same manager). In model (III), we restrict the sample to CLOs originated over the 2008-2014 period and examine their quarterly equity returns over a three-year horizon after their origination. In model (IV), we examine the average equity returns of CLOs originated in 2008-2014 over a three-year horizon after their origination. In model (IV), we further control for the average probability of a CLO's missing a quarterly equity payment (untabulated). The main independent variable of interest is *CLO test restrictiveness*, defined as the mean standardized restrictiveness of a CLO's capital coverage, interest coverage, rating and interest income tests. All variables are defined in the Appendix. The values of the continuous variables are winsorized at 1% and 99%. OLS regressions are used to estimate the models, with t-statistics reported in parentheses. Year, CLO manager and arranger fixed effects are included but not tabulated. Standard errors are corrected for heteroskedasticity and clustered at the CLO level (in model (IV), standard errors are clustered at the CLO arranger level and year fixed effects are excluded). ***, ** and * denote significance at the 1%, 5% and 10% (two-sided) levels, respectively. Coefficients of interest are in bold format.

TABLE 6
CLO test restrictiveness, trading strategy and equity returns

		CLO equity returns		
Variable	(I)	(II)	(III)	(IV)
		Trading strategy =		
	High portfolio turnover	*High portfolio diversification*	*High portfolio rebalancing*	*Loan holding period*
CLO test restrictiveness	**-9.885*** **	**-7.639** **	**-6.247** **	**-12.544*** **
	(-3.016)	**(-2.389)**	**(-2.058)**	**(-3.268)**
Trading strategy	2.203***	1.639***	0.600***	-0.165***
	(9.593)	(4.147)	(2.652)	(-3.682)
CLO test restrictiveness × Investment	**-5.656***	**-11.437** **	**-12.669*** **	**0.122**
	(-1.894)	**(-2.430)**	**(-3.564)**	**(0.174)**
Controls and Fixed Effects	Yes	Yes	Yes	Yes
Obs.	15,621	15,621	15,621	14,219
R^2	44.62%	43.83%	45.12%	44.52%

This table reports the results of the analyses on the effect of trading decisions by CLOs with restrictive tests on CLO quarterly equity returns. Across all models, the dependent variable is the annualized rate of a CLO's quarterly equity returns measured based on the cash distributions to equity holders (*CLO equity returns*). We employ four measures of CLOs' trading decisions: i) in model (I), an indicator variable of whether a CLO's quarterly trading volume ranks in the upper quartile of CLOs' trading volume (*High portfolio turnover*); in model (II), an indicator variable of whether a CLO's portfolio borrower concentration ranks in the bottom quartile of the variable (*High portfolio diversification*); in model (III), an indicator variable of whether a CLO's quarterly portfolio rebalancing ranks in the upper quartile of the variable (*High portfolio rebalancing*); in model (IV), the number of quarters a CLO holds a loan in the portfolio, averaged at the CLO-quarter of sale level (*Loan holding period*). *CLO test restrictiveness* is defined as the mean standardized restrictiveness of a CLO's capital coverage, interest coverage, rating and interest income tests. Model specification and control variables (untabulated) are the same as in Table 5. All variables are defined in the Appendix. The values of the continuous variables are winsorized at 1% and 99%. OLS regressions are used to estimate the models, with t-statistics reported in parentheses. Year, CLO manager and arranger fixed effects are included but not tabulated. Standard errors are corrected for heteroskedasticity and clustered at the CLO level. ***, ** and * denote significance at the 1%, 5% and 10% (two-sided) levels, respectively. Coefficients of interest are in bold format.

TABLE 7
CLO test restrictiveness and CLO note performance

Variable	(I) *CLO junior note rating downgrade*	(II) *High CLO note risk*	(III) *Early CLO note payments*
CLO test restrictiveness	**-0.059***	**-0.297****	**-0.168*****
	(-1.914)	**(-2.542)**	**(-3.397)**
CCC-rated loan bucket	-0.015	-0.010	0.291***
	(-0.283)	(-0.068)	(3.143)
Defaulted loan bucket	0.057***	0.180***	-0.191***
	(3.226)	(2.865)	(-3.708)
CLO quarterly note rating	0.008***		-0.008***
	(9.268)		(-4.303)
CLO test violation	0.022***	0.023**	0.024***
	(5.222)	(2.137)	(3.952)
CLO time to maturity	-0.018***	-0.124***	-0.108***
	(-7.910)	(-9.217)	(-16.354)
CLO principal balance outstanding	0.000	0.003	-0.013***
	(0.291)	(0.441)	(-3.220)
Junior to senior CLO note principal balance outstanding	-0.018***	-0.025	0.221***
	(-3.791)	(-1.535)	(13.239)
CLO quarterly coupon payments	-0.011***	-0.009	0.049***
	(-4.246)	(-0.637)	(6.004)
CLO tranche slicing	0.001	0.004	0.005***
	(0.987)	(1.354)	(3.955)
CLO vintage	0.009***	0.054***	0.002
	(2.657)	(5.475)	(0.216)
Fixed Effects	Yes	Yes	Yes
Obs.	15,621	15,621	15,621
R^2	18.40%	47.76%	20.87%

This table reports the results of the analyses on the relation between CLO test restrictiveness and CLO note performance. In model (I), the dependent variable is an indicator variable of whether a CLO's junior note quarterly rating is downgraded (*CLO junior note rating downgrade*). In model (II), the dependent variable is an indicator variable of whether a CLO's note is rated CCC+ or below during a quarter (*High CLO note risk*). In model (III), the dependent variable is an indicator variable of whether a CLO made early principal payments to noteholders during a quarter (*Early CLO note payments*). Across all models, the main independent variable of interest is *CLO test restrictiveness*, defined as the mean standardized restrictiveness of a CLO's capital coverage, interest coverage, rating and interest income tests. All variables are defined in the Appendix. The values of the continuous variables are winsorized at 1% and 99%. OLS regressions are used to estimate the models, with t-statistics reported in parentheses. Year, CLO manager and arranger fixed effects are included but not tabulated. Standard errors are corrected for heteroskedasticity and clustered at the CLO level. ∗∗∗, ∗∗ and ∗ denote significance at the 1%, 5% and 10% (two-sided) levels, respectively. Coefficients of interest are in bold format.

TABLE 8
CLO test restrictiveness and CLO note and equity pricing

Variable	(I) *CLO senior note price*	(II) *CLO junior note price*	(III) *CLO equity price*
CLO test restrictiveness	**4.221**	**19.032*** **	**-26.456** **
	(1.418)	**(4.251)**	**(-2.203)**
CLO note amount traded	0.338***	0.189	-1.800**
	(2.672)	(0.526)	(-2.235)
Rating of CLO note traded	-0.086**	-0.126*	
	(-2.174)	(-1.779)	
CCC-rated loan bucket	-0.354	-8.360	-18.180
	(-0.063)	(-1.348)	(-0.697)
Defaulted loan bucket	2.369	-9.335	-84.424**
	(0.729)	(-1.187)	(-2.351)
CLO quarterly note rating	-0.266***	-0.440**	-0.724*
	(-2.722)	(-2.470)	(-1.867)
CLO test violation	0.456	0.435	-5.846***
	(1.352)	(0.864)	(-3.710)
CLO time to maturity	-2.486***	-3.772***	7.798***
	(-5.295)	(-5.934)	(4.649)
CLO principal balance outstanding	-0.582***	-0.663***	1.318
	(-2.665)	(-4.032)	(1.194)
Junior to senior CLO note principal balance outstanding	-1.555**	-1.131	-4.832
	(-2.001)	(-1.182)	(-1.287)
CLO quarterly coupon payments	2.204***	3.851***	2.691*
	(7.423)	(7.204)	(1.685)
CLO tranche slicing	-0.006	-0.202*	0.103
	(-0.086)	(-1.746)	(0.328)
CLO vintage	-0.095	-3.947***	3.183*
	(-0.346)	(-5.966)	(1.658)
Obs.	2,358	1,875	850
R^2	73.27%	78.72%	49.78%

This table reports the results of the analyses on the relation between CLO test restrictiveness and CLO note and equity prices in the secondary market. In model (I) and (II), the dependent variable is a CLO's senior and junior note price, respectively, averaged at the CLO note-quarter level (*CLO note price*). In model (III), the dependent variable is the natural logarithm of a CLO's equity tranche price, averaged at the CLO tranche-quarter level (*CLO equity price*). Across all models, the main independent variable of interest is *CLO test restrictiveness*, defined as the mean standardized restrictiveness of a CLO's capital coverage, interest coverage, rating and interest income tests. *CLO tranche amount traded* is the natural logarithm of a CLO's tranche principal balance traded, averaged at the CLO tranche-quarter level. *Rating of CLO note traded* is the credit rating of a traded CLO note, averaged at the CLO note-quarter level. CLO note rating is a scale variable equal to 1 if the rating is AAA, 2 if AA+, and so forth. All other variables are defined in the Appendix. The values of the continuous variables are winsorized at 1% and 99%. OLS regressions are used to estimate the models, with t-statistics reported in parentheses. Year, CLO manager and arranger fixed effects are included but not tabulated. Standard errors are corrected for heteroskedasticity and clustered at the CLO level. ***, ** and * denote significance at the 1%, 5% and 10% (two-sided) levels, respectively. Coefficients of interest are in bold format.

TABLE 9
Robustness checks

Panel A: Alternative measures of CLO test restrictiveness.

	Dependent variable:	*CLO coverage test restrictiveness*	*CLO asset quality test restrictiveness*	*Controls*	*Obs.*	R^2
(I)	*High portfolio turnover*	0.230*** (3.019)	-0.029 (-0.325)	Yes	15,621	17.55%
(II)	*High portfolio diversification*	0.180* (1.928)	0.201* (1.851)	Yes	15,621	39.54%
(III)	*High portfolio rebalancing*	0.154*** (2.869)	0.149** (2.275)	Yes	15,621	32.56%
(IV)	*Loan holding period*	-2.372*** (-4.187)	-0.444 (-0.592)	Yes	14,219	37.81%
(V)	*CLO equity returns*	-5.126** (-2.401)	-4.504* (-1.924)	Yes	15,621	44.15%

This table reports the results of the robustness checks. Panel A reports the results of the analyses on the relation between CLO test restrictiveness, trading choices and equity returns under different definitions of CLO test restrictiveness. *CLO coverage test restrictiveness* is the mean standardized restrictiveness of a CLO's capital and interest coverage tests. *CLO asset quality test restrictiveness* is the mean standardized restrictiveness of a CLO's rating and interest income tests. All other model specifications and control variables (untabulated) are the same as in Table 3 (for models (I)-(IV)) and Table 5 (for model (V)). All variables are defined in the Appendix. The values of the continuous variables are winsorized at 1% and 99%. OLS regressions are used to estimate the models, with t-statistics reported in parentheses. Year, CLO manager and arranger fixed effects are included but not tabulated. Standard errors are corrected for heteroskedasticity and clustered at the CLO level. ***, ** and * denote significance at the 1%, 5% and 10% (two-sided) levels, respectively.

TABLE 9 (continued)

Panel B: Alternative measure of CLO equity returns.

	CLO equity returns 2			
	(I)	(II)	(III)	(IV)
Variable	Full sample	CLOs by managers who administer CLOs with restrictive and lax tests	3-year quarterly equity returns of CLOs originated in 2008-2014	3-year quarterly equity returns of CLOs originated in 2008-2014, CLO-level analysis
CLO test restrictiveness	**-2.929*** **	**-3.649*** **	**-0.029***	**-1.624**
	(-3.340)	**(-3.513)**	**(-1.761)**	**(-1.026)**
CCC-rated loan bucket	-3.291***	-3.572**	0.000	-0.755
	(-3.031)	(-2.570)	(0.011)	(-0.289)
Defaulted loan bucket	-2.449***	-2.553***	-0.025***	-8.542**
	(-4.135)	(-3.353)	(-3.091)	(-2.370)
CLO quarterly note rating	0.085***	0.077***	0.001**	0.086***
	(3.468)	(2.774)	(2.073)	(4.858)
CLO test violation	-0.910***	-0.951***	-0.001	0.197
	(-9.868)	(-8.533)	(-0.834)	(0.541)
CLO time to maturity	0.824***	0.751***	0.003*	-0.160
	(8.538)	(6.359)	(1.764)	(-0.653)
CLO principal balance outstanding	-0.020	-0.057	0.000	0.057*
	(-0.125)	(-0.350)	(1.286)	(1.815)
Junior to senior CLO note principal balance outstanding	-1.219***	-1.570***	0.001	0.694
	(-6.018)	(-6.620)	(0.400)	(1.701)
CLO quarterly coupon payments	-0.409***	-0.353***	0.002	-0.514***
	(-4.245)	(-2.905)	(0.865)	(-3.302)
CLO tranche slicing	0.052**	0.044*	-0.000	-0.021
	(2.328)	(1.762)	(-0.698)	(-0.810)
CLO vintage	0.658***	0.771***	0.006***	-0.365***
	(6.132)	(5.882)	(3.499)	(-2.916)
Obs.	15,621	11,204	3,483	430
R^2	37.68%	35.38%	24.89%	58.41%

Panel B reports the results of the analyses on the relation between CLO test restrictiveness and equity returns under a different definition of CLO equity returns. *CLO equity returns 2* is the percentage of a CLO's quarterly payments to equity holders divided by a CLO's equity par value. All other model specifications are the same as in Table 5. All variables are defined in the Appendix. The values of the continuous variables are winsorized at 1% and 99%. OLS regressions are used to estimate the models, with t-statistics reported in parentheses. Year, CLO manager and arranger fixed effects are included but not tabulated. Standard errors are corrected for heteroskedasticity and clustered at the CLO level. ∗∗∗, ∗∗ and ∗ denote significance at the 1%, 5% and 10% (two-sided) levels, respectively. Coefficients of interest are in bold format.