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Abstract

Insurance companies nonupled their CLO investments in the post-crisis period. This growth has far outpaced that of loans and bonds and is characterized by a strong preference for mezzanine tranches over triple-A tranches. Conditional on capital charges, insurance companies invest more in bonds and CLO tranches with higher yields. Importantly, they prefer CLO tranches because these carry higher yields relative to bonds. Preferences increased following the 2010 capital regulatory reform, resulting in insurance companies holding 40 percent of outstanding mezzanine tranches. Insurance companies contributed positively to CLOs' equity returns and played a critical role in the rise of loan securitization.

Key words: insurance companies, CLOs, regulatory arbitrage, corporate loans, securitization

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1 Introduction

CLO issuance in the U.S. increased by a factor of thirteen in the post crisis-decade, with the volume of outstanding CLOs more than doubling and reaching about $650B by 2019 (Figure 1). This growth has caught the attention of researchers who have investigated its impact on the cost and risk of corporate loans, the amplification of credit cycles, and the stability of the financial system.[1] However, to date little attention has been devoted to the drivers of that growth. That is the subject of this paper. We are particularly interested in understanding the role that insurance companies have played in the growth of corporate loans' securitization and identify the key factors behind that role.

Insurance companies have almost nonupled their CLO holdings in the last decade, reaching $125B in 2019. The growth in CLO investments has far outpaced that of corporate loans and bonds, and was characterized by a preference for mezzanine tranches (Aa, A or Baa rated) over triple-A tranches. Insurers' proclivity towards mezzanine tranches rated investment grade within the CLO asset class, and towards CLOs vis-à-vis other securities reflect a search for yield behavior.

Similar to Becker and Ivashina (2015), we argue that insurers' incentives to reach for yield stem from the capital adequacy regulation's coarse treatment of risk. In contrast to their focus on bond investments, we show those incentives extend and are even more prevalent among CLO investments. Further, and more importantly, we show that the regulation's similar treatment of corporate bonds and CLO tranches make the latter relatively more attractive to insurance companies. Specifically, insurance capital requirements for asset risk associated with fixed income investments are defined for six macro buckets of securities' credit quality named "NAIC designations" (NAIC, 2018, 2020). Insurers assign a NAIC designation to each investment according to a mapping from credit ratings. While the NAIC 1 category is mapped to three credit ratings (Aaa,

[1] See (Wang and Xia, 2010; Shivdasani and Wang, 2011; Benmelech et al., 2012; Nadauld and Weisbach, 2012; Bord and Santos, 2015); (Ivashina and Scharfstein, 2010); and (IMF, 2020; BoE, 2019; FSB, 2019; Ivashina and Vallée, 2020; SEC, 2020), respectively.

Aa and A), all the other NAIC buckets are associated only to one rating during our sample period. This implies that asset holdings falling into the NAIC 1 designation are characterized by a significantly marked heterogeneity in terms of credit risk, albeit requiring the same amount of regulatory capital. Therefore, conditional on the NAIC designation bucket, we conjecture that insurance companies have an incentive to invest more heavily in assets (bonds and CLO tranches) with higher yields. Further, given that the yield dispersion is higher among CLO tranches, they should have higher incentives to search for yield in the CLO market.

Our second hypothesis builds on insurance capital regulation equal treatment of corporate bonds and CLO tranches (except in certain circumstances described next). Given that CLO mezzanine tranches, other than the triple-A tranche, tend to carry higher yields than corporate bonds with the same credit rating this gives insurance companies a preference for CLOs' mezzanine tranches over corporate bonds with the same credit rating. These preferences were enhanced after 2010 when the National Association of Insurance Commissioners (NAIC) enacted a regulatory change of capital requirements for CLO holdings.[2] In essence, the reform allowed insurance companies to report CLO tranches purchased at discount (or highly impaired) in a lower NAIC category than that implied by the rating-based mapping. This further increased insurance companies' incentives to invest in higher yielding CLO tranches.

Insurance companies' preference for CLO mezzanine tranches together with their growing importance in this segment of the CLO market likely played a role in the CLO market. This is the focus of our last hypothesis. In particular, we investigate whether CLO deals in which insurance companies invest more heavily are characterized by a larger fraction of mezzanine tranches and a riskier pool of underlying collateral loans. We complement this investigation with a study of the returns on CLO tranches to ascertain

[2]That change was part of a broader reform initiated in 2009 and focused on mortgage-backed securities (MBS) aimed at providing capital relief to the insurance sector amid the massive wave of downgrades on asset-backed securities during the financial crisis (Becker et al., 2022; NAIC, 2021).

whether investors in CLO equity tranches benefited from insurance companies' growing appetite for CLO investments.

We use insurers' fixed income holdings at the security-company-year level to investigate if insurance companies hold a larger share of securities offering a higher yield within a NAIC designation bucket. We restrict our sample to CLO tranches and corporate bonds for which we have information on issuance and outstanding amounts throughout their lifetime. In addition, since the balance of CLOs might vary over time due to refinancing or principal amortization, we consider only insurers' first-time investments in each security.

We find that insurance companies invest more heavily in securities with higher yields within a NAIC bucket. An increase in the yield by one standard deviation implies an increase in the insurer's holding share by 14 basis points, which corresponds to an additional investment of $93 million for the median security in portfolio. We also find that, conditional on the capital requirement bucket, low-capital insurers hold higher fractions of high yielding securities, consistent with their higher risk-shifting incentives (Jensen and Meckling, 1976). Further, among property and casualty (P&C) insurers, those highly affected by the devastating natural disasters of 2017 are more prone to search for yield in that year.

Consistent with our priors, we find that insurance companies' search for yield is more prevalent within the CLO asset class, which is characterized by a higher dispersion of yields. Also insurers' search for yield within the CLO asset class increased during the years the 2010 regulatory reform was in place. Further, our results show that insurance companies that stood to benefit from the 2010 reform are more prone to search for yield following the implementation of the new rules.

In the second part of our empirical analysis, we document how insurers' search for yield behavior translated into a preference for CLO over corporate bond investments. To this end, we focus on securities rated investment grade which account for most of the

assets in insurers' portfolios.

We first show that the average yield on new investments by insurance companies in CLOs is significantly higher than the yield on new investments in corporate bonds with the same rating, and that the yields differential widens for decreasing levels of credit quality. These patterns map to insurers' investment preferences in a one-to-one fashion. We find that insurance companies purchase a larger portion of CLO tranches compared to corporate bonds with the same rating and this behavior is more pronounced for the lower rated securities. Further, insurance companies purchase a larger portion of CLO tranches compared to corporate bonds with the same rating the larger is the ratio of the average yield on insurers' investments in CLOs to the average yield of insurers' investments in corporate bonds for each specific rating-year combination. Lastly, we find that insurers' preference for CLOs over corporate bonds is concentrated during the period in which the 2010 regulatory regime gave special treatment to CLOs.

In the final part of our paper, we study the implications of insurance companies' search for yield for the CLO market. Our investigation shows that deals in which insurance companies have larger investments have larger mezzanine tranches rated investment grade. Also, CLO deals with a larger holding share by insurance companies have a larger fraction of debt tranches with a fixed-rate coupon and are more likely to be tailor made repackaged CLO deals, both features indicating that CLO managers construct CLO deals that are attractive to insurance companies. We further show that these relationships tend to be more pronounced among CLOs issued during the 2010 reform period *and* CLOs held by insurance companies that stood to benefit from the reform, pointing to a direction of causation.

We end our empirical investigation showing that CLO deals with larger investments by insurers invest in riskier loans, but the higher returns of these loans are catered only to holders of CLOs' equity tranches. Our results show that investors in equity tranches of CLOs with larger investments from insurance companies earn higher abnor-

mal returns, confirming that CLO equity holders rather than debt holders have benefited from insurance companies' strong preference for CLO mezzanine tranches.[3]

Our findings provide strong evidence that insurance companies' preference for CLOs affected the design of CLO deals. Their growing presence in the CLO market, in particular the mezzanine-tranche segment, add important support to our thesis that insurance companies played a key role in the growth of corporate loan secularization over the last decade. Insurance companies' CLO market share almost quintupled between 2013 and 2019 and that increase was mostly driven by mezzanine tranches rated investment grade (Aa, A or Baa rated), whose market share increased by a factor of eight (from 5% in 2009 to 44% in 2019). The importance of insurance companies in the CLO market likely goes beyond what these figures suggest. Mezzanine tranches play a critical role in the origination of CLOs not only because they account for about 26% of CLO deals but also, and perhaps more importantly, because their junior position allows for the creation of the triple-A tranches. Further, while there is plenty of demand for Aaa rated tranches, especially from banks due to the favorable treatment in capital regulation, banks play only a marginal role when it comes to the mezzanine tranches (DeMarco et al., 2020; IMF, 2020). But that is precisely where insurance companies' preferences are. In other words, insurance companies by owning a large fraction of the risky tranches that are not attractive to banks have become a critical player in the securitization of corporate loans.

Our paper is most closely related to the literature on insurance companies' search for yield by arbitraging regulation, including Becker and Ivashina (2015), Becker et al. (2022) and Liu (2019).[4] Becker and Ivashina (2015) document how capital regulation generates incentives to invest in higher yielding corporate bonds conditional on a NAIC

[3]Consistent with this assertion, we find that CLO deals with a larger holding share by insurance companies have a shorter non-call period and are more likely to be refinanced.

[4]Studies looking at banks' risk-taking incentives due to regulatory arbitrage include Kroszner and Strahan (2011); Acharya and Steffen (2015); Karolyi and Taboada (2015); Boyson et al. (2016); Demyanyk and Loutskina (2016); Boyer and Kempf (2020); Buchak et al. (2020).

designation bucket. We show that such incentives also affect, and are even more prevalent, when it comes to investments in CLO tranches. Further, we show that capital regulation has tilted insurance companies' investment preferences towards CLO tranches over corporate bonds and their investments have had an impact not only on the design of CLO deals but also on the returns of CLOs' equity investors. Our results unveil an important role played by insurance companies as investors in the CLO market, contributing to the expansion of corporate loan securitization observed in the last decade.

Becker et al. (2022) study the effect of the 2009-2010 capital regulatory reform on insurance companies' propensity to purchase mortgage-backed securities. We show that, while the extension of that reform to CLO holdings reinforced insurers' incentives to search for yield with CLOs, these incentives were at work even prior to the reform and depended crucially on the ratings-based framework of capital requirements. In addition, our work takes one step forward exploring how insurers' appetite for CLOs affected the design of CLOs.

Our paper is also related to studies of the growth of corporate loan securitization (Ivashina and Scharfstein, 2010; Wang and Xia, 2010; Shivdasani and Wang, 2011; Benmelech et al., 2012; Nadauld and Weisbach, 2012; Bord and Santos, 2015; Ivashina and Vallée, 2020), and studies of returns to investors in CLO equity tranches (Fabozzi et al., 2021; Cordell et al., 2022). Our paper expands this literature by documenting the role of insurance companies as investors in CLOs.[5] We expand the former studies by showing that, as of 2019, insurance companies account for about half of the investor base of CLO mezzanine tranches rated investment grade, contributing substantially to the demand of mezzanine tranches which is crucial in the origination process of CLOs as it allows for the creation of the highly sought triple-A tranches. We expand Cordell et al. (2022), who show that CLO equity tranches earn abnormal risk-adjusted returns,

[5]Foley-Fisher et al. (2023) document the increasing participation of insurance companies as CLO issuers through their affiliated asset managers. Bhardwaj et al. (2023) in turn provide some evidence that when insurance companies' operating cashflow increases they raise their CLO investments.

by documenting that insurance companies' strong demand for mezzanine debt tranches is a contributing factor for the abnormal returns that the CLO equity holders enjoy.

Lastly, our paper is related to the literature on the search for yield incentives during protracted periods of low interest rates. Most of the studies so far, including Peydro and Maddaloni (2011), Jimenez et al. (2014), Ioannidou et al. (2015), Dell'Ariccia et al. (2017), and Paligorova and Santos (2017) focused on banks. Our paper adds to this literature by uncovering a link between low interest rates and insurance companies' search for yield.[6]

The rest of our paper is organized as follows. Section 2 describes insurance companies' capital regulation, and lays out the hypotheses we investigate. Section 3 describes our data sources and characterizes our sample. Section 4 presents the results of our investigation of insurance companies' search for yield in the CLO and corporate bond markets. Section 5 discusses how insurers' search for yield behavior translated into a preference for CLOs over corporate bonds. Section 6 presents evidence from the CLO market from insurance companies' preference for CLOs. Section 7 concludes the paper.

2 Hypotheses: Insurance Companies' Preference for CLOs

2.1 Insurance Companies' Investments Over Time

Insurance companies are known for investing in corporate bonds and loans, (Becker and Ivashina, 2015) and (Bord and Santos, 2012), respectively. What is perhaps less understood is their increasing preference for CLOs, (Figure 2). Between 2009 and 2019, insurance companies' investments in corporate bonds went from \$1,143B to \$1,784B (a 56% increase) and their investments in loans went from \$18B to \$42B (a 132% increase). In the case of CLOs, their investments went from \$13B to \$125B, a 863% increase.

[6]Liu (2019) investigates how a decrease in insurers' cost of equity affects their underwriting growth and investment risk. Our work explores, instead, insurers' search for yield incentives conditional on the capital requirement (and, hence, the cost of capital) associated to a given security held in portfolio.

Further, insurance companies showed a clear preference for the mezzanine tranches (rated Aa, A or Baa) over the safest triple-A rated tranche. In 2011, 56% of their CLO investments were in triple-A rated tranches while 40% were in mezzanine tranches rated investment grade. By 2019, the former had declined to 44% while the latter had risen to 52%. For comparison, over the same time period the rating composition of insurance companies' bond investments remained mostly unchanged, with 80% invested in bonds rated single A or Baa.[7]

Insurance companies' increasing preference for mezzanine tranches has potentially relevant implications for the CLO market. Insurers' market share of CLO tranches moved from 4% in 2003 to 19% in 2019 (Figure 3).[8] This growth was mostly driven by investments in mezzanine tranches Aa, A or Baa rated, whose aggregate market share went from 5% in 2009 to 44% in 2019 (Figure 4).[9] Further, these tranches correspond, on average, to 22% of a CLO deal at issuance (triple-A tranches represent 62%, with junior tranches accounting for the remaining 16%). Interestingly, the rise in insurance companies' investment in mezannine tranches coincided with a rise in the average share of mezzanine tranches in CLO deals (Figure 5).

Differences in the yields of CLO tranches and bonds likely played a role in insurance companies' growing preference for CLOs' mezannine tranches. In the post-crisis decade, yields on CLO tranches rated investment grade yields were systematically higher than yields on equally rated bonds (Figure 6). These differences alone, however, do not explain insurance companies' growing preference for CLOs' mezzanine tranches. As we argue next, that preference derives from three features of their capital regulation.

[7]Limited availability of information on credit ratings assigned to bank loans prevents us from decomposing the time series of loan investments across rating categories.

[8]By contrast, insurance companies' market share of corporate bonds declined from 21% in 2003 to 18% in 2019. This downward trend is common across bonds rated Aa and below, whilst the market share of triple-A bonds remained at around 6% (Figure 4).

[9]Our estimates represent a lower bound because of the conservative approach we adopted to identify CLO tranches (see section 3). Indeed, DeMarco et al. (2020) estimate that domestic insurance companies held approximately 60% of Cayman-issued U.S. CLO tranches Aa, A or Baa rated in 2018. According to Liu and Schmidt-Eisenlohr (2019), Cayman-issued U.S. CLOs represent approximately 74% of total U.S. CLO securities in 2018.

2.2 Insurance Companies' Capital Regulation

The first feature is the absence of a strictly increasing relationship between capital requirements and asset risk. Capital requirements for fixed income investments are calculated as a weighted sum of the book value of these investments, with weights equal to a risk-based capital charge that captures the credit risk of each asset.[10] The capital charge is defined for six buckets of assets' credit quality named "NAIC designations" (NAIC, 2018, 2020) until June 2021, when a regulatory reform broke down those six buckets into 20 sub-brackets. Insurance companies assign the NAIC designation according to a mapping from credit ratings (Table 1). During our sample period (2003-2019), securities rated Aaa, Aa or A received the NAIC 1 designation and were subject to a (post-tax) risk-based capital charge of 0.3%. Lower credit ratings were associated with higher NAIC designations and risk-based capital weights. While the NAIC 1 designation is mapped to three different credit ratings (Aaa, Aa, A), all of the other NAIC categories are associated to a unique rating. This design requires insurance companies to set aside the same amount of capital for a subset of investments carrying different yields and exposing them to different levels of credit risk (those rated Aaa, Aa, A).

The second feature of insurance companies' capital regulation that likely played a role on their preference for CLOs is the equal treatment the regulation gives to debt securities with the same credit rating. The reason is that CLO tranches, other than those rated triple A, usually carry higher yields than equally rated corporate bonds.

The third feature is the regulatory change implemented after the Great recession. The mapping presented in Table 1 was in effect during our sample period, except for MBS and CLOs starting in 2009 and 2010, respectively. In 2009, the NAIC changed the capital requirements for residential MBS to provide relief to the insurance industry following the wave of downgrades in MBS during the subprime crisis (Becker et al., 2022; NAIC, 2021). The new regulation was extended to commercial MBS and CLO

[10] Appendix B of the Internet Appendix provides a broad overview on insurers' capital regulation.

investments in 2010 (Foley-Fisher et al., 2023), although the capital requirements for CLOs and MBS under the new regime were substantially different (NAIC, 2017).

The new framework introduced the so-called "modified filing exempt", MFE, method, which allowed insurers to assign CLO tranches purchased at discount or highly impaired a lower NAIC designation than that implied by the rating-based system of Table 1.[11] This regulatory regime remained in place until the reporting year 2018 (NAIC, 2019b). Starting in 2019, the ratings-based approach of Table 1 was restored.

Insurance companies appear to have exploited the regulatory reform to reduce capital charges associated with their CLO investments. Insurance companies were required to report separately the volume of CLO investments in the NAIC 1 category that would be in a different NAIC designation absent of the MFE approach. As we can see from Figure 7, the percentage of NAIC 1 CLO investments acquired under the MFE approach is indeed different from zero during the time period where the reform was in place (2010-2018) and reached its peak of 15% in 2015.

2.3 Hypotheses

We build on the features of the capital regulation discussed above to specify the three hypotheses which we investigate, starting with insurance companies' preference for higher yielding securities, then going onto their preference for CLO investments, in particular mezzannine tranches, and culminating with their impact on the CLO market.

The six-bucket designation system used in the insurance companies' capital regulation implies that the relationship between asset risk and cost of capital is a step function and, hence, not strictly increasing. Similar to Becker and Ivashina (2015) conjecture on insurance companies' corporate bond investments, this leads us to conjecture that insurers have incentives to maximize the return on their investments both in the bond and the CLO market i.e., to search for yield.

[11] Appendix B.1 of the Internet Appendix describes in detail the 2010 regulatory reform.

Hypothesis 1: Insurance companies have an incentive to invest in higher yielding securities (CLO tranches and corporate bonds) within a NAIC designation bucket.

The capital regulatory framework of insurance companies does not distinguish CLO tranches from corporate bonds with the same rating. However, as we document, CLO tranches, other than the triple-A tranche, carry higher yields than corporate bonds with the same credit rating. This gives us our second hypothesis.

Hypothesis 2: Insurance companies have a preference for CLO mezzanine tranches (those rated Aa, A and Baa) over corporate bonds with the same credit rating.[12]

The modified regulatory regime applied to CLOs in 2010-2018 altered the relationship between asset risk and cost of capital implied by the rating-based mapping, particularly for the risky tranches which are more likely to be downgraded, bear a loss, or be purchased at discount. Since the regulatory reform applied to both legacy and new investments in CLOs, it likely further tilted insurance companies' preferences for CLOs. We capitalize on this reform to consider two variants of our Hypotheses 1 and 2 where we postulate that insurance companies' search for yield and preference for CLO tranches (relative to bonds), respectively, increased after the 2010 regulatory reform.

Our last hypothesis is about the impact of insurance companies in the market for CLOs. Banks, the major investor in the CLO market, have strong disincentives to invest in CLO tranches that are not rated triple-A. Yet, those tranches are critical for the creation of banks' favored triple-A tranches. Given insurance companies' preference for the CLO mezzanine tranches we hypothesize they had an impact on the CLO market.

Hypothesis 3: CLO deals in which insurance companies invest more heavily have a (1) larger fraction of mezzanine tranches (rated investment grade); (2) riskier pool of underlying collateral loans; and (3) and their equity tranches earn higher risk-adjusted

[12]We focus on mezzanine tranches above investment grade because insurance companies usually do not invest in below-grade rated securities.

returns.

3 Data Sources and Sample Characterization

3.1 Data Sources

Our main data source is "Schedule D-Part 1" of the annual financial statement filings of life, P&C and health insurance companies submitted to the NAIC during 2003-2019. That schedule includes information at the security level on virtually all fixed-income holdings of insurance companies as of December 31 of each year. Schedule D reports for each security investment: the par value, book value, purchase cost, nominal interest rate, effective yield, NAIC designation, purchase date, and maturity date.

Given that Schedule D does not identify all types of securities (with the exception of loans in 2018 and 2019), we rely on a suite of matching exercises and textual analysis to identify CLOs, corporate bonds, and bank loans. We rely on Moody's Analytics Structured Finance Portal and Mergent Fixed Income Securities Database (FISD) to identify CLO and corporate bond holdings, respectively. We also attempted to identify corporate loans but opted for not including these in our study because loans often lack a unique identifier across data sets/providers, and we had access to limited information on outstanding volumes and loan credit ratings.

We complement our data on insurance companies' asset holdings with data on CLO tranches, corporate bonds, and insurers' financial conditions. We get data on CLO tranches from Moody's Analytics Structured Finance Portal. We are able to match this data using cusips for 99.8% of all insurers' holdings identified as CLOs. Our information on CLO tranches is available up to the beginning of November 2019 and, therefore, does not cover the full year of 2019. Also, we have the entire rating history only for a subset of tranches that are rated by Moody's (63% of all CLO tranches in our sample). For the remaining tranches, information on ratings (from Standard's & Poors and Fitch)

is available only at issuance. In this case we assume these tranches do not experience a change in credit rating throughout their life.[13] We also rely on Moody's Analytics Structured Finance Portal to get data on the structure of CLO deals.

We get data on corporate bonds from Mergent Fixed Income Securities Database (FISD) and Moody's. Lastly, we obtain information on the balance sheet and income statement of insurance companies from SNL financial.

3.2 Sample Characterization

Our sample comes from the fixed-income holdings of 5,685 life, P&C and health insurance companies between 2003 and 2019. The full portfolio of securities of these companies over that time period contains 16,620,911 observations. Life and P&C insurers each account for about 45% of these observations, whereas health insurance companies account for the remaining 11% observations. After we restrict to investments in CLOs and corporate bonds, we are left with 6,402,355 observations of which 129,440 are in CLOs. After we aggregate investments that insurance companies report in the same security in a given year we are left with 6,264,562 observations of which 128,917 are in CLOs.[14]

In the econometric analysis presented in section 4 and section 5, we restrict our sample to first-time investments of insurers in CLOs and corporate bonds, i.e., we keep only the observations corresponding to the year in which the original purchase of the asset took place. We do this because insurance companies make most of their investments when securities are first issued. This leaves us with a panel of 1,714,609 observations, with 57,507 pertaining to CLOs. Panel A of Table 2 reports summary statistics of the continuous variables used in the empirical analysis performed on this dataset.

Finally, our sample on the structure of CLOs which we use in section 6 con-

[13] We observe rating changes only for 16% of tranches rated by Moody's and most of the changes (downgrades and subsequent upgrades) occurred in 2009 and 2011. This is consistent with Griffin and Nickerson (2021), who documents that credit agency actions on CLO tranches are very limited even during the covid-19 shock.

[14] We aggregate these observations at the security-company-year level by summing up the par value, book value and actual cost of the investments, averaging the interest rate, and calculating a weighted average yield with weights equal to the par value of each investment.

tains information at the time of issuance for 2,211 USD deals issued between 2003 and 2019. We complement this data with (annual) information on (i) outstanding balance, (ii) refinancing and (iii) payments to holders of the equity tranche of these CLO deals throughout their lifetime. Panel B of Table 2 reports summary statistics of the continuous variables pertaining to the empirical analysis performed on this dataset.

4 Insurance Companies' Search for Yield

In this section, we begin by investigating insurance companies' incentives to invest in higher yielding securities (CLO tranches and bonds) within a NAIC designation bucket (Hypothesis 1). Next, we investigate the potential role of the 2010 regulatory reform on insurance companies' search for yield incentives. We finish the section with a discussion of some robustness tests.

4.1 Insurance Companies' Preference for higher yielding securities

We start our empirical analysis of Hypothesis 1 with a graphical inspection of insurance companies' investments.[15] Figure 8 shows the time series of insurers' new CLOs holdings that fall into the highest credit quality designation (NAIC 1) as a percentage of the total volume outstanding of these tranches based on percentiles of the distribution of CLOs yields for each year. Yields represent the effective rate of return on the investment in a given security as reported by the insurance company.

In line with Hypothesis 1, there is a clear preference for the riskiest tranches within NAIC 1. The search for yield behavior in CLOs pertaining to the NAIC 1 bucket is very pronounced both in the pre-crisis period, when interest rates were relatively high, and in the post-crisis period, when short-term interest rates were close to the zero lower bound. In 2003-2006, the market share of CLO tranches with yields above the 66th

[15]We restrict our sample to first-time investments of each insurance company in a given security because, for example, the share of a CLO tranche that an insurance company owns may vary due to refinancing or changes in the outstanding balance of the CLO (e.g., amortization of principal).

percentile is 25 to 40 percentage points higher than that of tranches with yields in the bottom tercile, whilst from 2011 onward the gap between the extreme buckets ranges from 10 to 35 percentage points. The compression of the three market shares in 2007-2010 is hardly surprising given the CLO market freeze during the financial crisis (Figure 1). Note that the three market shares experience a drop in 2019, after the regulatory reform of 2010 was repealed.

We obtain a similar picture when we look at tranche ratings rather than yields (Figure 9). In this case, the market share of mezzanine tranches in NAIC 1, that is those rated Aa and single A, is consistently above that of triple-A tranche, except for the financial crisis when the three market shares overlap.

Insurance companies' reach for yield within the NAIC 1 bucket seems to be more prevalent within CLOs than bonds (Figure 8-9). As we noted above, the market share of CLO tranches with yields above the 66th percentile is 10 to 40 percentage points higher than that of tranches with yields in the bottom tercile throughout our sample period. By contrast, the difference in the market share of corporate bonds with yields above the 66th percentile and yields below the 33th percentile does not exceed 10 percentage points. This was expected given that yields of CLO tranches are more disperse than corporate bonds' yields, especially in the NAIC 1 designation bucket, thereby creating better opportunities to search for yield (Figure 10).[16]

Next, We test formally our Hypothesis 1 by estimating the following baseline econometric model:

$$\begin{aligned}\frac{Holdings_{sct} \times 100}{Outstanding\ amount_{st}} =& \alpha + \beta_1 Yield_{sct} + \beta_2 Time\ to\ maturity_{sct} \\ &+ \beta_3 Outstanding\ amount_{st} + \mu_{d(s),t} \\ &+ \mu_{c,t} + \mu_{a(s)} + \mu_{l(c)} + \varepsilon\end{aligned} \tag{1}$$

[16]Both the standard deviation of yields and the difference in yields between triple-A and single-A securities is significantly larger for CLO tranches compared to corporate bonds reported in the NAIC 1 designation.

where the dependent variable is the amount held by insurance company c in security s with NAIC designation d in year t when the insurer makes its first investment in that security, $Holdings_{sct}$, as a percentage of the volume outstanding of security s at year-end t, $Outstanding\ amount_{st}$. The key variable of interest is $Yield_{sct}$, the yield of security s reported by company c in year t. We expect the coefficient on this variable, β_1, to be positive, in line with the premise that insurers invest more heavily in securities offering higher yields within a NAIC category.

We attempt to identify that effect controlling for the time to maturity of the security in years, $Time\ to\ maturity_{sct}$, and the volume outstanding of security s at issuance, $Outstanding\ amount_s$. These allow us to disentangle search for yield from time and issue size preferences of insurance companies. Importantly, we include NAIC designation-year fixed effects, $\mu_{d(s),t}$, to investigate reach for yield within each bucket of risk-based capital charges. Finally, we saturate our model with: company-year fixed effects, $\mu_{c,t}$, to control for company-specific time varying and time invariant conditions that may affect insurers' incentives to invest in a given security; type of asset (CLO or corporate bond) fixed effects, $\mu_{a(s)}$, to account for asset-specific characteristics that may affect insurers' preference for a security class; and line of business fixed effects, $\mu_{l(c)}$, to control for differences in the business model of life, P&C and health insurance companies which may impact their investment choices. Standard errors are clustered at the company level and year level (two-way clustering).[17]

Table 3 reports the results of model 1. The first column reports the estimates of our baseline model. The coefficient on $Yield_{st}$ is positive and highly statistically significant, corroborating the hypothesis that insurance companies invest more in securities with higher yields within a NAIC designation. An increase in the yield by one standard deviation (2.14 percentage points in the subsample where this regression is estimated) implies a 14 basis points increase in insurers' holding share, which is somewhat above the

[17]We select the proper clustering level following Petersen (2009), Cameron et al. (2011), and Cameron and Miller (2015).

median holding share (0.12). The median outstanding volume of CLOs and corporate bonds in the subsample portfolio where we estimate the model is $650 million. Thus, a 14 basis points increase in the holding share of an insurer corresponds to an additional investment of $93 million for the median security in the portfolio.

In columns 2 and 3 we replace company-year fixed effects with a set of company-specific controls. These include size (natural logarithm of total admitted assets), ROE (net income to total adjusted capital), capital ratio (total adjusted capital to total admitted assets), and either CAL risk-based capital ratio (column 2) or ACL risk-based capital ratio (column 3).[18] While the ACL risk-based capital ratio captures the distance from the minimum capital requirement that insurance companies must comply with to run their business, the CAL risk-based capital ratio captures the distance from the first capital threshold that triggers oversight actions from insurance regulators. We lose 40,688 observations (out of 1,691,393) in columns 2 and 3 due to missing information on financial metrics for some insurers that are covered in the holding data starting in 2019 but are not covered in the SNL Financial's data. Irrespective of the risk-based capital ratio used, the yield's coefficient is very close to that of the baseline regression but somewhat larger.

Column 4 extends our baseline specification to include issuer fixed effects to account for insurance companies' preference towards certain issuers. These fixed effects are largely collinear with the security type fixed effects, as no CLO issuer is also a corporate bond issuer and vice versa. Thus, not surprisingly, this regression delivers results which are virtually the same to those of the baseline model.

Finally, in column 5 we take a first look at insurers' relative incentives to search for yield within CLOs vs. corporate bonds conditional on each NAIC bucket. The coefficient of the CLO dummy suggests that, ceteris paribus, insurance companies hold a higher share of CLO tranches compared to corporate bonds. More importantly, and

[18]Similar to Koijen and Yogo (2015), we use total adjusted capital as a measure of insurers' equity.

in line with the investment patterns depicted in Figures 8 and 9, the search for yield behavior of insurers appears to be relatively more pronounced in the CLO asset class. The positive and statistically significant coefficient of the interaction term between the yield and the CLO dummy indicates that a one standard deviation increase in the yield (2.14 percentage points in the subsample where this regression is estimated) implies an increase in the holding share of CLO tranches in a given NAIC bucket that is 2.38 percentage points higher than that of corporate bonds. This result reveals that insurance companies have better opportunities to search for yield within the CLO space given the evidence we presented above on the larger dispersion of the yields within CLO tranches compared to corporate bonds (Figure 10). We investigate this hypothesis thoroughly in the next section.

Overall, the results presented above confirm Hypothesis 1 that the design of the insurance sector's capital regulation for asset risk with discontinuous buckets of capital charges generates incentives for insurers to search for yield both in the CLO and corporate bond market segments.

4.2 Importance of the 2010 regulatory reform

As we discussed in section 2, the 2010 regulatory reform allowed insurance companies to assign CLO tranches purchased at discount or highly impaired a lower NAIC designation than the one obtained according to the rating mapping of Table 1. For example, the percentage of NAIC 1 CLO investments that would have been in another NAIC designation absent of the reform is positive between 2010 and 2018, with a peak of 15% in 2015 (Figure 7). This likely increased insurers' incentives to reach for yield within the CLO asset class during the time period the reform was in place (2010-2018). To investigate this hypothesis we include a triple interaction between the yield, the CLO dummy and a dummy equal to one if the year falls into the 2010-2018 time period. As we can see from column 1 of Table 4, the coefficient of the triple interaction is positive

and statistically significant confirming that after the 2010 regulatory reform insurance companies increased their investments in CLOs relative to bonds within NAIC buckets.

We capitalize on the 2010 reform to do the following additional test. Given that the reform implied a positive and presumably exogenous shock to some insurers, i.e. those that had CLO tranches at the end of 2009 that could be assigned a lower NAIC designation following the reform, we hypothesize that these insurance companies have an additional incentive to invest in riskier assets following the reform.

Column 2 of Table 4 tests that hypothesis in a diff-in-diff setup. The treatment and control groups are formed by insurance companies that, based on their CLO holdings at year-end 2009, stood to benefit or not from the 2010 reform, respectively. The positive and statistically significant coefficient of the triple interaction confirms that insurers that benefit from the 2010 reform are more prone to search for yield following the implementation of the reform. As for the validity of our diff-in-diff approach, we present some graphical evidence comparing holdings of CLOs with a given credit quality of treated and control insurers before and after 2010. Figure 11 plots the time series of the estimated coefficients of a linear model where we regress the aggregate volume of CLO tranches held by insurance companies at the time of their first investment in the CLO tranche as a percentage of the total volume outstanding of these tranches by NAIC designation buckets on year dummies and NAIC designation fixed-effects for the treated and the control groups. The parallel trend assumption is satisfied prior to the reform, whereas after 2010 affected insurers appear to purchase a higher portion of CLOs.

4.2.1 Other robustness tests

In Appendix C of the Internet Appendix to our paper, we carry out three additional robustness tests. First, we explore differences in insurers' search for yield over time. This is important because our sample period (2003-2019) encompasses a protracted period of low interest rates, which has been linked to increased risk-taking by the banking

industry.[19] Our results show that insurance companies searched for yield both in the pre-crisis period (when interest rates were relatively high) and in the post-crisis period (when interest rates were relatively low), but this behavior is stronger during the latter time period.

Second, we investigate the heterogeneity in insurers' search for yield behavior across their capital standards. In the banking literature, well capitalized banks are believed to be less prone to take on risk.[20] Therefore, we expect stronger evidence of search for yield among insurers with lower capital ratios.[21] Irrespective of the capitalization metric adopted (capital ratio, CAL RBC ratio, and ACL RBC), we find that insurance companies with a lower capital ratio, or closer to the minimum capital requirement, are more prone to search for yield.

Finally, we investigate the search for yield heterogeneity across P&C companies, the insurers in our sample more exposed to natural disasters. Specifically, we investigate whether P&C insurers that were hard hit by disaster events, as captured by the yearly change in their net income, search for yield more aggressive in 2005 and 2017 relative to less affected companies.[22] Insurance companies experiencing higher losses may try to boost their net income by investing in securities offering higher returns. Indeed, the only two years when poorly performing insurance companies search for yield more actively is in 2005 and 2017, the two years in our sample period with record losses from natural disasters. This finding corroborates our previous results on low-capital, adding support to our evidence that insurance companies search for yield in both corporate

[19] See, for example, Altunbas et al. (2014), Peydro and Maddaloni (2011), Dell'Ariccia et al. (2017), Jimenez et al. (2014), Ioannidou et al. (2015) and Paligorova and Santos (2019).

[20] Repullo (2000) shows this link in a model where capital is used as a cushion against adverse contingencies, and Jimenez et al. (2014) and Dell'Ariccia et al. (2017) find evidence consistent with this insight.

[21] Of course this builds on the assumption that the banking insight applies to insurance companies. It is also worth noting that, even within the banking literature, there are different views on the impact of capital on banks' risk taking incentives (e.g. Rochet (1992)).

[22] The aggregate value of nationwide property damage peaked in 2005 and 2017, reaching almost $100B in both years and implying significant insured losses. In 2005, hurricane Katrina caused large-scale devastation in the Gulf Coast region, and 2017 saw a devastating hurricane season with hurricanes Harvey, Irma and Maria and an unprecedented break out of wildfires in Northern California.

bonds and CLO tranches. In the next section, we go a step further and investigate whether regulation tilts insurance companies' preference for searching for yield using CLOs over corporate bonds (Hypothesis 2).

5 Insurance Companies' Preference for CLOs over Bonds

As we discussed in Section 2, insurance companies' capital requirements treat CLO and corporate bond investments alike. However, Figure 6 shows that the average yield on insurers' investments in CLOs is higher than the yield on insurers' investments in corporate bonds for all rating categories, except the triple-A, starting in 2005.[23] In addition, as we noted earlier, insurance companies hold mainly investment grade CLOs and corporate bonds. This lead us to our Hypothesis 2, that insurance companies have a preference for CLO mezzanine tranches rated Baa and above over corporate bonds with the same credit rating.

We investigate this prediction in this section, starting with a granular comparison of the yields on CLO tranches and corporate bonds. To this end, we estimate the following model:

$$\begin{aligned} Yield_{sct} =& \alpha + \beta_1 dummy\ CLO_s + \beta_2 Time\ to\ maturity_{sct} \\ &+ \beta_3 Outstanding\ amount_{st} + \mu_{r(s),t} + \mu_{c,t} + \mu_{l(c)} + \varepsilon \end{aligned} \tag{2}$$

where $Yield_{sct}$ is the yield of security s with rating r reported by company c at time t and $\mu_{r(s),t}$ stands for rating-year fixed effects. We estimate the model on the subsample of insurers' first time investments in CLO tranches and corporate bonds rated Aaa, Aa, A and Baa. Column 1 of Table 5 reports the estimate of this regression. We find a positive and statistically significant coefficient for the CLO dummy, indicating that, on

[23] Using the effective interest rate reported by insurance companies on CLO and bond investments acquired at the same time, ensures that our comparison is reliable despite the different type of coupon (fixed versus floating) of the two asset classes. Also, our results are in line with the evidence presented by Cordell et al. (2022), who show that CLO tranches have higher returns than corporate bonds even after accounting for the different duration between the two asset classes.

average, the yield on insurers' new investments in CLOs is 0.7 percentage points higher than the yield on new investments in corporate bonds with the same rating. When we interact the CLO dummy with the rating in model 2, we find that the difference in yields between the two asset classes is statistically significant only for securities rated Aa and below. Importantly, this difference increases monotonically from 0.5 percentage points for the Aa rating class to 1.6 percentage points for the Baa rating class.

A natural question is why securities with the same credit rating offer different yields, conditional on their size and time-to-maturity. Cordell et al. (2022) suggest that CLO tranches may have a different risk-profile than corporate bonds due to the embedded prepayment option (which only applies to some corporate bonds), and lower liquidity in bad times. Nickerson and Griffin (2017), in turn, provide evidence of inflated ratings given to CLO tranches reflecting an underestimation of default correlation. To the extent that some of the yield difference derives from a difference in default risk this will likely give insurance companies a preference for CLO tranches over corporate bonds given that both securities receive the same treatment under their capital regulation. We investigate this hypothesis next, starting with the following econometric specification:

$$\begin{aligned}\frac{Holdings_{cst} \times 100}{Outstanding\ amount_{st}} =& \alpha + \beta_1 dummy\ CLO_s + \beta_2 Time\ to\ maturity_{st} \\ &+ \beta_3 Outstanding\ amount_{st} + \mu_{r(s),t} \\ &+ \mu_{c,t} + \mu_{l(c)} + \varepsilon\end{aligned} \tag{3}$$

where the dependent variable is the amount held by insurer c in the security s with rating r at time t (when the insurer makes its first investment in the security) as a percentage of the volume outstanding of the security in that year.

Columns 3-4 of Table 5 show the results of this exercise. The large and highly significant coefficient of the CLO dummy in column 3 confirms that insurance companies have a strong preference for CLOs over corporate bonds with the same credit rating. Consistent with the evidence presented in column 2, this preference increases with risk,

i.e. as the difference in yields between CLOs and corporate bonds widens (column 4).

Next, we relate insurance companies' preference for CLOs over corporate bonds to the difference in yields between the two asset classes. To that end, we extend model 3 by interacting the CLO dummy with the CLO-bond yields ratio to estimate the following type of regression:

$$\begin{aligned}\frac{Holdings_{cst} \times 100}{Outstanding\ amount_{st}} =& \alpha + \beta_1 dummy\ CLO_s + \beta_2 \frac{Yield\ CLOs_{rt}}{Yield\ bonds_{rt}} \\ &+ \beta_3 dummy\ CLO_s \times \frac{Yield\ CLOs_{rt}}{Yield\ bonds_{rt}} \\ &+ \beta_4 Time\ to\ maturity_{st} + \beta_5 Outstanding\ amount_{st} \\ &+ \mu_{r(s)} + \mu_{c,t} + \mu_{l(c)} + \varepsilon\end{aligned} \tag{4}$$

where $\frac{Yield\ CLOs_{rt}}{Yield\ bonds_{rt}}$ is the yields ratio. Column 5 of Table 5 reports the result of this model. The interaction between the yields ratio and the CLO dummy is positive and statistically significant, indicating that insurance companies purchase a larger portion of CLO tranches compared to corporate bonds the larger is the difference between the yields on CLO investments and the yields on bond investments within a given rating.

5.1 The 2010 reform and insurance companies' preference for CLOs

Following the approach we adopted in the previous section, we investigate whether insurers' relative preference for CLOs further increased with the passage of the 2010 reform.[24] The results of this exercise are reported in Table 6.

The positive and statistically significant coefficient of the triple interaction of the CLO dummy with the reform dummy and the yields ratio in Column 1 suggests that insurance companies' response to the yields ratio is more pronounced after the 2010 regulatory reform. In addition, insurers that stood to benefit more from the reform exhibit

[24]We have also investigated how the effect of insurance companies' capitalization interacts with the yields ratio. While the simple capital ratio does not imply any differential effect, we find that firms closer to the minimum capital requirements are more sensitive to the yields ratio when deciding the extent of their investments in CLO tranches vis-à-vis corporate bonds with the same rating, further suggesting that higher leverage brings stronger incentives to search for yield.

a stronger preference for CLO tranches vis-à-vis corporate bonds compared to other insurers in the post-2009 period, albeit being less sensitive to the yields ratio (column 2). Together, these results add further support to our thesis that the design of the capital regulation has tilted insurance companies' preferences towards CLO investments.

5.2 Insurance sector preference for CLOs: Aggregate results

The evidence documented in Table 5 showing insurance companies' preference for CLO tranches over corporate bonds was unveiled on models estimated at the security-company-year level. A natural question to ask is whether this finding is also present at an aggregated level. We investigate this question next.

As a first step, we consolidate securities holdings at the insurer-asset class-rating-year level.[25] To that end, we aggregate up the data at the security-company-year level so that we can calculate the volume of insurers' first-time investments in CLOs (or corporate bonds) as a percentage of the total volume outstanding of these securities within a given rating category and a specific year.[26] Next, and following our security-level analysis, we estimate the following model at insurance company level:

$$\begin{aligned}\frac{Holdings_{arct} \times 100}{Outstanding\ amount_{art}} =& \alpha + \beta_1 dummy\ CLO_a + \beta_2 Time\ to\ maturity_{arct} \\ &+ \beta_3 Outstanding\ amount_{art} + \boldsymbol{X'_{ct}}\beta_{\mathbf{4}} + \mu_r \\ &+ \mu_c + \mu_{l(c)} + \varepsilon\end{aligned} \tag{5}$$

where the dependent variable is the amount of first-time investments by company c in the asset class a (CLO tranches or corporate bonds) with rating r in year t as a percentage of the total volume outstanding of the asset class with that rating in that year. The key variable of interest is the CLO dummy variable $dummy\ CLO_a$. $Time\ to\ maturity_{arct}$

[25] Using this level of aggregation rather than the security-level is also important to reduce the mechanic impact from the rise in the number of insurance companies investing in CLOs over time.

[26] By construction, this dataset includes observations pertaining to insurers' "zero investments" in a given asset class-rating category. For example, if a company does not hold any CLO tranche rated Baa in a given year, the percentage of Baa-rated CLOs held by that company in that year is reported with a value of zero.

is the average time-to-maturity of all new investments by insurer c in the asset class a with rating r in year t, X'_{ct} is a set of firm controls, and $\mu_{r(a)}$ are rating fixed effects.

The results of this exercise are reported in Table 7. As expected, the coefficient of the CLO dummy in column 1 is positive and statistically significant, confirming that insurance companies acquire a larger fraction of CLOs compared to corporate bonds. In column 2, we investigate insurance companies' relative investment preferences following the 2010 regulatory reform. To that end, we interact the CLO dummy with a dummy identifying the time period in which the 2010 regulatory reform was into effect (2010-2018). In line with our prior findings, the new results show that insurers' preference for CLOs over corporate bonds is concentrated during the period in which the new regulatory regime was in place.

Up to this point, we have investigated insurers' preference for CLO tranches vis-à-vis corporate bonds focusing on the amount of new investments in CLOs and corporate bonds by insurance companies in proportion to the total volume outstanding of these two asset classes. An alternative and, perhaps, more intuitive way to explore the preference of insurers for one asset type versus the other would be to look at the the amount of, e.g., new investments in CLOs as a percentage of the total new investments in CLOs and corporate bonds made by insurance companies. We implement this alternative approach, by estimating the following econometric specification:

$$\begin{aligned}\frac{\textit{CLO holdings}_{rct} \times 100}{\textit{Total holdings}_{rct}} =& \alpha + \beta_1 \frac{\textit{Yield CLOs}_{rt}}{\textit{Yield Bonds}_{rt}} + \beta_2 \frac{\textit{CLOs Outstanding amt}_{rt}}{\textit{Bonds Outstanding amt}_{rt}} \\ &+ \boldsymbol{X'_{ct}\beta_3} + \mu_r + \mu_c + \mu_{l(c)} + \mu_t + \varepsilon\end{aligned} \tag{6}$$

where the dependent variable is the amount of first-time investments by company c in CLO tranches with rating r in year t as a percentage of the total volume of new investments in CLOs and corporate bonds with that rating in that year. The key variable of interest is the yields ratio, $\frac{\textit{Yield CLOs}_{rt}}{\textit{Yield bonds}_{rt}}$. $\frac{\textit{CLOs Outstanding amt}_{rt}}{\textit{Bonds Outstanding amt}_{rt}}$ is the ratio of the total outstanding amount of CLO tranches with rating r in year t to the total outstanding

amount of corporate bonds with rating r in year t.

Column 3 of Table 7 reports the estimates of this model. The coefficient of the yields ratio is positive and statistically significant, indicating that insurance companies direct a larger portion of their new investments within a given rating class towards CLOs the higher is the yields ratio.[27] Following our previous exercises, in column 5 we investigate the effect of the 2010 regulatory reform. To that end, we split our sample into the time period where the 2010 regulatory reform period was in place (2010-2018) and the remaining of the sample. Contrary to our prior evidence, we do not find a statistically significant difference in the asset allocation of insurers' portfolio between CLOs and corporate bonds following the 2010 reform, possibly because it took some time until insurers' preference for CLOs over corporate bonds tilted significantly their portfolio allocation.

In Appendix E of the Internet Appendix to our paper, we present two additional tests. First, we investigate how insurance companies' preferences for CLOs over corporate bonds varies with insurance companies' capital standards. We show that firms closer to the minimum capital requirements are more responsive to the yields ratio when deciding to invest in CLO tranches vis-à-vis corporate bonds with the same rating.

Second, we examine the sensitivity of insurers' preference for CLOs over corporate bonds to the yields ratio over time. We find that up to 2008, when CLO tranches carried lower yields than corporate bonds for most buckets of credit rating, insurance companies purchased a lower portion of CLO tranches compared to corporate bond with the same rating. However, as soon as CLO yields became larger than corporate bond yields during the financial crisis, insurers' preference flipped leaning towards CLOs rather than corporate bonds and became progressively stronger in the post-crisis decade.

[27]Before the crisis, insurance companies that invested in CLOs tended to be large. As the time went by, a progressively higher fraction of smaller insurance companies began investing in CLOs. To rule out concerns that are findings are driven by new entrants, which may not be influential investors, we re-estimated column 3 on the subsample of insurance companies that invest in CLO tranches both in the 2003-2008 time period and in the post-crisis decade (2009-2019). The coefficient of the yields ratio remained highly significant and, if anything, increases in magnitude. This suggests that the largest and more sophisticated insurers are actually the main drivers of the shift from corporate bonds to CLOs investments observed in the insurance industry.

In sum, the results we reported in this section provide supporting evidence for Hypothesis 2 that capital regulation's similar treatment of corporate bonds and CLO tranches gave insurance companies an incentive to invest in the latter, in particular the CLO mezzanine tranches rated investment grade. In the next section, we investigate to what extent these insurance companies' preferences affected the market for CLOs.

6 Implications of Insurance Companies' Preference for CLOs

In this section we investigate to what extent insurance companies' preference for CLOs has had an effect in the CLO market. Specifically, we investigate to what extent they have affected the capital structure, collateral pool, and returns to tranche holders of CLO deals. To this end, we consider a comprehensive sample of 2,211 USD CLO deals issued between 2003 and 2019.[28] During our sample period, insurance companies invest in tranches pertaining to 1,875 CLO deals, holding on average 14% of each CLO deal and 32% of the mezzanine tranches rated investment grade in the year of origination.

6.1 Design of CLO Deals

We start by testing Hypothesis 3.1 that CLO deals with a larger holding share by insurance companies have a larger fraction of mezzanine tranches. A casual look at Figure5 shows that the relative importance of mezzanine tranches rated investment grade increased during our sample period, contrasting with the equity and triple-A rated tranches whose importance appear to have declined somewhat.

We investigate Hypothesis 3.1 formally by estimating the following regression on CLO deals at issuance:

$$\frac{Tranche_{rdmt} \times 100}{Issue\ amount_{dmt}} = \alpha + \beta_1 \frac{Insurers\ holdings_{dmt} \times 100}{Issue\ amount_{dmt}} + \mu_{mt} + \varepsilon \tag{7}$$

[28] Our original sample from Moody's Analytics Structured Finance Portal includes 2,386 CLO deals. We exclude 28 multi-currency CLO deals for which we cannot determine the balance in USD of all their tranches.

where the dependent variable is the par value of a tranche/tranches with rating r of CLO deal d issued in year t and managed by manager m, $Tranche_{rdmt}$, as a percentage of the total issue amount of CLO deal d in year t, $Issue\ amount_{dmt}$.[29] Both the numerator and the denominator of the dependent variable are calculated by excluding combo notes pertaining to the same CLO deal (i.e. notes that consist in a repackage of two or more tranches of the CLO deal) to avoid double counting. $Insurers\ holdings_{dmt}$ is the par value of insurers' aggregate holdings of CLO deal d in the year of the origination. We saturate the regression including manager-year fixed effects, μ_{mt}, and issuance year's macro conditions. The coefficient of interest is β_1, which captures the correlation between the percentage of a CLO deal represented by tranches with a given rating and the percentage of the deal held by insurance companies. Standard errors are clustered by manager and issuance year (two-way clustering).

Table 8 reports the results of this exercise. We estimate the regression of equation 7, along with two extensions, for the subgroups of Aaa tranches (columns 1-3), mezzanine tranches rated investment grade (columns 4-6), tranches rated below investment grade (columns 7-9), and equity tranches (column 10). The first specification suggests that the triple-A tranche share is inversely correlated to the percentage of the CLO deal held by insurance companies. When we move to mezzanine tranches rated investment grade, the coefficient of insurers' holding share flips sign, while remaining statistically significant (column 4). The correlation is, instead, negative for the subset of tranches rated below investment grade (column 7) and is not significant for equity tranches (column 10). Consistently with our priors, this evidence suggests that CLO deals in which insurance companies invest more heavily are characterized by a larger fraction of mezzanine tranches rated investment grade, while keeping a similar size to that of other deals. A one standard deviation increase in the share of a CLO deal held by insurance companies (14 percentage points in the subsample where this regression is estimated) is

[29]For CLO deals whose tranches are originated over a time period spanning two different years, we consider the second year as the issuance year.

associated with an increase in the share of mezzanine tranches rated investment grade by 5 percentage points.

Another important feature of CLOs' design worth looking at is the composition of the coupon type of CLO tranches. While CLO tranches are typically floating-rate securities, about 10% of debt tranches in our sample have a fixed-rate coupon. Life insurance companies, which account for 78% of insurers' aggregate holdings of CLOs and corporate bonds in 2019, typically fund themselves with long-term insurance products. Thus, they have incentives to invest in long-duration assets such as fixed-rate securities to match the duration of their liabilities. This suggests that, ceteris paribus, CLO deals in which insurance companies invest more heavily are characterized by a larger share of fixed-rate tranches. We test this hypothesis by estimating a modified version of equation 7 where the dependent variable is $\frac{Tranche_{fdmt} \times 100}{Issue\ amount_{dmt}}$, the par value of a tranche/tranches with a fixed-rate coupon f of CLO deal d issued in year t and managed by manager m, $Tranche_{fdmt}$, divided by the total issue amount of CLO deal d in year t, $Issue\ amount_{dmt}$.

Models 11-13 of Table 8 report the estimates of this exercise along with two extensions. The positive and statistically significant coefficient of the CLO deal's holding share by insurance companies confirms our prior.

The results we unveiled showing a positive correlation between insurers' aggregate holdings of a CLO deal and the relative size of (i) mezzanine tranches rated investment grade and (ii) fixed-rate debt tranches cannot be interpreted as causal. While CLO managers may design a CLO deal to meet insurers' preference for mezzanine tranches and fixed-rate tranches, insurance companies may select themselves into CLO deals characterized by a larger fraction of mezzanine tranches and debt tranches with a fixed-rate coupon. We attempt to shed some light on the direction of causation by exploiting the 2010 regulatory reform. As we documented in the previous section, following the 2010 regulatory reform, insurance companies searched for yield more and further increased their investments in CLOs relative to bonds within NAIC buckets. As such, we would

expect an increase in the relative size of mezzanine tranches and fixed-rate tranches in CLO deals issued after the implementation of the reform.

To investigate this conjecture, we extend the baseline models including an interaction between insurance companies' holding share of the CLO deal and a dummy equal to one for the time period in which the reform was in place (columns 2, 5, 8 and 12). The positive and statistically significant coefficients of the interaction term in columns 5 and 12 suggest that the correlation between insurers' holding share and (i) the percentage of mezzanine tranches rated investment grade and (ii) the percentage of fixed-rate debt tranches is stronger for as long as the reform was in place.

While these results help ease concerns with reverse causality, they are still only suggestive of a causal link between insurance companies' CLO preferences and the design of CLO deals. To further help establish this link, we take a closer look at the insurance companies that stood to benefit from the 2010 regulatory reform. As discussed in section 4, the 2010 reform implied a positive and fairly exogenous shock to the RBC ratio of insurers holding CLO tranches purchased at discount or highly impaired prior to the implementation of the reform. We, thus, test if the positive relation between the percentage of the CLO deal held by insurance companies and (i) the portion of mezzanine tranches rated investment grade and (ii) the fraction of debt tranches with a fixed-rate coupon is stronger the higher is the size of the investment in the CLO deal by insurers that benefit from the reform after 2009. To this end, we rely on a diff-in-diff setup with continuous treatment (columns 3, 6, 9 and 13). In line with our hypothesis, the coefficient of the triple interaction is positive and statistically significant for the share of mezzanine tranches rated investment grade (column 6) and the share of fixed-rate debt tranches (column 13), whereas it is negative and statistically significant or not significant for the share of triple-A tranches and tranches below investment grade, respectively.

As a final test of the impact of insurance companies on the design of CLOs, in Appendix E of the Internet Appendix we investigate their role on repackaged CLOs. These

are CLO deals associated with a set of combo notes produced by repackaging part or all debt and equity tranches of CLOs. Combo notes are often structured as principal-only securities, meaning that the cash flows from the underlying CLO tranches are used to pay down the principal balance of the combo note. Depending on the composition of the underlying CLO tranches, this feature may allow combo notes to achieve a better rating than some of the individual underlying components (NAIC, 2019a; Morningstar, 2019).[30] Typically, combo notes are structured in bilateral transactions exactly to be tailor made to the investor's specific coupon and rating target (NAIC, 2019a; Morningstar, 2019). The extent to which insurance companies invest in repackaged CLO deals is a signal of whether they lean towards custom-made CLOs. Indeed, our investigation shows that insurance companies invest more heavily in repackaged CLO deals. Further, we find that insurance companies hold a larger share of repackaged CLO deals during the time period in which the reform was in place and this is especially true the higher is the size of the investment in the repackaged CLO deal made by insurers that stood to benefit from the reform.

Altogether, the results reported in this subsection show that insurance companies' growing preference for CLOs, particularly after 2010, contributed to a rise in the relative importance of mezzanine tranches rated investment grade. Given this rise occurred at the expense of the triple-A and below-grade tranches could it have impacted the risk of CLOs' underlying collateral. We investigate this question in the next section.

6.2 CLOs' collateral pool

The fact that CLO deals with a larger holding share by insurance companies are characterized by a larger fraction of mezzanine tranches rated investment grade (and a smaller share of triple-A and below-grade tranches) suggests that CLO managers will find it easier to include riskier loans in the collateral pool of CLOs they place with insurance

[30]NAIC (2019a) notes that rating agencies methodologies identify a loss or default only when interest payments are not met.

companies. This forms the conjecture of our Hypothesis 3.2, which we investigate next.

Our starting point to perform this analysis is a granular dataset with information on the collateral pool of CLO deals at the security investment-CLO deal-issuance year level. As before, we consider only USD CLO deals issued between 2003 and 2019, but focus now on their loan investments.[31] A crucial information contained in our dataset is the interest rate spread, which directly captures the risk premium associated with the loan. We, thus, estimate the following regression:

$$Spread_{ldmt} = \alpha + \beta_1 \frac{Insurers\ holdings_{dmt} \times 100}{Outstanding\ volume_{dmt}} + \mu_{mt} + \varepsilon \tag{8}$$

where $Spread_{ldmt}$ is the spread of loan l in the collateral pool of CLO deal d managed by manager m and at origination year t. We include CLO manager-issuance year fixed effects and we cluster standard errors by manager and year (two-way clustering).

Column 1 of Table 9 reports the estimates of this model. The positive and statistically significant coefficient of the insurance companies' holding share suggests that CLO deals in which insurance companies invest more heavily are backed by riskier loans than other CLO deals. In the next specification we replace the dependent variable with the weighted average spread of loans in the collateral pool of CLO deals at origination to account for the relative size of loans in the collateral pool. Weights are given by the size of each loan investment in the portfolio. The estimates of Column 2 show that not only our result is confirmed, but the magnitude is somewhat higher. A one standard deviation increase in insurance companies' holding share implies an increase in the weighted average spread of collateral loans by 8 basis points.[32]

[31] We exclude bond investments (they account only for a small fraction of the collateral pool of CLOs), and investments in credit lines, revolvers, and term loans A because the are non-typical underlying loans for CLO deals (they represent only 3% of the cross section of loan investments in the collateral pool of CLO deals at origination). We drop repackaged CLO deals as their collateral is composed by CLO tranches rather than bank loans.

[32] Similar to previous analyses, we investigated whether this effect on the risk of collateral increased after the 2010 reform. While the results suggest the reform strengthened that link, the effect is not statistically significant. This may be because insurance companies' demand for CLOs has only a second order impact on CLOs' underlying collateral and/or the fact that it takes time for CLO managers to find their targeted corporate loans in the market.

This evidence that CLOs with a larger ownership stake of insurance companies have hold a riskier pool of collateral loans poses an interesting question: who benefits from the larger returns of these loans? We attempt to shed light on this question next.

6.3 Returns on CLOs' tranches

While we are unable to investigate the effect on CLO managers because we do not have comprehensive data on their compensation arrangements, we can ascertain the potential effects of insurance companies' CLO investments on debt holders and equity holders. To that end, we start by looking at the interest rate spread set for debt tranches at issuance of the CLO deal using the following econometric model:

$$Weighed\ Average\ Spread_{rdmt} = \alpha + \beta_1 \frac{Insurers\ holdings_{dmt} \times 100}{Issue\ amount_{dmt}} + \mu_{mt} + \varepsilon \qquad (9)$$

where $Weighed\ Average\ Spread_{rdmt}$ is the weighted average spread of debt tranches with rating r of CLO deal d in the year of origination t. The estimates reported in columns 3-5 of Table 9 show that senior tranches and, especially, mezzanine tranches rated investment grade, of CLO deals with a larger holding share by insurance companies pay a lower spread at origination.[33] A one standard deviation increase in insurance companies' holding share (corresponding to 14%) implies a decline in the weighted average spread of triple-A tranches and mezzanine tranches rated investment grade by 3 basis points and 17 basis points, respectively.[34]

We documented above that insurance companies' investments in CLOs are associated with riskier pools of collateral loans and a larger share of mezzanine tranches

[33]This evidence is line with the evidence unveiled by Acharya et al. (2022) in the corporate bond space showing that investors' preference for investment grade securities during the Federal Reserve Quantitative Easing led to a reduction in the cost of funding for risky firms just above the investment grade threshold.

[34]For the sake of space, we do not report here the results of the heterogeneity analysis performed exploiting the 2010 regulatory reform. While we do not find any statistically significant heterogeneity for triple-A and below investment grade tranches, we observe that the negative correlation between insurance companies' holding share and the spread of mezzanine tranches rated investment grade is stronger for CLO deals with larger investments by insurers that stood to benefit from the reform in the aftermath of the regulatory change. These results are available upon request.

rated investment grade but no effect on the share of the equity tranche. While our finding that the spread earned by mezzanine tranches rated Aa-A-Baa correlates negatively with the holding share of insurers is consistent with a higher detachment point of those tranches in the waterfall structure, this result may also indicate that CLO equity holders benefit from the increased demand by insurance companies for CLOs. We take a close look at this assertion by investigating the returns (including risk-adjusted returns) of equity holders of CLO deals in which insurance companies invest more heavily.

Following Fabozzi et al. (2021) and Cordell et al. (2022), we calculate different metrics for the returns to the equity tranche of CLO deals and we estimate the following type of regression:

$$Equity\ return_{dmt} = \alpha + \beta_1 \frac{Insurers\ holdings_{dmt} \times 100}{Issue\ amount_{dmt}} + \mu_{mt} + \varepsilon \tag{10}$$

where $Equity\ return_{dmt}$ is a measure of the returns to the equity tranche of CLO deal d managed by manager m and originated in year t. We start with a simple measure of equity returns for our full set of CLO deals, including those that have not matured or terminated yet. We follow Fabozzi et al. (2021) and compute the average of the annualized returns earned by holders of the equity tranche in each pay period until the minimum of the reinvestment end date, the first refinancing date (if deal is refinanced in our sample period), or the last pay period in 2019.[35] We consider only the time frame up to the end of the reinvestment period because it is difficult to distinguish between interest and principal payments in many CLO deals and we want to exclude principal amortization from our calculations. In addition, we drop observations after the first refinancing date to capture returns to the equity tranche that are driven solely by the original structure of the CLO deal.

The estimates reported in column 6 of Table 9 indicate that equityholders of

[35]We exclude repackaged CLOs, which typically do not have an equity tranche, and deals for which the equity tranche is not consistently reported over time. The equity tranche of the underlying CLOs or repackaged CLO deals is usually repacked with debt tranches to generate the combo notes that compose the repackaged deal.

CLO deals with larger investments from insurance companies earn higher returns. A one standard deviation increase in insurance companies' holding share (14%) implies a 14 basis points increase in the average annualized returns of equityholders.[36]

Next, we consider the internal rate of return, a more standard measure to gauge the returns to the equity tranche throughout its lifetime. We calculate the internal rate of return using the historical record of interest and principal payments to equityholders during the entire life of the CLO deal. By construction, we can generate this measure only for CLO deals that reached maturity or were terminated by the end of our sample period. Further, we drop deals for which we miss the full history of payments to the equity tranche. This leaves us with a sample of 733 deals.[37] The estimates reported in column 7 reveal that the internal rate of return experienced by holders of equity tranches is higher for CLO deals characterized by larger investments by insurance companies. A one standard deviation increase in insurance companies' holding share (14%) implies an increase in the internal rate of return by 1.5 percentage points.

A limitation of the two equity return metrics used so far is that they do not account for risk. Recall our finding that CLO deals where insurance companies invest more are characterized by a riskier pool of collateral loans. Towards that end, we begin by considering the public market equivalent (PME) of Kaplan and Schoar (2005) to estimate the returns earned by equityholders on a risk-adjusted basis. This approach is equivalent to obtaining risk-adjusted returns under the assumption that the beta of CLO equity tranches is equal to one. We calculate the PME versus the S&P 500, meaning that we discount each cash flow to the equity tranche of a CLO deal using the returns on the S&P 500. A PME greater than one would indicate that CLO equity tranches outperform the S&P 500. Table2 shows that the average PME of equity tranches of CLO deals is 1.13 in our sample, suggesting that these assets earn abnormal returns.

[36]The heterogeneity analysis performed exploiting the 2010 regulatory reform does not produce statistically significant results and, hence, we do not report it here.

[37]Once we account for the manager-vintage fixed effects, the actual observations drop to 460.

Our focus, though, is on how the PME of equity tranches varies across CLO deals with different insurance investments.

This is exactly what we investigate in column 8 of Table 9. The positive and significant coefficient of *% CLO held by ICs* suggests that equityholders of CLO deals with higher insurers investments earn higher returns even on a risk-adjusted basis. A one standard deviation increase in insurance companies' holding share (14%) implies an increase in the PME by 0.03.

Given the intrinsic riskiness of CLO equity tranches, it is reasonable to think that those securities have a beta greater than one, meaning they are characterized by a higher systematic risk. To address this issue and following Cordell et al. (2022), we enrich our analysis by considering a more sophisticated measure of risk-adjusted returns which accounts for systematic risk — the generalized public market equivalent (GPME) of Korteweg and Nagel (2016).[38] To get statistical inference and mimic the analysis presented in Table 9, we compare the GPME of equity tranches of CLO deals with high versus low holdings by insurance companies conditional on the issuance year of the CLO. Further, to ensure that we estimate the GPME on a sufficiently large set of CLO deals, we group deals based on whether their origination year falls into a six time intervals of two or three years (2003-2004, 2005-2006, 2007-2008, 2010-2011, 2012-2013, 2014-2016).[39] Then, for each time interval, we calculate the GPME of equity tranches of CLO deals whose insurance companies' holding share at origination is above or below the median for that time frame. To estimate the GPME, we consider a general CAPM stochastic discount factor (SDF). Specifically, the SDF parameters are identified to correctly price benchmark funds that receive the same inflows as the CLO equity tranches but that invest in the CRSP value-weighted index and one-month T-bills.

[38]We thank Arthur Korteweg and Stefan Nagel for providing us with the hmatlab code for the GPME estimation on their websites.

[39]There are only six CLO deals issue in 2009 in our sample and none of them complies with our quality control tests. Thus, we exclude CLO deals issued in 2009 from these calculations.

The estimates presented in Table 10 reveal that holders of the equity tranche of CLO deals with larger insurers' investments earn risk-adjusted abnormal returns throughout our sample, with the only exception of equity investors in CLO deals originated during 2012-2013. More importantly, those equityholders consistently experience higher returns on a risk-adjusted basis than equityholders of CLO deals where insurance companies do not invest or invest little.

Cordell et al. (2022) show that, unlike CLO debt tranches, equity tranches receive abnormal risk-adjusted returns, suggesting that equityholders earn economic rents at the expense of debtholders. We also find that equity tranches of CLO deals our sample period experience abnormal returns on a risk-adjusted basis (our GPME estimate of 0.659 is very close to the 0.664 reported by Cordell et al. (2022) in a similar setup). Cordell et al. (2022) speculate that such rents could derive from the demand for credit, i.e., borrowers willing to pay higher spreads, or the demand for CLO tranches, i.e. investors in debt tranches willing to accept lower spreads. The evidence presented in Table 9, combined with the regulatory arbitrage we documented in the previous sections, provides empirical support to the latter suggestion, that is CLO equityholders benefit from the lower returns that mezzanine debt holders earn in response to insurance companies' strong demand for these debt tranches.

In the Internet Appendix E we provide two additional pieces of evidence that support this assertion. We show that CLO deals in which insurance companies' have larger investments tend to have shorter non-call periods, and are more likely to be refinanced. Both of those features are important for equity holders. At the end of the non-call period, equityholders have the option to refinance the deal. The ability to refinance is important because it gives CLO managers the ability to take advantage of a reduction in market spreads on CLO debt or to extend the maturity of a CLO, or both.

In conclusion, the results we unveiled in this section show that insurance companies' preference for mezzanine tranches rated investment grade has contributed to an

increase in the relative importance of these tranches in CLO deals. This rise was accompanied by an increase in the risk of underlying collateral. Importantly, we find that the higher returns generated by the underlying riskier loans are catered to holders of equity tranches. This suggests that riskier corporate borrowers and equityholders in CLO deals have benefited from insurance companies' strong preference for CLO mezzanine tranches induced by their capital regulation design: the former by having better access to bank funding and the latter by enjoying a higher return on their investments.

6.4 Insurances' companies contribution to the growth of the CLO market

Our results show that insurance companies' proclivity towards CLO tranches affected the design of CLO deals (structure of the waterfall, underlying pool of loans, return on tranches) but they are silent about the relative importance of insurance companies in the rise of CLOs after the financial crisis. We try to get a sense of this importance next using some back of the envelop calculations.

Between 2003 and 2019, the outstanding volume of CLOs increased by $555.5B, with about one fourth of that increase (%131B) relating to mezzanine tranches rated investment grade. Insurance companies account for 48% of that increase in mezzanine tranches (their investments grew by $62B over the same period). If we focus on the post-crisis period, we see that insurance companies' role is even more important. They funded 67% of the $82B increase in the outstanding volume of investment grade mezzanine tranches over the 2011-2019 time period.

These figures, while remarkable, capture only a portion of insurance companies' role in the post-crisis growth of CLOs. The reason is that investment-grade mezzanine tranches play a critical role in the origination of the much sought triple-A tranches. They accounted for 15.1% of CLOs' funding in 2003 and by 2019 their funding share of CLOs reached 22.9%.[40] Over the same period of time, insurance companies' funding of

[40]For reference, for below-grade investment tranches the corresponding figures are 1.5% and 4.8%; for the equity tranche

investment-grade mezzanine tranches went from 13% to 38%.

7 Conclusions

Using data on asset holdings of insurance companies over 2003-2019, we document an increasing preference for CLO investments vis-à-vis corporate bond investments. That preference is particularly strong for mezzanine tranches rated investment grade (i.e., Aa, A and Baa rated). We show that this is consistent with a search for yield behavior. Conditional on the asset type and capital charge, insurance companies invest more in securities offering higher yields. That search for yield behavior has led insurance companies to favor CLOs over corporate bonds. Conditional on the credit rating of the security, insurance companies tend to purchase a higher fraction of CLO tranches compared to corporate bonds the larger is the difference in the yields carried by the two asset classes. Similarly, we find that the share of new securities in portfolio represented by CLO tranches grows for increasing levels of the yields differential.

We explore the implications of the observed proclivity of insurance companies towards CLOs for the CLO market. Insurance companies have become an important class of investors in CLO securities, representing roughly half of the investor base in CLO mezzanine tranches rated investment grade. The demand for mezzanine tranches is critical for the issuance of CLOs as their junior position allows for the creation of senior tranches rated triple-A highly sought by banks. We document that insurers' preference for CLO mezzanine tranches had an impact on the design of CLO deals. In particular, we find that CLO deals with higher insurers' investments are characterized by a larger share of mezzanine tranches rated investment grade and a riskier pool of collateral loans. We also find that while those mezzanine debt tranches carry lower spreads, equity tranches of deals with large insurers' investments have higher returns even when we account for

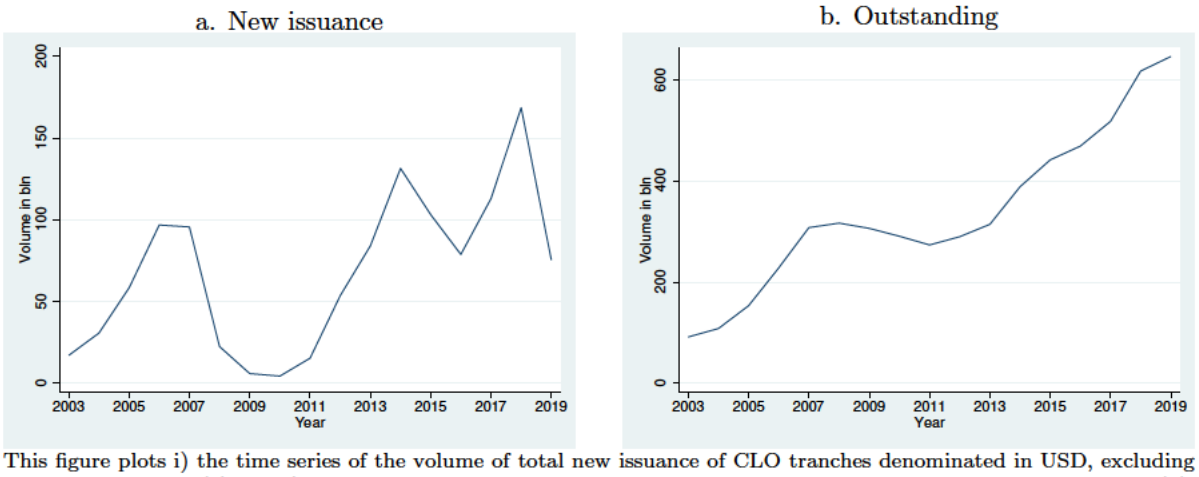
the figures are 9.5% and 11.1%.

risk. Altogether, our results suggest that insurance companies have played an important role in the expansion of corporate loans' securitization observed in the last decade and in the process likely contributed to an expansion of credit to riskier corporate borrowers.

Our findings provide three interrelated economic insights. First, they confirm that regulation is able to strongly affect firms' incentives to take on risk. While most of the literature has explored this link within banks or insurance companies, our findings highlight an important implication from the different design of capital regulation applied to banks and insurance companies. Second, our results show that insurance companies have been playing a complementary role to banks in the securitization of corporate loans and, by extension, in the growth of the shadow banking sector. Third, corporate loans' securitization together with the differences between banks' and insurers' capital regulation has contributed to the transfer a substantial portion of credit risk from the banking sector to the insurance sector.

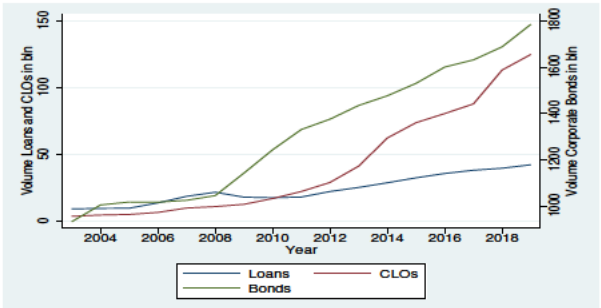
This brings us to some potentially important questions for future research. For example, to what extent the current structure of financial intermediaries broadens the availability of bank credit in particular to riskier borrowers? Similarly, to what extent the current structure is better suited to guarantee funding to corporations over the business cycle than one based on banks alone? Finally, is the allocation of credit risk throughout the financial system promoted by the current structure optimal?

Figure 1: U.S. CLOs New Issuance and Outstanding



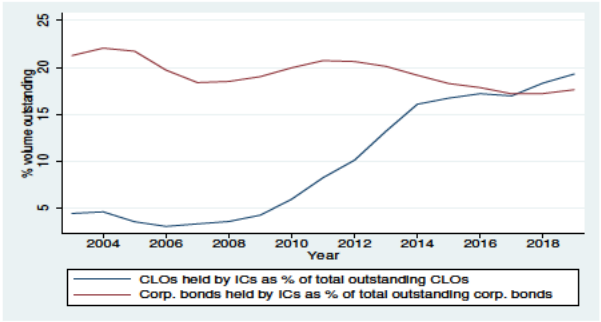
This figure plots i) the time series of the volume of total new issuance of CLO tranches denominated in USD, excluding refinanced tranches (a) and ii) the time series of the total outstanding volume of CLO tranches denominated in USD (b), over the time period 2003-2019 on a yearly basis. The data covers CLOs issuance and CLOs outstanding up to November 8, 2019. Source: Moody's Analytics Structured Finance Portal.

Figure 2: Insurance Companies' Investments Over Time



This figure plots the time series of insurance companies' holdings of bonds, corporate loans and CLOs as of December 31 of each year during the time period 2003-2019. Source: Schedule D-Part 1 of the annual financial statement filings of life, P&C and health insurance companies submitted to the NAIC and retrieved from SNL Financial.

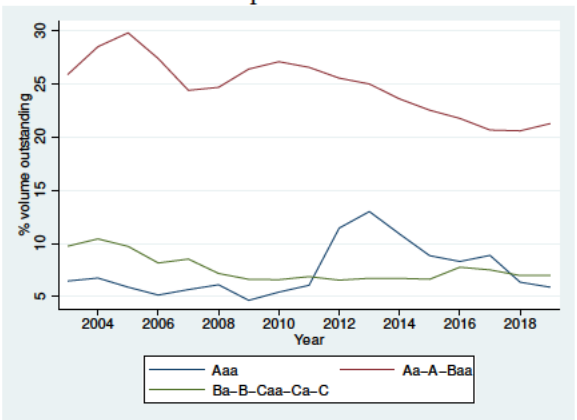
Figure 3: Insurance Companies' Market Shares of CLOs and Corporate Bonds



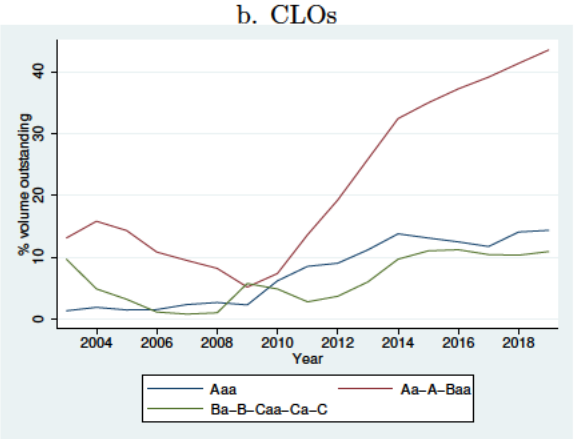
This figure plots the time series of i) the aggregate volume of CLO holdings of insurance companies as percentage of the total volume outstanding of CLO tranches (blue line) and ii) the aggregate volume of corporate bond holdings of insurance companies as percentage of the total volume outstanding of corporate bonds (red line) as of December 31 of each year during the time period 2003-2019. Source: Schedule D-Part 1 of the annual financial statement filings of life, P&C and health insurance companies submitted to the NAIC and retrieved from SNL Financial; Moody's Analytics Structured Finance Portal; Mergent Fixed Income Securities Database (FISD).

Figure 4: Insurance Companies' Market Shares of Corporate Bonds and CLOs

a. Corporate bonds

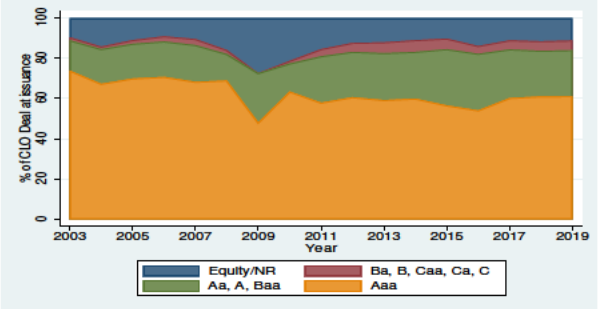


b. CLOs



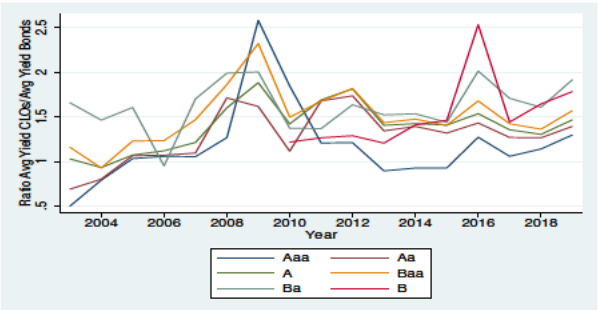
This figure plots the time series of i) the aggregate volume of corporate bond holdings of insurance companies as percentage of the total volume outstanding of corporate bonds by credit rating (a) and ii) the time series of the aggregate volume of CLO holdings of insurance companies as percentage of the total volume outstanding of CLO tranches by credit rating (b), as of December 31 of each year during the time period 2003-2019. Source: Schedule D-Part 1 of the annual financial statement filings of life, P&C and health insurance companies submitted to the NAIC and retrieved from SNL Financial; Mergent Fixed Income Securities Database (FISD); Moody's ; Moody's Analytics Structured Finance Portal.

Figure 5: Composition of CLO Deals over Time



This figure plots the time series of the average share of CLO deals at origination represented by i) triple-A tranches, ii) Aa, A and Baa rated tranches, iii) below investment grade tranches, iv) and equity tranches during the time period 2003-2019. Source: Moody's Analytics Structured Finance Portal.

Figure 6: Yield on Insurance Companies' Investments in CLOs to Yield of Insurance Companies' Investments in Corporate Bonds by Rating

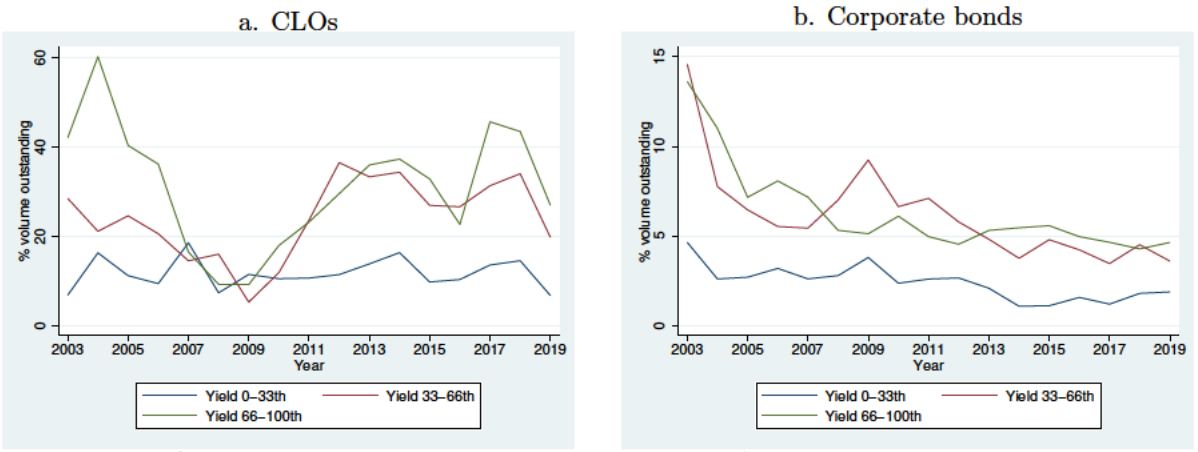


This figure plots the time series of the "yields ratio" of insurers' first-time investments in CLO tranches and corporate bonds, that is the ratio of the average yield of new investments in CLOs to the average yield of new investments in corporate bonds, by credit rating as of December 31 of each year during the time period 2003-2019. Source: Schedule D-Part 1 of the annual financial statement filings of life, P&C and health insurance companies submitted to the NAIC and retrieved from SNL Financial. Information on the credit rating of corporate bonds comes from Mergent Fixed Income Securities Database (FISD) and Moody's, whereas information on the credit rating of CLOs comes from Moody's Analytics Structured Finance Portal.

Figure 7: Insurance Companies' Share of NAIC 1 Investments Reported According to the MFE Process

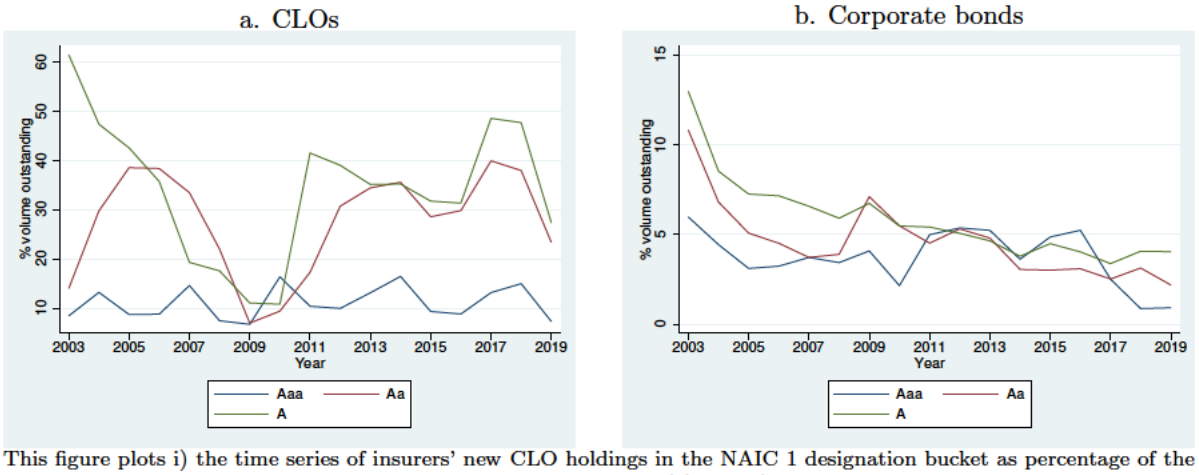
This figure plots the time series of (i) the percentage of CLO holdings in the NAIC 1 designation bucket reported according to the "modified filing exempt" approach, MFE, as identified from the "AM" suffix included in the NAIC designation (blu line), and (ii) the percentage of CLO holdings in the NAIC 1 designation bucket that have a credit rating different from Aaa, Aa or A (red line). Source: Schedule D-Part 1 of the annual financial statement filings of life, P&C and health insurance companies submitted to the NAIC and retrieved from SNL Financial. Information on the credit rating of CLOs comes from Moody's Analytics Structured Finance Portal.

Figure 8: Share of CLOs and Corporate Bonds Held by Insurance Companies by Percentiles of the Distribution of Yields



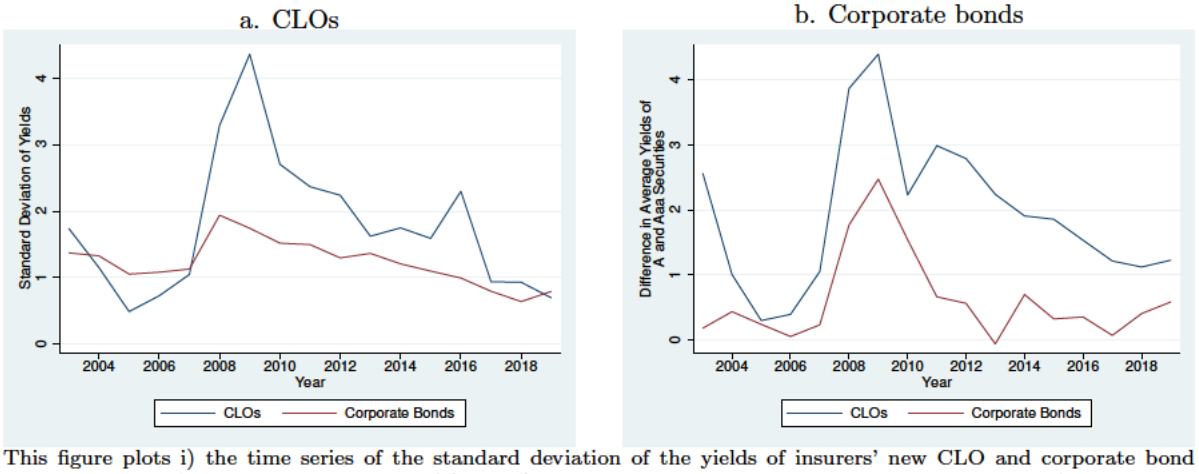
This figure plots i) the time series of insurers' new CLO holdings in the NAIC 1 designation bucket as percentage of the total volume outstanding of these CLO tranches based on percentiles of the distribution of CLOs yields (a) and ii) the time series of insurers' new corporate bond holdings in the NAIC 1 designation bucket as percentage of the total volume outstanding of these corporate bonds based on percentiles of the distribution of corporate bonds yields (b) reported by insurance companies as of December 31 of each year during the time period 2003-2019. New CLO and corporate bond holdings and are identified as first-time investments in a given CLO tranche and agiven corporate bond by an insurance company. Source: Schedule D-Part 1 of the annual financial statement filings of life, P&C and health insurance companies submitted to the NAIC and retrieved from SNL Financial.

Figure 9: Share of CLOs and Corporate Bonds Held by Insurance Companies by Rating



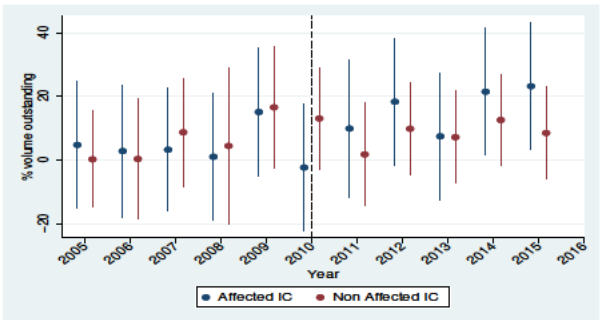
This figure plots i) the time series of insurers' new CLO holdings in the NAIC 1 designation bucket as percentage of the total volume outstanding of these CLO tranches by credit rating (a) and ii) the time series of insurers' new corporate bond holdings in the NAIC 1 designation bucket as percentage of the total volume outstanding of these corporate bonds by credit rating (b) reported by insurance companies as of December 31 of each year during the time period 2003-2019. New CLO and corporate bond holdings and are identified as first-time investments in a given CLO tranche or corporate bond by an insurance company. Source: Schedule D-Part 1 of the annual financial statement filings of life, P&C and health insurance companies submitted to the NAIC and retrieved from SNL Financial; Moody's Analytics Structured Finance Portal; Moody's; Mergent Fixed Income Securities Database (FISD).

Figure 10: Yields' Dispersion of CLOs and Corporate Bonds in the NAIC 1 Designation



This figure plots i) the time series of the standard deviation of the yields of insurers' new CLO and corporate bond holdings in the NAIC 1 designation bucket (a) and ii) the time series of the difference in the average yield (in percentage points) of single-A and triple-A new insurers' holdings of CLO tranches and corporate bonds (b) as of December 31 of each year during the time period 2003-2019. New CLO and corporate bond holdings are identified as first-time investments in a given CLO tranche or corporate bond by an insurance company. Source: Schedule D-Part 1 of the annual financial statement filings of life, P&C and health insurance companies submitted to the NAIC and retrieved from SNL Financial; Moody's Analytics Structured Finance Portal; Moody's; Mergent Fixed Income Securities Database (FISD).

Figure 11: Share of CLOs Held by Insurance Companies Affected and Not Affected by the 2010 Regulatory Reform



This figure plots the time series of the estimated coefficients, along with their 95% confidence intervals, of a linear model where we regress the aggregate volume of CLO tranches held by insurance companies at the time of their first investment in the asset as a percentage of the total volume outstanding of these tranches by NAIC designation buckets on year dummies and including NAIC designation fixed-effects for (i) insurance companies that benefit (blue line) and (ii) do not benefit (red line) from the 2010 regulatory reform based on their CLO holdings as of December 31, 2009. Source: Schedule D-Part 1 of the annual financial statement filings of life, P&C and health insurance companies submitted to the NAIC and retrieved from SNL Financial; Moody's Analytics Structured Finance Portal.

Table 1: Risk-Based Capital Requirements for Asset Risk

	RBC charge (%)			
NAIC Designation	Life (pre-tax)	Life (post-tax)	P&C and Health	Credit Rating
1	0.40%	0.30%	0.30%	Aaa, Aa, A
2	1.30%	0.96%	1.00%	Baa
3	4.60%	3.39%	2.00%	Ba
4	10.00%	7.38%	4.50%	B
5	23.00%	16.96%	10.00%	Caa
6	30.00%	19.50%	30.00%	Ca, C

This table reports the risk-based capital charges for asset risk applied to fixed income investments of Life, P&C and Health insurance companies. The regulation defines risk-based capital charges associated to fixed income securities held by Life insurers both on a pre-tax and post-tax basis, whereas no tax adjustment is required in the case of P&C and Health insurers. Source: NAIC.

Table 2: Summary statistics

Panel A						
	N	mean	std dev	25th pct	median	75th pct
New investment as % of volume outstanding	1,701,739	0.93	4.26	0.03	0.12	0.50
Yield (%)	1,707,526	4.41	2.14	3.04	4.22	5.52
Time-to-maturity (years)	1,714,384	9.46	7.56	5.00	8.00	10.00
Outstanding Amount ($bln)	1,708,652	0.93	0.94	0.40	0.65	1.15
NAIC designation	1,714,482	1.82	0.98	1.00	2.00	2.00
Size	1,707,607	14.32	2.49	12.55	14.23	16.22
ROE	1,677,419	0.07	0.21	0.02	0.07	0.14
Capitalization	1,680,248	0.31	0.23	0.10	0.30	0.47
CAL RBC ratio	1,676,505	6.37	14.43	2.70	3.87	5.35
ACL RBC ratio	1,676,505	12.73	28.85	5.39	7.75	10.69
Panel B						
	N	mean	std dev	25th pct	median	75th pct
Aaa Tranches as % of CLO	2,211	61.93	13.32	60.33	62.86	66.16
Aa-A-Baa Tranches as % of CLO	2,211	22.36	11.76	19.45	22.22	23.76
Ba-B-Caa-Ca-C Tranches as % of CLO	2,211	4.16	2.47	3.18	4.39	5.63
Equity Tranches as % of CLO	2,211	10.22	5.59	8.03	9.26	10.37
% of CLO held by ICs	2,208	13.98	14.01	3.27	11.44	19.62
% of CLO held by ICs Benefit Reform	2,211	6.89	10.59	0.48	4.01	8.73
Fixed-rate Tranches as % of CLO	2,211	3.02	11.26	0.00	0.00	2.44
Length Non-call period (Years)	2,169	3.89	1.59	3.00	3.00	5.00
Weighted Avg Spread Loans (%)	1,515	3.62	0.90	3.29	3.62	3.91
Weighted Avg Spread Aaa Tranches (%)	2,018	1.10	0.50	0.79	1.25	1.46
Weighted Avg Spread Aa-A-Baa Tranches (%)	2,025	2.17	0.89	1.73	2.30	2.68
Weighted Avg Spread Ba-B-Caa-Ca-C Tranches (%)	1,796	5.61	1.31	4.95	5.70	6.45
Average annualized rate of return (%)	1,832	4.52	1.52	3.51	4.51	5.38
Internal rate of return (%)	733	6.89	16.62	1.64	10.49	17.42
PME	733	1.32	0.70	0.79	1.13	1.85

This table reports the summary statistics of the continuous variables pertaining to i) the panel dataset on insurers' new investments in CLOs and corporate bonds at the security-company-year level (panel A) and ii) the panel dataset on the structure of CLO deals at the deal-issuance year level (panel B).

Table 3: Search for yield: Baseline regressions

	(1)	(2)	(3)	(4)	(5)
Dependent variable	Insurance company's holding as percentage of total volume outstanding				
Yield	0.067**	0.069**	0.069**	0.069**	0.003
	(0.02)	(0.03)	(0.03)	(0.03)	(0.01)
dummy CLO					4.680***
					(0.86)
dummy CLO x Yield					1.114***
					(0.22)
Time-to-maturity	-0.003	-0.002	-0.002	-0.000	0.001
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Outstanding Amount	-0.299***	-0.331***	-0.331***	-0.307***	-0.296***
	(0.05)	(0.05)	(0.05)	(0.04)	(0.05)
Size		0.256***	0.256***		
		(0.02)	(0.02)		
ROE		-0.325	-0.325		
		(0.21)	(0.21)		
Capital ratio		0.030	0.030		
		(0.13)	(0.13)		
CAL RBC ratio		0.002***			
		(0.00)			
ACL RBC ratio			0.001***		
			(0.00)		
constant	0.944***	-2.715***	-2.715***	0.906***	0.880***
	(0.10)	(0.32)	(0.32)	(0.09)	(0.05)
NAIC designation x Year FE	Yes	Yes	Yes	Yes	Yes
Security type (CLO or bond) FE	Yes	Yes	Yes	Yes	No
Security issuer FE	No	No	No	Yes	No
Type insurer FE	Yes	Yes	Yes	Yes	Yes
Insurer x Year FE	Yes	No	No	Yes	Yes
Two-way clustering	Insurer, Year	Insurer, Year	Insurer, Year	Insurer, Year	Insurer, Year
N	1691393	1650705	1650705	1690436	1691393
R^2	0.292	0.205	0.205	0.422	0.299
$Adj - R^2$	0.274	0.205	0.205	0.404	0.282
F-stat	25.318***	26.054***	26.054***	28.863***	32.32***
Degrees of freedom	(3, 16)	(7, 16)	(7, 16)	(3, 16)	(5, 16)

This table reports panel regression estimates of the linear regression model of equation 1 and its extensions analyzing insurers' search for yield in the CLO and corporate bond asset classes. The models are estimated on a granular dataset at the security-company-year level covering first-time investments by insurance companies in CLO tranches and corporate bonds. The dependent variable is the amount held by an insurance company in a given security and in a certain year (when the insurer makes its first investment in the security) as a percentage of the volume outstanding of the security in that year. As for the independent variables, *Yield* is the yield (i.e., the effective rate or return) of the security reported by the insurer; *dummy CLO* is a dummy variable equal to one if the security is a CLO tranche and zero otherwise; *Time-to-maturity* is the time to maturity of the security in years reported by the insurer; *Outstanding Amount* is the volume outstanding of the security; *Size* is the natural logarithm of total admitted assets of the insurer; *ROE* is the ratio of net income to total adjusted capital of the insurer; *Capital ratio* is the ratio of total adjusted capital to total admitted assets of the insurer; *CAL RBC ratio* is the CAL risk-based capital ratio of the insurer; *ACL RBC ratio* is the ACL risk-based capital ratio of the insurer. For each independent variable the first row reports the coefficient, the second row reports in parenthesis the robust standard error that is corrected for multiclustering at the insurer and year level. Fixed effects are included, "Yes", or not included, "No". ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Table 4: Search for yield: The 2010 Regulatory Reform

	(1)	(2)
Sample		Insurers that are operative in 2009
Dependent variable	Insurance company's holding as percentage of total volume outstanding	
Yield	-0.011	0.037*
	(0.01)	(0.02)
dummy CLO	6.641**	
	(2.59)	
dummy CLO x Yield	0.598**	
	(0.26)	
dummy Reform x Yield	0.024*	
	(0.01)	
dummy Reform x dummy CLO	-2.567	
	(2.58)	
dummy Reform x dummy CLO x Yield	0.708**	
	(0.33)	
Year>2009 x Yield		0.076*
		(0.04)
Benefit Reform		1.284***
		(0.43)
Benefit Reform x Yield		-0.121***
		(0.04)
Benefit Reform x Year>2009		-1.105*
		(0.55)
Benefit Reform x Year>2009 x Yield		0.144*
		(0.08)
Time-to-maturity	0.000	-0.003
	(0.00)	(0.00)
Outstanding Amount	-0.296***	-0.349***
	(0.05)	(0.05)
Size		0.245***
		(0.02)
ROE		-0.324
		(0.25)
Capital ratio		0.081
		(0.13)
constant	0.885***	-2.634***
	(0.05)	(0.34)
NAIC designation x Year FE	Yes	Yes
Security type (CLO or bond) FE	No	Yes
Type insurer FE	Yes	Yes
Insurer x Year FE	Yes	No
Two-way clustering	Insurer, Year	Insurer, Year
N	1691393	1520349
R^2	0.300	0.213
$Adj - R^2$	0.283	0.213
F-stat	25.199***	21.137***
Degrees of freedom	(8, 16)	(11, 16)

This table reports panel regression estimates of a series of extensions to the linear regression model of equation 1 analyzing the heterogeneity of insurers' search for yield based on the 2010 regulatory reform. The models are estimated on a granular dataset at the security-company-year level covering first-time investments by insurance companies in CLO tranches and corporate bonds. Model 2 is estimated on the subsample of insurance companies operating in 2009. The dependent variable is the amount held by an insurance company in a given security and in a certain year (when the insurer makes its first investment in the security) as a percentage of the volume outstanding of the security in that year. As for the independent variables, *Yield* is the yield (i.e., the effect rate or return) of the security reported by the insurer; *dummy CLO* is a dummy variable equal to one if the security is a CLO tranche and zero otherwise; *dummy Reform* is a dummy equal to one if the year falls into the time period 2010-2018, when the 2010 regulatory reform was into effect, and zero otherwise; *Benefit Reform* is a dummy variable equal to one if, based on the CLO holdings at 2009 year-end, the insurer benefits from positive shock to its RBC ratio as a result of the 2010 regulatory reform; *Time-to-maturity* is the time to maturity of the security in years reported by the insurer; *Outstanding Amount* is the volume outstanding of the security; *Size* is the natural logarithm of total admitted assets of the insurer; *ROE* is the ratio of net income to total adjusted capital of the insurer; *Capital ratio* is the ratio of total adjusted capital to total admitted assets of the insurer. For each independent variable the first row reports the coefficient, the second row reports in parenthesis the robust standard error that is corrected for multiclustering at the insurer and year level. Fixed effects are included, "Yes", or not included, "No". ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Table 5: Insurance Companies' Preference for CLOs vis-à-vis Corporate Bonds

	(1)	(2)	(3)	(4)	(5)
Sample	Assets with Aaa, Aa, A and Baa rating				
Dependent variable	Yield (%)		Insurance company's new holding as percentage of total volume outstanding		
dummy CLO	0.704***		10.530***		-0.684
	(0.11)		(0.81)		(3.73)
Yield CLO/Yield Bond ratio					0.563
					(0.39)
dummy CLO x Yield CLO/Yield Bond ratio					7.909**
					(2.87)
Rating=Aaa		-0.677***		0.369**	
		(0.21)		(0.13)	
Rating=Aa		-0.214***		0.141**	
		(0.03)		(0.05)	
Rating=Baa		0.532***		-0.132***	
		(0.04)		(0.02)	
Rating=Aaa x dummy CLO		0.238		4.780***	
		(0.27)		(0.66)	
Rating=Aa x dummy CLO		0.473***		10.654***	
		(0.11)		(1.04)	
Rating=A x dummy CLO		0.927***		12.136***	
		(0.11)		(0.96)	
Rating=Baa x dummy CLO		1.556***		12.708***	
		(0.14)		(1.33)	
Time-to-maturity (years)	0.061***	0.062***	-0.001	-0.001	-0.002
	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)
Outstanding Amount ($bln)	0.071***	0.062***	-0.257***	-0.268***	-0.250***
	(0.01)	(0.01)	(0.05)	(0.04)	(0.04)
constant	3.159***	2.986***	0.847***	0.943***	0.068
	(0.07)	(0.08)	(0.04)	(0.05)	(0.57)
Rating	-	-	-	-	Yes
Rating x Year FE	Yes	No	Yes	No	No
Type insurer FE	Yes	Yes	Yes	Yes	Yes
Insurer x Year FE	Yes	Yes	Yes	Yes	Yes
Two-way clustering	Insurer, Year	Insurer, Year	Insurer, Year	Insurer, Year	Insurer, Year
N	1275763	1275763	1276043	1276043	1276043
R^2	0.685	0.682	0.313	0.320	0.310
$Adj - R^2$	0.675	0.672	0.291	0.298	0.288
F-stat	70.687***	38.091***	58.055***	26.209***	31.976***
Degrees of freedom	(3, 16)	(9, 16)	(3, 16)	(9, 16)	(5, 16)

This table reports panel regression estimates of (i) the linear regression model of equation 2 and its extensions (columns 1-2) and (ii) the linear regression model of equation 3 and its extensions (columns 3-5) analyzing insurers' preference for CLOs over corporate bonds. The models are estimated on a granular dataset at the security-company-year level covering first-time investments by insurance companies in CLO tranches and corporate bonds rated Aaa, Aa, A or Baa. The dependent variable of columns 1-2 is the yield (i.e., the effect rate or return) of the security reported by the insurer; the dependent variable of columns 3-5 is the amount held by an insurance company in a given security and in a certain year (when the insurer makes its first investment in the security) as a percentage of the volume outstanding of the security in that year. As for the independent variables, *dummy CLO* is a dummy variable equal to one if the security is a CLO tranche and zero otherwise; *Yield CLO/Yield Bond ratio* is ratio of the average yield on insurers' new investments in CLOs to the average yield of insurers' new investments in corporate bonds for each rating-year pair; *Time-to-maturity* is the time to maturity of the security in years reported by the insurer; *Outstanding Amount* is the volume outstanding of the security. For each independent variable the first row reports the coefficient, the second row reports in parenthesis the robust standard error that is corrected for multiclustering at the insurer and year level. Fixed effects are included,"Yes", not included, "No", or subsumed by other fixed effects, "-". ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Table 6: Insurance Companies' Preference for CLOs vis-à-vis Corporate Bonds: The 2010 Regulatory Reform

	(1)	(2)
Sample	Assets with Aaa, Aa, A and Baa rating	
Dependent variable	Insurance company's new holding as percentage of total volume outstanding	
dummy CLO	25.621**	33.948***
	(9.26)	(6.88)
Yield CLO/Yield Bond ratio	0.356	0.189
	(0.33)	(0.35)
dummy CLO x Yield CLO/Yield Bond ratio	-11.553*	-13.211***
	(5.81)	(3.87)
dummy Reform x dummy CLO	-33.134***	
	(9.95)	
dummy Reform x Yield CLO/Yield Bond ratio	-0.259	
	(0.58)	
dummy Reform x dummy CLO x Yield CLO/Yield Bond ratio	24.751***	
	(6.41)	
Year>2009 x dummy CLO		-45.897***
		(7.25)
Year>2009 x Yield CLO/Yield Bond ratio		0.325
		(0.44)
Year>2009 x dummy CLO x Yield CLO/Yield Bond ratio		28.647***
		(4.48)
Benefit Reform x dummy CLO		-0.281
		(6.70)
Benefit Reform x Yield CLO/Yield Bond ratio		1.312**
		(0.53)
Benefit Reform x dummy CLO x Yield CLO/Yield Bond ratio		0.918
		(3.19)
Benefit Reform x Year>2009 x dummy CLO		25.195***
		(7.69)
Benefit Reform x Year>2009 x Yield CLO/Yield Bond ratio		0.297
		(1.42)
Benefit Reform x Year>2009 x Yield CLO/Yield Bond ratio x dummy CLO		-15.680***
		(4.55)
Time-to-maturity	-0.002	0.002
	(0.00)	(0.00)
Outstanding Amount	-0.255***	-0.281***
	(0.05)	(0.05)
constant	0.627	0.040
	(0.66)	(0.55)
Rating FE	Yes	Yes
Type insurer FE	Yes	Yes
Insurer x Year FE	Yes	Yes
Two-way clustering	Insurer, Year	Insurer, Year
N	1276043	1156793
R^2	0.316	0.334
$Adj - R^2$	0.294	0.313
F-stat	24.190***	-
Degrees of freedom	(8, 16)	-

This table reports panel regression estimates of extensions of the linear regression model of equation 3 analyzing how the sensitivity of insurers' preference for CLOs over corporate bonds to the yields ratio varies based on the 2010 Regulatory Reform. The models are estimated on a granular dataset at the security-company-year level covering first-time investments by insurance companies in CLO tranches and corporate bonds rated Aaa, Aa, A or Baa. The dependent variable is the amount held by an insurance company in a given security and in a certain year (when the insurer makes its first investment in the security) as a percentage of the volume outstanding of the security in that year. As for the independent variables, *dummy CLO* is a dummy variable equal to one if the security is a CLO tranche and zero otherwise; *Yield CLO/Yield Bond ratio* is ratio of the average yield on insurers' new investments in CLOs to the average yield of insurers' new investments in corporate bonds for each rating-year pair; *Time-to-maturity* is the time to maturity of the security in years reported by the insurer; *Outstanding Amount* is the volume outstanding of the security. For each independent variable the first row reports the coefficient, the second row reports in parenthesis the robust standard error that is corrected for multiclustering at the insurer and year level. Control variables and fixed effects are included,"Yes", or not included, "No". ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Table 7: Insurance Companies' Preference for CLOs vis-à-vis Corporate Bonds: Aggregate Results

	(1)	(2)	(3)	(4)	(5)
Sample	Holdings with Aaa, Aa, A and Baa rating				
Dependent variable	Insurance company's new holding of asset classes by rating as percentage of total volume outstanding		Insurance company's new holding of CLOs by rating as percentage of total new holdings of CLOs and corporate bonds		
dummy CLO	0.316***	-0.025			
	(0.10)	(0.17)			
Year=2007-2008				-0.746***	
				(0.25)	
Year=2009-2015				0.823	
				(0.53)	
Year=2016-2019				5.899***	
				(1.22)	
dummy Reform x dummy CLO		0.585***			
		(0.10)			
Yield CLO/Yield Bond ratio			10.144**		
			(3.78)		
dummy Reform					1.139
					(1.36)
Time-to-maturity (years)	0.107***	0.106***			
	(0.01)	(0.01)			
Outstanding Amount ($bln)	0.000***	0.000***			
	(0.00)	(0.00)			
Outstanding CLO/ Outstanding Bond ratio			25.572***	24.085***	24.913***
			(4.48)	(3.91)	(4.47)
Size	0.204***	0.203***		0.976***	2.725***
	(0.03)	(0.03)		(0.29)	(0.74)
ROE	-0.022	-0.022		1.453***	0.927*
	(0.03)	(0.03)		(0.43)	(0.46)
Capital ratio	0.107*	0.106		-2.827**	0.228
	(0.06)	(0.06)		(1.31)	(2.21)
CAL RBC ratio	0.001***	0.001***		0.038***	0.049***
	(0.00)	(0.00)		(0.01)	(0.01)
constant	-2.653***	-2.643***	-13.366**	-12.409***	-34.507***
	(0.32)	(0.32)	(5.66)	(3.78)	(9.41)
Rating x Year FE	Yes	Yes	No	No	No
Rating FE	-	-	Yes	Yes	Yes
Type insurer FE	Yes	Yes	Yes	Yes	Yes
Insurer x Year FE	No	No	Yes	No	No
Insurer FE	Yes	Yes	-	Yes	Yes

Continued on next page

Table 7 - continued from previous page

Two-way clustering	Insurer, Year	Insurer, Year	Insurer, Year	Insurer, Year	Insurer, Year
N	332837	332837	110660	113076	113076
R^2	0.366	0.370	0.611	0.374	0.361
$Adj - R^2$	0.358	0.362	0.416	0.350	0.337
F-stat	90.601***	83.412***	18.171***	17.013***	8.345***
Degrees of freedom	(7, 16)	(8, 16)	(2, 16)	(8, 16)	(6, 16)

This table reports panel regression estimates of the linear regression model of equation 5 and its extensions (columns 1-2) and of the linear regression model of equation 6 and its extensions (columns 3-5) analyzing insurers' preference for CLOs over corporate bonds at the aggregate level. Models 1-2 are estimated on a dataset at the insurer-asset class-rating-year level covering first-time investments by insurance companies in CLO tranches and corporate bonds rated Aaa, Aa, A or Baa. The dependent variable is the amount of first-time investments of an insurance company in one asset class (CLO or corporate bond) with a given rating in a certain year as percentage of the total volume outstanding of the asset class with that rating in that year. Models 3-5 are estimated on a dataset at the insurer-rating-year level covering first-time investments by insurance companies in CLO tranches and corporate bonds rated Aaa, Aa, A or Baa. The dependent variable is the amount of first-time investments of an insurance company in CLO tranches with a given rating in a certain year as percentage of the total volume of new investments in CLOs and corporate bonds with that rating in that year. As for the independent variables, *dummy CLO* is a dummy variable equal to one if the asset class consists in CLO tranches and zero otherwise; *Yield CLO/Yield Bond ratio* is ratio of the average yield on insurers' new investments in CLOs to the average yield of insurers' new investments in corporate bonds for each rating-year pair; *dummy Reform* is a dummy equal to one if the year falls into the time period 2010-2018, when the 2010 regulatory reform was into effect, and zero otherwise; *Time-to-maturity* is the average time-to-maturity of all new investments of the insurer in the asset class for each rating-year pair; *Outstanding Amount* is the total volume outstanding of the asset class for each rating-year pair; *Outstanding CLO/Outstanding Bond ratio* is the ratio of the total outstanding amount of CLO tranches to the total outstanding amount of corporate bonds for each rating-year pair; *Size* is the natural logarithm of total admitted assets of the insurer; *ROE* is the ratio of net income to total adjusted capital of the insurer; *Capital ratio* is the ratio of total adjusted capital to total admitted assets of the insurer; *CAL RBC ratio* is the CAL risk-based capital ratio of the insurer. For each independent variable the first row reports the coefficient, the second row reports in parenthesis the robust standard error that is corrected for multiclustering at the insurer and year level. Fixed effects are included, "Yes", not included, "No", or subsumed by other fixed effects, "-". ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Table 8: Capital structure of CLO deals

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Sample		Aaa			Aa-A-Baa			Ba-B-Caa-Ca-C		Equity		All tranches	
Dependent variable					Tranches as % of CLO							Fixed-rate Tranches as % of CLO	
% of CLO held by ICs	-0.298**	-0.101**	-0.221***	0.355**	0.026	0.290**	-0.029***	-0.006	0.002	-0.015	0.424***	0.178*	-0.036
	(0.12)	(0.04)	(0.05)	(0.17)	(0.03)	(0.11)	(0.01)	(0.01)	(0.04)	(0.03)	(0.11)	(0.09)	(0.05)
dummy Reform x % of CLO held by ICs		-0.219			0.365*			-0.026*				0.272*	
		(0.14)			(0.18)			(0.01)				(0.13)	
Year>2009 x % of CLO held by ICs			0.278***			-0.365**			0.007				0.312**
			(0.06)			(0.13)			(0.04)				(0.11)
% of CLO held by ICs Benefit Reform			0.070			-0.209			0.005				0.261
			(0.16)			(0.14)			(0.05)				(0.16)
% of CLO held by ICs Benefit Reform x % of CLO held by ICs			0.004			-0.002***			0.000				-0.008
			(0.00)			(0.00)			(0.00)				(0.01)
Year>2009 x % of CLO held by ICs Benefit Reform			0.127			0.046			-0.014				-0.659**
			(0.33)			(0.39)			(0.06)				(0.27)
Year>2009 x % of CLO held by ICs Benefit Reform x % of CLO held by ICs			-0.013**			0.011***			-0.001				0.016*
			(0.01)			(0.00)			(0.00)				(0.01)
constant	66.416***	66.300***	62.070***	17.107***	17.300***	22.138***	4.664***	4.651***	4.301***	10.402***	-2.943*	-2.799*	0.222
	(1.79)	(1.64)	(0.88)	(2.44)	(2.22)	(1.35)	(0.14)	(0.13)	(0.08)	(0.47)	(1.61)	(1.50)	(0.97)
Manager x Issuance Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Two-way clustering	Manager, Year	Manager, Year	Manager, Year	Manager, Year	Manager, Year	Manager, Year	Manager, Year	Manager, Year	Manager, Year	Manager, Year	Manager, Year	Manager, Year	Manager, Year
One-way clustering													
N	1703	1703	1703	1703	1703	1703	1703	1703	1703	1703	1703	1703	1703
R^2 (Pseudo R^2 for probit)	0.623	0.626	0.683	0.522	0.532	0.630	0.635	0.636	0.648	0.634	0.462	0.466	0.496
$Adj - R^2$	0.436	0.439	0.524	0.284	0.298	0.442	0.452	0.454	0.470	0.452	0.194	0.199	0.242
F-stat	5.981**	6.834***	-	4.571**	2.858*	-	8.596***	4.886**	2487.433***	0.202	14.889***	8.678***	8.295***
Degrees of freedom	(1 , 15)	(2 , 15)	-	(1 , 15)	(2 , 15)	-	(1 , 15)	(2 , 15)	(6, 15)	(1 , 15)	(1 , 15)	(2 , 15)	(6, 15)

This table reports regression estimates of the linear regression models of equation 7 and its extensions analyzing the design CLO deals in relation to the share of the CLO deal held by insurance companies. The models are estimated on a dataset at the CLO deal-manager-issuance year level covering information on CLO deals issued over the time period 2003-2019 and whose tranches are denominated in USD. The dependent variable is the percentage of a CLO deal represented by tranches rated (i) triple-A (columns 1-3), (ii) Aa, A and Baa (columns 4-6), (iii) Ba, B, Caa, Ca, C (columns 7-9), (iv) equity tranches (column 10), or the percentage of a CLO deal represented by tranches fixed-rate tranches (columns 11-13) in the year of the issuance. Both the numerator and the denominator of the dependent variable exclude combo notes pertaining to the CLO deal. As for the independent variables, *% CLO held by ICs* is the percentage of the CLO deal held by insurance companies in the year of issuance of the CLO deal (the numerator of this variable includes holdings of combo notes pertaining to the CLO deal whereas the denominator does not); *dummy Reform* is a dummy equal to one if the year falls into the time period 2010-2018, when the 2010 regulatory reform was into effect, and zero otherwise; *% CLO held by ICs Benefit Reform* is the percentage of the CLO deal held by insurance companies that benefit from the 2010 regulatory reform based on their CLO holdings at year-end 2009 in the year of issuance of the CLO deal. For each independent variable the first row reports the coefficient, the second row reports in parenthesis the robust standard error that is corrected for multiclustering at the CLO manager and year level. Fixed effects are included, "Yes", not included, "No", or subsumed by other fixed effects, "-". ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Table 9: Collateral pool, debt tranches and equity tranches of CLO deals

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sample	Collateral pool of CLO deals		Debt tranches of CLO deals			Equity tranche of CLO deals		
			Aaa	Aa-A-Baa	Ba-B-Caa-Ca-C	All CLO deals until min(reinv. date, refi. date)	Matured and Terminated CLO deals	
Dependent variable	Spread (%)	Weighted Average Spread (%)	Weighted Average Spread (%)			Average annualized rate of return (%)	IRR (%)	PME
% of CLO held by ICs	0.003**	0.006**	-0.002*	-0.012**	-0.005	0.010**	0.110*	0.002***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.06)	(0.00)
constant	3.550***	3.556***	1.145***	2.346***	5.694***	4.391***	7.161***	1.359***
	(0.02)	(0.04)	(0.01)	(0.06)	(0.08)	(0.05)	(0.49)	(0.00)
Manager x Issuance Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Two-way clustering	Manager, Year	Manager, Year	Manager, Year	Manager, Year	Manager, Year	Manager, Year	Manager, Year	Manager, Year
N	321246	1051	1555	1558	1374	1419	460	460
R^2	0.208	0.874	0.941	0.780	0.728	0.646	0.778	0.824
$Adj - R^2$	0.206	0.802	0.911	0.670	0.583	0.465	0.644	0.718
F-stat	4.570**	6.152**	4.081*	7.673**	0.832	6.937**	3.885*	16.114***
Degrees of freedom	(1, 16)	(1, 14)	(1, 14)	(1, 14)	(1, 14)	(1, 14)	(1, 11)	(1, 11)

This table reports panel regression estimates of three econometric models analyzing the riskiness of the underlying pool of loans of CLO deals based on equation 8 (models 1-2), the spread of debt tranches of CLO deals based on equation 9 (models 3-5), and the return earned by the equity tranche of CLO deals based on equation 10 (models 6-8) in relation to the share of the CLO deal held by insurance companies. Model 1 is estimated on a dataset at the loan investment-CLO deal-manager-issuance year level; models 2-7 are estimated on various datasets at the CLO deal-manager-issuance year level. The datasets cover information on CLO deals issued over the time period 2003-2019 and whose tranches are denominated in USD. The dependent variable of model 1 is the interest rate spread charged on a loan investment belonging to the collateral pool of a CLO deal at the end of the year of origination, excluding credit lines, revolving loans and Term Loan A facilities; the dependent variable of model 2 is the weighted average spread of loan investments in the collateral pool of a CLO deal in the year of issuance, excluding credit lines, revolving loans and Term Loan A facilities; the dependent variable of models 3-5 is the weighted average spread of debt tranches of CLO deals by groups of credit ratings at origination of the deal, excluding combo notes; the dependent variable of model 6 is the average of the annualized rate of returns earned by the equity tranche of CLO deals (excluding deals that represent a repackage of CLO tranches from another/other CLO deal/s) in each pay period during the life of the deal until the minimum between the end of the reinvestment period, the first refinancing date (in case the CLO deal is refinanced) and the last pay date in 2019 (when our sample ends); the dependent variables of model 7 is the internal rate of return (IRR) earned by the equity tranche of CLO deals matured or terminated during our sample period, excluding CLO deals that represent a repackage of CLO tranches from another/other CLO deal/s; the dependent variable of model 8 is the public market equivalent (PME) of Kaplan and Schoar (2005) for the equity tranche of CLO deals matured or terminated during our sample period, excluding CLO deals that represent a repackage of CLO tranches from another/other CLO deal/s, calculated by discounting the period cash flows to the equity tranche using the returns of the S&P 500. As for the independent variables, *% CLO held by ICs* is the percentage of the CLO deal held by insurance companies in the year of issuance of the CLO deal (the numerator of this variable includes holdings of combo notes pertaining to the CLO deal whereas the denominator does not). For each independent variable the first row reports the coefficient, the second row reports in parenthesis the standard error. Standard errors of model 1, 3-8, and 10-11 are corrected for multiclustering at the CLO manager and year level. Standard errors of models 2 and 9 are clustered by year. Fixed effects are included, "Yes", not included, "No", or subsumed by other fixed effects, "-". ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Table 10: Generalized public market equivalent of equity tranches of CLO deals

Sample	(1) CLO deals with high % held by ICs	(2)	(3) CLO deals with low % held by ICs	(4)
CLO deal issuance year	N deals	GPME	N deals	GPME
2003-2004	21	0.126***	21	-0.182*
		[0.000]		[0.086]
2005-2006	106	0.842***	106	0.819***
		[0.000]		[0.000]
2007-2008	78	1.095***	89	0.906***
		[0.000]		[0.000]
2010-2011	15	0.608***	16	-0.120
		[0.000]		[0.387]
2012-2013	75	0.033	76	-0.021
		[0.650]		[0.880]
2014-2016	64	0.184***	65	0.142***
		[0.000]		[0.008]

This table reports the estimates of the generalized public market equivalent (GPME) of Korteweg and Nagel (2016) for the equity tranche of different subgroups of CLO deals matured or terminated by November 2019. CLO deals are grouped based on i) their issuance year into six buckets of two-year/three-year periods and ii) whether the percentage of the CLO deal held by insurance companies in the year of origination is above (columns 1 and 2) or below (columns 3 and 4) the median for CLO deals issued in the corresponding time interval. Since there are only six CLO deals issued in 2009 in our sample and none of them complies with our quality control constraints, we exclude CLO deals issued in 2009 from these estimates. The number of CLO deals pertaining to each subgroup is reported in columns 1 and 3. The estimates of the GPME for each subgroup of CLO deals are reported in columns 2 and 4. We consider a general CAPM stochastic discount factor (SDF). The SDF parameters are identified to correctly price benchmark funds that receive the same inflows as the CLO equity tranches but that invest in the CRSP value-weighted index and one-month T-bills. The p-values of the J-test that the GPME estimate is equal to zero are reported in square brackets under the GPME estimate. ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

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Internet Appendix to

Insurance companies and the growth of corporate loans' securitization

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Internet Appendix to
Insurance companies and the growth of corporate loans' securitization

A Overview

This appendix contains additional information and results for our paper Insurance companies and the growth of corporate loans' securitization. We begin by presenting information on insurance capital regulation that complements the description we presented in Section 2 of our paper. Specifically, Section B below describes in detail the capital regulation applicable to insurance companies while It also describes the changes to that regulation implemented in 2010 that are relevant for insurance companies' investment in CLOs.

Section C complements the analysis reported in Section 4 of the paper on insurance companies' search for yield. Here we report the results of three additional robustness tests investigating (i) differences in insurers' search for yield over time; (ii) the heterogeneity in insurers' search for yield behavior across their capital standards; (iii) the search for yield heterogeneity across P&C companies in response to natural disasters.

Section D complements the analysis reported in Section 5 of the paper on insurance companies' preferences for CLOs over corporate bonds. Specifically, we investigate how these preferences manifested themselves before, during and after the financial crisis. Additionally, we investigate how these preferences vary with insurance companies' capital standards.

Finally, Section E complements the analysis reported in Section 6 of our paper on the impact of insurance companies on the CLO market. Specifically, we investigate to what extent insurance companies played a role on (i) the creation of CLO deals backed

by CLO tranches from other deals, (ii) the length of the non-call period, and (iii) the refinancing of CLO deals.

B Insurance Companies' Capital Regulation

Capital adequacy is the key microprudential tool of solvency regulation for insurance companies. While the U.S. insurance industry is regulated at the state level, regulatory capital requirements are harmonized across states thanks to NAIC's coordination role.[1] All states have adopted the risk-based capital framework designed by the NAIC and first implemented in the early 1990s. Similar to bank capital regulation, that framework defines a minimum amount of capital that insurance companies must maintain in relation to their size and risk profile, and specifies a series of actions that will be implemented against non-compliers. The risk-based capital regime is intended to limit risk-taking of insurers and provide a safety buffer to policyholders and bondholders against insolvency.

The risk-based capital requirement, denoted "authorized control level" (ACL) risk-based capital, is calculated as a function of insurers' exposures to different types of risk. Broadly speaking, the framework classifies risks into three macro categories: asset risk, underwriting risk, and all other business risk. Subcategories of those risks depend on the the specific type of insurer, implying that the capital formula slightly differs across the three main lines of business, i.e. life, P&C, and health. Importantly, the current regulatory framework sets the required capital at the legal entity level (and not at the consolidated level).[2]

The assessment of insurers' solvency conditions is based on the "risk-based capital ratio" — the ratio of "total adjusted capital" (which is essentially the insurer statutory

[1]The NAIC is an organization governed by the chief insurance regulators from the 50 states, the District of Columbia and the five U.S. territories. State regulators coordinate through the NAIC to define common standards, conduct peer review, and oversee the insurance industry.

[2]NAIC created a "Group Capital Calculation Working Group" that is currently developing a capital requirement to be applied at the group level.

capital and surplus) to the ACL risk-based capital. A capital shortage may trigger four levels of regulatory actions, which are progressively more severe for decreasing values of the risk-based capital ratio. For example, if total adjusted capital falls below 200% of the risk-based capital requirement, this indicates the company breached the "company action level" (CAL) and is required to submit a plan to restore its level of capitalization.

Important for us are the capital requirements for asset risk associated to fixed income investments, including corporate bonds, loans and CLOs. These are calculated as a weighted sum of the book value of fixed income investments, with weights equal to a risk-based capital charge that captures the credit risk of each asset. As explained in section 2, the risk-based capital charge is defined for different buckets of assets' credit quality named "NAIC designations" (NAIC, 2018, 2020). The original regulatory framework defined 6 different NAIC designations, which have been broken down into 20 subcategories starting in 2021. A NAIC 1 designation corresponds to securities with the highest credit quality, whereas a NAIC 6 designation corresponds to securities with the lowest credit quality. Insurance companies in our sample assign a NAIC designation (and the associated risk-based capital charge) to fixed income investments by converting credit ratings according to the mapping presented in Table 1.

With regards to the book value of an asset, it corresponds to "amortized cost" for NAIC 1-5 holdings of life insurers and NAIC 1-2 holdings of P&C and health insurers, unless the asset is impaired. Amortized cost means that the purchase premium or discount is amortized throughout the life of the investment. The book value corresponds, instead, to the lower between the amortized cost and the fair value for NAIC 6 assets of life insurers and NAIC 3-6 of P&C and health insurers. Securities that are not temporarily impaired should be reported at fair value.

B.1 The 2010 Reform of Capital Requirements for CLO Investments

In 2010, the NAIC introduced a new methodology to calculate capital requirements for CLO investments (Foley-Fisher et al., 2023). The new framework allowed insurers to assign CLO tranches purchased at discount or highly impaired a lower NAIC designation than the designation implied by the rating-based mapping of Table 1. Specifically, insurers could adopt the following multi-step process (named "modified filing exempt", MFE):

1. convert the credit rating of a CLO tranche into a NAIC designation according to the mapping of Table 1. If the conversion results in a NAIC 1 or a NAIC 6 designation, assign this class of risk.

2. It the conversion results in a NAIC 2-5 category, compare the ratio $\textit{book value} \times 100/\textit{par value}$ to the breakpoints of Table B1 to determine the "initial NAIC designation". If this corresponds to NAIC 1-5, assign this class of risk. For example, suppose that the credit rating conversion delivers a NAIC 2. This designation may be replaced with a NAIC 1 if the book value is lower than 97.88% of the investment's par value.

3. If the initial designation obtained in the previous step is NAIC 6, then compare the ratio $\min(\textit{book value}, \textit{fair value}) \times 100/\textit{par value}$ to the pricing matrix of Table B1 and assign the final designation accordingly.

This multi-step process was applied until the reporting year 2018 (NAIC, 2019b). Starting in 2019, the ratings-based approach of Table 1 was restored.

As per statutory guidelines, the NAIC designation of CLOs determined according to points 2 and 3 of the MFE process must be reported with the suffix "AM". While a NAIC designation including this substring does not automatically signal an exception to the baseline rating mapping for the NAIC 2-6 categories, all NAIC 1 designations including the "AM" suffix identify tranches whose credit rating would not translate into

a NAIC 1. This means that, for the NAIC 1 category, we are able to exactly identify the volume of CLOs reported based on the 2010 reform.

Table B1: Modified Filing Exempt Approach

	NAIC Designation Breakpoints				
Life	1>2	2>3	3>4	4>5	5>6
NAIC 2	97.88	100.00	104.69	116.23	132.04
NAIC 3	93.49	95.52	100.00	111.02	126.12
NAIC 4	84.22	86.04	90.08	100.00	113.61
NAIC 5	74.13	75.73	79.29	88.02	100.00
P&C and Health	1>2	2>3	3>4	4>5	5>6
NAIC 2	99.14	100.00	101.81	106.20	123.13
NAIC 3	97.28	98.22	100.00	104.31	120.94
NAIC 4	93.36	94.16	95.87	100.00	115.94
NAIC 5	80.52	81.22	82.69	86.25	100.00

This table reports the NAIC designation breakpoints used in the "modified filing exempt", MFE, approach introduced by the 2010 regulatory reform to assign a NAIC designation to CLO tranches rated Baa to Caa. The MFE approach remained into effect from the reporting year 2010 to the reporting year 2018. Source: NAIC.

C Insurance companies' search for yield: Additional results

In this section, we report the results of three additional robustness tests investigating (i) differences in insurers' search for yield over time; (ii) the heterogeneity in insurers' search for yield behavior across their capital standards; (iii) the search for yield heterogeneity across P&C companies in response to natural disasters.

C.1 Search for yield over time

We begin by exploring possible differences in insurers' search for yield over time. This is important because our sample period (2003-2019) encompasses a protracted period of low interest rates, which has been linked to increased risk-taking by the banking industry.[3] It also overlaps with the 2010 regulatory reform, which made it easier for insurance companies to search for yield in the CLO market. The results of our investigation on

[3]See, for example, Altunbas et al. (2014), Peydro and Maddaloni (2011), Dell'Ariccia et al. (2017), Jimenez et al. (2014), Ioannidou et al. (2015) and Paligorova and Santos (2019).

the heterogeneity of the effects over time are reported in Table C1.

Column 1 of Table C1 investigates whether insurance companies' incentives to reach for yield changed across different economic and monetary policy regimes: pre-crisis (2003-2006), financial crisis (2007-2008), zero lower bound (ZLB) period (2009-2015) and post-ZLB (2016-2019). The interaction terms between the yield and the time dummies suggests that insurance companies searched for yield both in the pre-crisis period (when interest rates were relatively high) and the post-crisis period (when interest rates were relatively low), but this behavior is stronger (more than triple in magnitude) during the latter time period.

Interestingly, in the post-crisis decade, insurers' incentives to invest in higher yielding securities within a NAIC category is more pronounced in the post-ZLB period, when the policy rate increased, compared to the ZLB-period. This remains true even when we control for the asset class (column 2), but the difference in the interaction coefficients of the ZLB period and the post-ZLB shrinks significantly. Overall, this suggests that the economic cycle affects significantly firms' propensity to search for yield, with insurers investing in higher yield securities within a NAIC bucket in periods of economic growth, irrespective of the levels of interest rates. However, monetary policy seems also to play a role, as this phenomenon is reinforced in an environment of low interest rates. It is worth noting that, while new issuance of CLOs plummeted during the financial crisis (Figure 1) making reaching for yield de facto not viable for CLO investments at that time, new issuance of corporate bonds also dropped but did not freeze (Figure C1). However, given insurance companies' apparent preference for searching for yield within the CLO asset class (column 5 of Table 3), the collapse in new issuance of CLOs in 2008-2010 (as a result of a broader aversion of investors towards asset-backed securities) might be the key driver behind insurers' vanished propensity to invest in higher yield securities during the financial crisis.

Figure C1: U.S. Corporate Bonds New Issuance

This figure plots the time series of the volume of total new issuance of corporate bonds denominated in USD over the time period 2003-2019 on a yearly basis. Source: Mergent Fixed Income Securities Database (FISD).

C.2 Heterogeneity across insurance companies' capital standards

Our next tests explore the heterogeneity in insurers' search for yield behavior across insurance companies with different capital standards. In the banking literature, well capitalized banks are believed to be less prone to take on risk.[4] Therefore, we expect stronger evidence of search for yield among insurers with a low level of capitalization.[5] Columns 3 through 5 of Table C1 report the results for three different measures of insurance companies' capitalization: capital ratio, CAL RBC ratio, and ACL RBC ratio, respectively. Irrespective of the capitalization metric adopted, we find that insurance companies with a lower capital ratio or closer to the minimum capital requirements are more prone to search for yield.

C.3 Heterogeneity across insurance companies' exposures to natural disasters

Our final test on the search for yield heterogeneity across firms focuses on P&C companies, the category of insurers in our sample more exposed to natural disasters. Figure C2 shows the time series of nationwide property damage from federally-designed disasters from 1964 to 2018. During the last two decades, major disasters occurred in 2005, when

[4]Repullo (2000) shows this link in a model where capital is used as a cushion against adverse contingencies, and Jimenez et al. (2014) and Dell'Ariccia et al. (2017) find evidence consistent with this insight.

[5]Of course this builds on the assumption that the banking insight applies to insurance companies. It is also worth noting that, even within the banking industry, there are different views on the impact of capital on banks' risk taking incentives (e.g. Rochet (1992)).

hurricane Katrina caused large-scale devastation in the Gulf Coast region, and in 2017, which saw a devastating hurricane season with hurricanes Harvey, Irma and Maria and an unprecedented break out of wildfires in Northern California. The aggregate value of nationwide property damage peaked exactly in 2005 and 2017, reaching almost $100B in both years and implying significant insured losses.

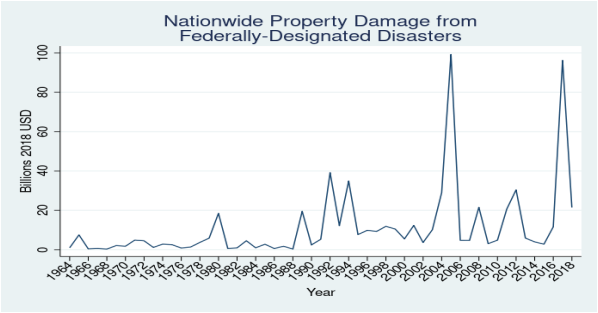
We, thus, investigate if P&C insurers that were hard hit by disaster events, as captured by the yearly change in their net income, search for yield more aggressive in 2005 and 2017 relative to less affected companies. The idea is that insurance companies experiencing higher losses may try to boost their net income by investing in securities offering higher returns. To this end, we generate a dummy variable equal to one if the change in net income scaled by lagged total assets of a P&C insurer in a given year is below the median (henceforth abridged "below median dummy") and zero otherwise and we interact this variable with the effective yield and a time dummy for 2005 and 2017, respectively. The results of this investigation are reported in column 6 of Table C1.

Indeed, the only two years when poorly performing insurance companies search for yield more actively is in 2005 and 2017, the two years in our sample period with record losses from natural disasters. While the interaction between the yield and the below median dummy is not statistically significant, the triple interactions of the yield, the below median dummy, and the time dummies for 2005 and 2017 are both positive and significant. Since the coefficient of the triple interaction of 2017 is more than twice that of 2005, this suggests the search for yield in response to the increase in insured losses due to catastrophic events was much stronger in 2017 than 2005. We instigated in columns 7 and 8 whether insurance companies' responses continued after 2005 and 2017 and found no evidence of persistence, suggesting that their additional search for yield was indeed to compensate for the record looses they experienced on those two years.

This finding corroborates our previous results on low-capital, adding support to

our evidence that insurance companies exploit the design of their capital regulation and search for yield through their investments in both corporate bonds and CLO tranches.

Figure C2: Weather and Climate Disaster Events



This figure plots the time series of nationwide property damage from federally-designed disasters from 1964 to 2018. Source: Spatial Hazards Events Database for the United States (Sheldus).

Table C1: Search for yield: Heterogeneity analysis

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				All insurers		P&C insurers	Years 2003-2006 P&C insurers with 2005 Δ*Net Income* below the median	P&C insurers with 2017 Δ*Net Income* below the median
Dependent variable	Insurance company's holding as percentage of total volume outstanding							
Yield			0.127**	0.074**	0.074**	0.031**	-0.006	0.036*
			(0.04)	(0.03)	(0.03)	(0.02)	(0.01)	(0.02)
Year=2003-2006 x Yield	0.032*	0.02						
	(0.02)	(0.01)						
Year=2007-2008 x Yield	0.014	-0.001						
	(0.03)	(0.02)						
Year=2009-2015 x Yield	0.115***	0.086**						
	(0.04)	(0.03)						
Year=2016-2019 x Yield	0.363***	0.113***						
	(0.07)	(0.04)						
Capitalization x Yield			-0.173**					
			(0.06)					
CAL RBC ratio x Yield				-0.001*				
				(0.00)				
ACL RBC ratio x Yield					-0.000*			
					(0.00)			
Year=2005 x Yield						-0.021*	0.008	
						(0.01)	(0.01)	
Year=2017 x Yield						-0.025**		0.069**
						(0.01)		(0.03)
Year>2005 x Yield							0.005	
							(0.01)	
Year>2017 x Yield								-0.006
								(0.06)
Below Median ΔNet Income						0.007		
						(0.04)		
Below Median ΔNet Income x Yield						-0.004		
						(0.01)		
Below Median ΔNet Income x Year=2005						-0.087		
						(0.07)		
Below Median ΔNet Income x Year=2017						-0.382***		
						(0.07)		
Below Median ΔNet Income x Year=2005 x Yield						0.029*		
						(0.02)		
Below Median ΔNet Income x Year=2017 x Yield						0.103***		
						(0.02)		
Time-to-maturity	-0.011*	-0.004	-0.002	-0.002	-0.002	-0.001	0.002	0.001
	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)
Outstanding Amount	-0.571***	-0.300***	-0.331***	-0.330***	-0.330***	-0.213***	-0.504**	-0.198***
	(0.06)	(0.05)	(0.05)	(0.05)	(0.05)	(0.03)	(0.07)	(0.03)
Size			0.257***	0.256***	0.256***			
			(0.02)	(0.02)	(0.02)			
ROE			-0.312	-0.324	-0.324			
			(0.21)	(0.21)	(0.21)			
Capital ratio			0.756***	0.036	0.036			
			(0.26)	(0.13)	(0.13)			
CAL RBC ratio			0.001	0.004***				
			(0.00)	(0.00)				
ACL RBC ratio					0.002***			
					(0.00)			

Continued on next page

Table C1 - continued from previous page

$Size_{t-1}$						0.155***	0.209***	0.143***
						(0.02)	(0.03)	(0.03)
ROE_{t-1}						-0.000***	-0.001	-0.001
						(0.00)	(0.00)	(0.00)
Capital $ratio_{t-1}$						0.001	0.000	-0.003*
						(0.00)	(0.00)	(0.00)
CAL RBC $ratio_{t-1}$						0.000	0.000	0.000**
						(0.00)	(0.00)	(0.00)
constant	0.890***	0.942***	-2.988***	-2.732***	-2.732***	-1.841***	-1.300***	-1.300***
	(0.09)	(0.07)	(0.35)	(0.33)	(0.33)	(0.24)	(0.42)	(0.32)
NAIC designation x Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Security type (CLO or bond) FE	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Type insurer FE	Yes	Yes	Yes	Yes	Yes	No	No	No
Insurer x Year FE	Yes	Yes	No	No	No	No	No	No
Two-way clustering	Insurer, Year	Insurer, Year	Insurer, Year	Insurer, Year	Insurer, Year	Insurer, Year	Insurer, Year	Insurer, Year
N	1691393	1691393	1650705	1650705	1650705	622644	34165	298099
R^2	0.192	0.292	0.205	0.205	0.205	0.130	0.071	0.148
$Adj - R^2$	0.172	0.274	0.205	0.205	0.205	0.130	0.071	0.148
F-stat	14.456***	11.556***	24.609***	24.166***	24.166***	-	-	78.946***
Degrees of freedom	(6, 16)	(6, 16)	(8, 16)	(8, 16)	(8, 16)	-	-	(9, 15)

This table reports panel regression estimates of a series of extensions to the linear regression model of equation 1 analyzing the heterogeneity over time and across companies of insurers' search for yield in the CLO and corporate bond asset classes. The models are estimated on a granular dataset at the security-company-year level covering first-time investments by insurance companies in CLO tranches and corporate bonds. Model 6 is estimated on the subsample of P&C insurers; model 7 and model 8 are estimated on the subsamples of P&C insurers whose yearly change in net income scaled by lagged total assets is below the median in 2005 and 2017, respectively. The dependent variable is the amount held by an insurance company in a given security and in a certain year (when the insurer makes its first investment in the security) as a percentage of the volume outstanding of the security in that year. As for the independent variables, *Yield* is the yield (i.e., the effect rate or return) of the security reported by the insurer; *Below Median ΔNet Income* is a dummy variable equal to one if the change in net income of a P&C insurer is below the median; *Time-to-maturity* is the time to maturity of the security in years reported by the insurer; *Outstanding Amount* is the volume outstanding of the security; *Size* is the natural logarithm of total admitted assets of the insurer; *ROE* is the ratio of net income to total adjusted capital of the insurer; *Capital ratio* is the ratio of total adjusted capital to total admitted assets of the insurer; *CAL RBC ratio* is the CAL risk-based capital ratio of the insurer; *ACL RBC ratio* is the ACL risk-based capital ratio of the insurer. For each independent variable the first row reports the coefficient, the second row reports in parenthesis the robust standard error that is corrected for multiclustering at the insurer and year level. Fixed effects are included, "Yes", or not included, "No". ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

D Insurers' preferences for CLOs: Additional results

In this section, we investigate how insurance companies' preferences for CLOs over corporate bonds varies with insurance companies' capital standards and over time (before, during and after the financial crisis).

We begin by exploring the role of insurer's capital standards. Models 1-3 of Table D1 extend model 5 of Table 5 to include a triple interaction of the CLO dummy with the yields ratio and each of the variables capturing firm capitalization used before (capital ratio, CAL risk-based capital ratio and ACL risk-based capital ratio). While the simple capital ratio does not imply any differential effect, we find that firms closer to the minimum capital requirements are more sensitive to the yields ratio when deciding the extent of their investments in CLO tranches vis-à-vis corporate bonds with the same rating. This result is in line with the idea that higher leverage brings stronger incentives to search for yield.

Next, we investigate the sensitivity of insurers' preference for CLOs over corporate bonds to the yields ratio over time. Following the approach we adopted in the paper we carry out this analysis both using granular security-company-year level data and consolidated securities holdings at the insurer-asset class-rating-year level. In the latter case, we aggregate up the granular data at the security-company-year level so that we can calculate the volume of insurers' first-time investments in CLOs (or corporate bonds) as a percentage of the total volume outstanding of these securities within a given rating category and a specific year.[6]

The estimates of column 4 in Table D1 report the results from our granular data analysis. They indicate that there is not a significant difference across the four macroeconomic regimes considered in the previous section (pre-crisis, financial crisis, ZLB and post-ZLB).

[6]By construction, this dataset includes observations pertaining to insurers' "zero investments" in a given asset class-rating category. For example, if a company does not hold any CLO tranche rated Baa in a given year, the percentage of Baa-rated CLOs held by that company in that year is reported with a value of zero.

The results when we consider the aggregated data are reported in column 5. Here we test how those preferences varied over the four time periods we considered in the previous section: pre-crisis (2003-2006), financial crisis (2007-2008), zero lower bound (ZLB) period (2009-2015) and post-ZLB (2016-2019). We find that in the pre-crisis period, when the yields ratio was between 0.5 and 1.25 for all investment grade rating classes, insurance companies purchased a lower portion of CLO tranches compared to corporate bonds with the same rating, suggesting a preference for corporate bonds over CLOs. However, their preference flipped starting with the financial crisis when the yields differential between CLOs and corporate bonds widened. In the post-crisis decade, as the yields ratio continued to be at relatively high levels, insurers' preference for CLOs over corporate bonds with the same rating became much more pronounced.

Table D1: Insurance Companies' Preference for CLOs vis-à-vis Corporate Bonds over time

	(1)	(2)	(3)	(4)	(5)
Sample	Assets with Aaa, Aa, A and Baa rating				Holdings with Aaa, Aa and Baa rating
Dependent variable	Insurance company's new holding as percentage of total volume outstanding				Insurance company's new holding of CLOs by rating as percentage of total new holdings of CLOs and corporate bonds
dummy CLO	6.610	-1.702	-1.702	11.801	
	(5.12)	(3.82)	(3.82)	(10.08)	
Yield CLO/Yield Bond ratio	-0.929*	-0.494*	-0.494*	0.143	
	(0.46)	(0.28)	(0.28)	(0.59)	
dummy CLO x Yield CLO/Yield Bond ratio	5.251	8.357**	8.357**	12.615	
	(3.91)	(2.99)	(2.99)	(10.83)	
Capital ratio x dummy CLO	-16.611				
	(10.84)				
CAL RBC ratio x dummy CLO		0.053			
		(0.06)			
ACL RBC ratio x dummy CLO			0.026		
			(0.03)		
Capital ratio x Yield CLO/Yield Bond ratio	1.531**				
	(0.64)				
CAL RBC ratio x Yield CLO/Yield Bond ratio		0.007***			
		(0.00)			
ACL RBC ratio x Yield CLO/Yield Bond ratio			0.004***		
			(0.00)		
Capital ratio x dummy CLO x Yield CLO/Yield Bond ratio	-3.428				
	(8.33)				
CAL RBC ratio x dummy CLO x Yield CLO/Yield Bond ratio		-0.091*			
		(0.05)			
ACL RBC ratio x dummy CLO x Yield CLO/Yield Bond ratio			-0.045*		
			(0.02)		
Year=2003-2006 x dummy CLO					-0.399***
					(0.08)
Year=2007-2008 x dummy CLO				5.340	0.095***
				(11.86)	(0.03)
Year=2009-2015 x dummy CLO				-13.278	0.330***
				(10.83)	(0.10)
Year=2016-2019 x dummy CLO				-21.104*	1.003***
				(10.15)	(0.09)
Year=2007-2008 x Yield CLO/Yield Bond ratio				-0.534	
				(0.57)	
Year=2009-2015 x Yield CLO/Yield Bond ratio				0.562	
				(0.62)	
Year=2016-2019 x Yield CLO/Yield Bond ratio				2.272*	
				(1.10)	
2007-2008 x dummy CLO x Yield CLO/Yield Bond ratio				-14.778	
				(11.82)	
Year=2009-2015 x dummy CLO x Yield CLO/Yield Bond ratio				-3.428	
				(11.42)	
Year=2016-2019 x dummy CLO x Yield CLO/Yield Bond ratio				1.055	
				(10.94)	

Continued on next page

Table D1 - continued from previous page					
Time-to-maturity	0.003	-0.003	-0.003	-0.001	0.103***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)
Outstanding Amount	-0.326***	-0.309***	-0.309***	-0.267***	0.000***
	(0.05)	(0.06)	(0.06)	(0.05)	(0.00)
constant	-1.473**	-1.901***	-1.901***	-0.742	-2.632***
	(0.59)	(0.39)	(0.39)	(0.56)	(0.31)
Insurer controls	Yes	Yes	Yes	-	Yes
Rating	Yes	Yes	Yes	Yes	-
Rating x Year FE	No	No	No	No	Yes
Type insurer FE	Yes	Yes	Yes	Yes	Yes
Insurer FE	No	No	No	No	Yes
Insurer x Year FE	No	No	No	Yes	No
Two-way clustering	Insurer, Year	Insurer, Year	Insurer, Year	Insurer, Year	Insurer, Year
N	1242690	1242690	1242690	1276043	332837
R^2	0.249	0.217	0.217	0.322	0.375
$Adj - R^2$	0.249	0.217	0.217	0.300	0.367
F-stat	29.454***	26.928***	26.928***	-	-
Degrees of freedom	(12, 16)	(12, 16)	(12, 16)	-	-

This table reports panel regression estimates of various extensions of the linear regression model of equation 4 (columns 1-4) and of the linear regression model of equation 5 (column 5) analyzing insurers' preference for CLOs over corporate bonds over time. Models 1-4 are estimated on a granular dataset at the security-company-year level covering first-time investments by insurance companies in CLO tranches and corporate bonds rated Aaa, Aa, A or Baa. The dependent variable is the amount held by an insurance company in a given security and in a certain year (when the insurer makes its first investment in the security) as a percentage of the volume outstanding of the security in that year. Model 5 is estimated on a dataset at the insurer-asset class-rating-year level covering first-time investments by insurance companies in CLO tranches and corporate bonds rated Aaa, Aa, A or Baa. The dependent variable is the amount of first-time investments of an insurance company in one asset class (CLO or corporate bond) with a given rating in a certain year as percentage of the total volume outstanding of the asset class with that rating in that year. As for the independent variables, *dummy CLO* is a dummy variable equal to one if the security is a CLO tranche and zero otherwise; *Yield CLO/Yield Bond ratio* is ratio of the average yield on insurers' new investments in CLOs to the average yield of insurers' new investments in corporate bonds for each rating-year pair; *Time-to-maturity* is the time to maturity of the security in years reported by the insurer; *Outstanding Amount* is the volume outstanding of the security; *Capital ratio* is the ratio of total adjusted capital to total admitted assets of the insurer; *CAL RBC ratio* is the CAL risk-based capital ratio of the insurer; *ACL RBC ratio* is the ACL risk-based capital ratio of the insurer. Insurers' controls include *Size*, *ROE*, *Capital ratio*, and *CAL RBC ratio* or *ACL RBC ratio* depending on the specification. For each independent variable the first row reports the coefficient, the second row reports in parenthesis the robust standard error that is corrected for multiclustering at the insurer and year level. Control variables and fixed effects are included,"Yes", not included, "No", or subsumed by other fixed effects, "-". ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

E Insurance companies' impact on CLOs' design

In this section we report the results of three additional tests we carried out while investigating the potential impact of insurance companies on the design of CLOs. Specifically, we investigate to what extent insurance companies played a role on (i) the creation of CLO deals backed by CLO tranches from other deals (henceforth abridged "repackaged CLOs"), (ii) the length of the non-call period, and (iii) the refinancing of CLO deals.

Let us start with repackaged CLOs. These CLO deals are associated with a set of combo notes. These notes are produced by repackaging part or all debt and equity tranches of CLOs. In some cases, CLO tranches can be combined with government bonds for principal protection. Combo notes can be structured either based on a CLO or as part of a separate special-purpose vehicle. We refer to repackaged CLO deals as those generated in the latter case. Combo notes are often structured as principal-only securities, meaning that the cash flows from the underlying CLO tranches are used to pay down the principal balance of the combo note. Depending on the composition of the underlying CLO tranches, this feature may allow combo notes to achieve a better rating than some of the individual underlying components (NAIC, 2019a; Morningstar, 2019).[7] Typically, combo notes are structured in bilateral transactions exactly to be tailor made to the investor's specific coupon and rating target (NAIC, 2019a; Morningstar, 2019). The extent to which insurance companies invest in repackaged CLO deals is a signal of whether they lean towards custom-made CLOs. Thus, we estimated the following econometric model:

$$Repackaged\ CLO_{dmt} = \alpha + \beta_1 \frac{Insurers\ holdings_{dmt} \times 100}{Issue\ amount_{dmt}} + \mu_{mt} + \varepsilon \tag{1}$$

where $Repackaged\ CLO_{dmt}$ is a dummy equal to one if CLO deal d issued in year t and managed by manager m is a repackaged deal and zero otherwise.

[7] NAIC (2019a) argues that most rating agencies methodologies identify a loss or a default only when interest payments are not met.

Column 1 of Table E1 reports the estimates of this model. The positive and statistically significant coefficient of the insurers' holding share in the origination year reveals that insurance companies invest more heavily in repackaged CLO deals, i.e., deals that are most likely designed to meet their desired rating and return. We estimate this regression using a linear model rather than a probit model because we need to include a set of time-varying fixed effects to identify the correlation of interest in a clean way (manager-issuance year fixed effects). Nonlinear models with fixed effects are known to suffer from the so called "incidental parameters problem" (Neyman and Scott, 1948; Lancaster, 2000), which makes the maximum likelihood estimator (MLE) inconsistent. Using a linear model to fit a regression where the outcome variable is binary, on the other hand, exposes to inconsistent estimates. As a robustness check, we re-estimate equation 1 using a probit model (column 2) including manager-issuance year dummies. Note that the sample on which this non-linear model is estimated shrinks compared to that of column 1 due to the fact that many observations of the manager-issuance year dummies which perfectly predict the outcome variable (also known as "perfect separation") need to be dropped to avoid infinitely large maximum likelihood estimates.[8] The probit estimation confirms that insurance companies invest more in repackaged CLO deals.

In columns 3 and 4 we repeat the heterogeneity analysis exploiting the 2010 regulatory reform. We find that insurance companies hold a larger share of repackaged CLO deals during the time period in which the reform was in place and this is especially true the higher is the size of the investment in the repackaged CLO deal made by insurers that stood to benefit from the reform.

Next, we look at the length of the non-call period and the refinancing of CLO deals. The non-call period is defined as the time frame where the CLO managers cannot call or refinance the CLO debt tranches. Typically, the non-call period lasts between

[8]We cluster standard errors only by year, as two-way clustering is not supported by the probit function and software used. This represents, though, a minor limitation, given that we include manager-issuance year fixed effects and the data set is characterized by a much a higher serial correlation than cross correlation of residuals.

two and seven years depending on the reinvestment period (the average length in our sample is four years). At the end of the non-call period, equity holders have the option to refinance the deal. Usually, they do so to take advantage of a reduction in market spreads on CLO debt or to extend the maturity of a CLO, or both. This process can involve either individual tranches or the full set of tranches in the deal (also known as "reset"). In the former case, some of the existing tranches are called and re-issued at current market spreads, whereas the rest of the CLO deal (including the other tranches, the reinvestment period and the maturity date) remains unchanged. In case of a reset, instead, all tranches belonging to the deal are called and re-issued at a lower spread and both the reinvestment period and the maturity date are extended.

Given our evidence on insurance companies' preference for CLO securities vis-à-vis corporate bonds we posit that, at the margin, CLO managers will find it easier to issue deals with a relatively short non-call period and place these with insurance companies. We test this hypothesis by estimating the following type of model:

$$\textit{Non-call period}_{dmt} = \alpha + \beta_1 \frac{\textit{Insurers holdings}_{dmt} \times 100}{\textit{Issue amount}_{dmt}} + \mu_{mt} + \varepsilon \tag{2}$$

where $\textit{Non-call period}_{dmt}$ is the length in years of non-call period of CLO deal d issued in year t and managed by manager m. Consistent with our prior, the estimates reported in column 5 of Table E1 indicate that CLO deals characterized by a larger insurers' holding share at origination have a shorter non-call period. This negative correlation emerges during the 2010 regulatory reform period (column 6), but there is not a significant difference in the non-call period across CLO deals in the post-2009 period based on the holding share by insurance companies that had a benefit from the reform (column 7).

Our final test on the design of CLO deals builds on CLOs' refinancing decisions. Refinancing has become a common phenomenon starting in 2015 due to a tightening in CLO spreads (Ellington, 2018). The share of refinanced deals increased from 2% in 2015

to 21% in 2017, but followed a downward path in 2018-2019 (Figure E1).[9] We identify refinanced CLO deals by combining explicit information on refinancing, that is available from 2011 onward, with information on the issuance date and the outstanding balance of CLO debt tranches during the entire life of the deal. A CLO deal is typically refinanced once, but there are cases of deals with multiple refinancing up to a maximum of 3.

We investigate if insurers' holding share is related to the likelihood that a deal is refinanced or not. Given insurance companies' increased role as investors in the CLO market, we posit that CLO managers will find it easier to refinance CLOs heavily owned by insurance companies. To test this hypothesis, we consider all CLO deals during their lifetime and estimate the following regression:

$$dummy\ Refinancing_{dmt} = \alpha + \beta_1 \frac{Insurers\ holdings_{dmt-1} \times 100}{Outstanding\ volume_{dmt-1}} + \mu_{mt} + \varepsilon \tag{3}$$

where $dummy\ Refinancing_{dmt}$ is a dummy equal to one if CLO deal d managed by manager m is refinanced in year t and zero otherwise. $Insurers\ holdings_{dmt-1}$ is the amount held by insurance companies in deal d in year $t-1$ (hence lagged of one period), and $Outstanding\ volume_{dmt-1}$ is the total volume outstanding of tranches belonging to deal d at year-end $t-1$. Similar to the previous analysis, we include manager-year fixed effects effects, to control for any manager-year specific conditions that may affect the likelihood of a refinancing. Standard errors are clustered by manager and year (two-way clustering).

Column 8 of Table E1 reports the estimates of this regression. Consistent with our prior, the coefficient of insurers' lagged holding share is positive and statistically significant. We, next, re-estimate equation 3 using a probit model (column 9) to account for the binary dependent variable.[10] For ease of interpretation and comparison with the

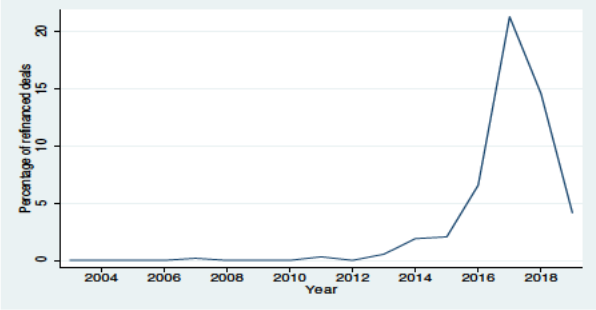
[9] As mentioned earlier, information on CLOs in 2019 is partial as we have data on issuance only up to November 2019. So, it is possible that we underestimate the share of refinanced deals in 2019.

[10] We lose a significant amount of observations that represent perfect predictors.

previous specification, we report the marginal effect of insurers' lagged holding share keeping all the other regressors constant at the sample means. As in the linear model, CLO deals with higher insurance companies' investments are more likely to be refinanced.

In the following specification, we extend model 9 to explore a possible heterogeneity in the correlation during the time period in which the regulatory reform of 2010 remained in place. We find that the extent of insurers' holding of a CLO deal is positively associated with the likelihood of a refinancing exactly during the time of the reform (2010-2018). We do not find, though, that the positive correlation between refinancing and the size of insurers' investment in the CLO deal is stronger the higher is the holding share by insurance companies that stood to benefit from the 2010 reform (column 11).

Figure E1: Percentage of Refinanced CLOs



This figure plots the time series of the percentage of refinanced CLO deals on a yearly basis over the period 2003-2019. The sample includes CLO deals outstanding during this time window and excluding multi-currency CLO deals. Source: Moody's Analytics Structured Finance Portal.

Table E1: Repackaging, Callability and Refinancing of CLO deals

Sample	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Issuance of CLO deals							Entire life of CLO deals			
Model	Linear	Probit	Linear	Linear	Linear	Linear	Linear	Linear	Probit	Linear	Linear
Dependent variable	Repackaged CLO					Length Non-call Period			Refinancing		
% of CLO held by ICs	0.005**	0.049***	0.000	-0.000	-0.007**	0.006*	0.017**	0.003*	0.004***	-0.000***	0.000
	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)
dummy Reform x % of CLO held by ICs			0.005**			-0.014***				0.004**	
			(0.00)			(0.00)				(0.00)	
Year>2009 x % of CLO held by ICs				-0.000			-0.020**				0.004
				(0.00)			(0.01)				(0.00)
% of CLO held by ICs Benefit Reform				0.000			-0.015				0.000
				(0.00)			(0.03)				(0.00)
% of CLO held by ICs Benefit Reform x % of CLO held by ICs				-0.000			-0.000				-0.000
				(0.00)			(0.00)				(0.00)
Year>2009 x % of CLO held by ICs Benefit Reform				-0.003			0.034				0.001
				(0.00)			(0.03)				(0.00)
Year>2009 x % of CLO held by ICs Benefit Reform x % of CLO held by ICs				0.000***			-0.000				-0.000
				(0.00)			(0.00)				(0.00)
constant	-0.055*	-2.123***	-0.052*	0.011	4.010***	4.003***	3.896***	0.050***	-1.249***	0.051***	0.045**
	(0.03)	(0.42)	(0.03)	(0.01)	(0.05)	(0.04)	(0.04)	(0.01)	(0.14)	(0.01)	(0.02)
Manager x Issuance Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Two-way clustering	Manager, Year		Manager, Year	Manager, Year	Manager, Year	Manager, Year	Manager, Year	Manager, Year		Manager, Year	Manager, Year
One-way clustering		Year							Year		
N	1703	89	1703	1703	1685	1685	1685	10663	4640	10663	10663
R^2 (Pseudo R^2 for probit)	0.466	0.468	0.480	0.594	0.613	0.614	0.616	0.237	0.147	0.240	0.238
$Adj - R^2$	0.199		0.221	0.389	0.421	0.421	0.422	0.127		0.131	0.128
F-stat	6.130**		3.550*	-	4.827**	6.660***	-	4.508*		23.223***	-
Degrees of freedom	(1 , 15)		(2 , 15)	-	(1 , 15)	(2 , 15)	-	(1, 15)		(2, 15)	-

This table reports panel regression estimates of the regression model of equation 1 and its extensions (columns 1-4), of the regression model of equation 2 and its extension (columns 5-7), and of the regression model of equation 3 and its extensions (columns 8-11) analyzing the design and the likelihood of refinancing of CLO deals in relation to the share of the CLO deal held by insurance companies. Models 1-7 are estimated on a dataset at the CLO deal-manager-issuance year level covering information on CLO deals issued over the time period 2003-2019 and whose tranches are denominated in USD. The dependent variable of models 1-4 is a dummy equal to one if the CLO deal is a repackage of CLO tranches from another/other CLO deal/s; the dependent variable of models 5-7 is the length of the non-call period of the CLO deal. Models 8-11 are estimated on a dataset at the CLO deal-manager-year level covering information on CLO deals outstanding during the time period 2003-2019 whose tranches are denominated in USD. The dependent variable is a dummy equal to one if a CLO deal is refinanced in a given year and zero otherwise. As for the independent variables, *% CLO held by ICs* is the percentage of the CLO deal held by insurance companies in the year of issuance of the CLO deal in models 1-7 and the percentage of the CLO deal held by insurance companies lagged of one year with respect to *Refinancing* in models 8-11 (the numerator of this variable includes holdings of combo notes pertaining to the CLO deal whereas the denominator does not); *dummy Reform* is a dummy equal to one if the year falls into the time period 2010-2018, when the 2010 regulatory reform was into effect, and zero otherwise; *% CLO held by ICs Benefit Reform* is the percentage of the CLO deal held by insurance companies that benefit from the 2010 regulatory reform based on their CLO holdings at year-end 2009 in the year of issuance of the CLO deal in models 1-7 and lagged of one year with respect to *Refinancing* in models 8-11, respectively. Models 1, 3-8, and 10-11 report the estimates of a linear regression. Models 2 and 9 reports the estimates of a probit model. The coefficient of *% CLO held by ICs* in model 9 represents the marginal effect of insurers' lagged holding share keeping all other regressors constant at the sample means. For each independent variable the first row reports the coefficient, the second row reports in parenthesis the standard error. Standard errors of model 1, 3-8, and 10-11 are corrected for multiclustering at the CLO manager and year level. Standard errors of models 2 and 9 are clustered by year. Fixed effects are included, "Yes", not included, "No", or subsumed by other fixed effects, "-". ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

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