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Insurers Monitor Shocks to Collateral: Micro Evidence from Mortgage-backed Securities

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Abstract

This paper uncovers if and how insurance companies react to shocks to collateral in their portfolio of securitized assets. We address this question in the context of commercial real estate cash flow shocks, which are informationally opaque to holders of commercial mortgage-backed securities (CMBS). Using detailed micro data, we show that cash flow shocks during the COVID-19 pandemic predict CRE mortgage delinquency, especially those stemming from lease expiration of offices, reflecting lower demand for these properties. Insurers react to such cash flow shocks by selling more exposed CMBS—mirrored by a surge in small banks holding CMBS—and the composition of their CMBS portfolio affects their trading behavior in other assets. Our results indicate that institutional investors actively monitor underlying asset risk, and even gain an informational advantage over some banks.

JEL codes: G20, G21, G22, G23

Keywords: Insurance Sector, Risk Management, Mortgage Default, Commercial Real Estate, CMBS, Work-from-home

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1. Introduction

Growing risks in mortgage-backed securities, along with perceived failure by intermediaries to perform due diligence and risk management, are considered some of the main causes of the Global Financial Crisis (Chen et al., 2020). For commercial mortgage-backed securities (CMBS), such risks arise due to the uncertainty about cash flows generated by the underlying mortgages. Yet, monitoring these cash flows is particularly challenging in CMBS as these securities often contain several underlying assets and complex structures (Ghent, Torous and Valkanov, 2019). By studying how investors react to salient shocks to (expected) cash flows, we can infer whether they monitor such risks in complex assets.

In this paper, we exploit cash flow shocks during the COVID-19 pandemic that vary by the type of property serving as mortgage collateral. Retail properties faced shocks due to lockdowns, leading immediately to significantly lower revenue. By contrast, the shift to hybrid work arrangements reduced demand for office spaces, thereby affecting their current and expected revenue and value (Gupta, Mittal and Nieuwerburgh, 2023). This poses additional challenges to CMBS investors' monitoring efforts. Moreover, the extent to which investors differ in their due diligence and risk-bearing capabilities also determines how commercial real estate (CRE) risks associated with lower office demand are shared across intermediaries.

Specifically, we explore how insurers—one of the largest investor groups in mortgage-backed securities—react to increases in CRE mortgage risks induced by cash flow shocks both during COVID-19 and in its wake. To this end, we exploit rich data on mortgages included in CMBS deals, containing detailed loan and property characteristics, as well as information about the lease contracts between borrowers and their core tenants. Lease expiration has a strong positive effect on CRE loan default for offices, especially following the COVID-19 pandemic, when demand for office real estate dwindled as a result of hybrid work arrangements. We present evidence in line with the view that insurers monitor collateral characteristics such as property type and lease expiration dates, and reduce their holdings of CMBS exposed to these risks after the onset of the pandemic. Moreover, the composition of insurers' CMBS portfolio has implications for how these investors react to salient risks in the remainder of their asset portfolio. Finally, we document how the reduction in CMBS holdings by insurers is accompanied by a significant increase in the holdings of private-label CMBS in particular by small banks.

We start out by discussing the link between borrower cash flows obtained from rental income and mortgage delinquency, and how this information would influence CMBS investors' behavior depending on monitoring. Since the value of a commercial property equals the present discounted value of the cash flows that can be obtained from renting such property, changes in cash flows and changes in property value are intimately connected. Lower demand for CRE would affect delinquencies through their effect on cash flows obtained from renting out properties, and risks to these cash flows are more likely to materialize once a tenant agreement ends. Importantly, if lease agreement information is monitored by investors, then these investors would be more likely to sell CMBS with a larger share of mortgages linked to leases expiring when faced with unexpected shocks to collateral demand. Moreover, this monitoring effort could make investors less reactive to risks in other assets if their capacity to monitor such risks is limited.

To test the relationships between information about CRE cash flow risks, loan delinquency, and institutional investors' trading behavior, we use comprehensive monthly panel data on CMBS deals, bonds and loans against CRE, along with detailed information on the asset portfolios of U.S. insurance companies. The mortgage data enable us to observe the default status of each loan while also capturing relevant information about the underlying properties, including their location and designated use. The dataset also contains rental contract characteristics such as lease expiration dates and tenant occupancy share for certain types of properties. Following our discussion, we posit that changes in rental cash flows are more common when tenant lease contracts expire, since elevated early termination fees can incentivize tenants to retain their lease until it expires.[1] The lease expiration timing generates a negative cash flow shock for borrowers if they need time to find a new tenant or if they cannot renew the lease at a similar rent. Indeed, we find spikes in delinquency that coincide with months in which the lease contracts of borrowers' main tenants expire, especially for offices, rendering the monitoring of lease expirations potentially valuable.

We next turn to differences in default for properties with and without leases expiring, before and after the COVID-19 pandemic. The underlying rationale is that cash flow shocks

[1]This should hold true under the condition that the costs of terminating the rental contract early are higher than the savings from moving to a smaller office space.

should be stronger following a systematic drop in demand for commercial real estate. The COVID-19 period is characterized by structural changes in demand for office space due to hybrid working arrangements (Barrero, Bloom and Davis, 2021). Lower demand for offices reduces current and expected rental income, lowering the value of commercial real estate properties. We show evidence consistent with the presence of a structural shift in demand for office space, leading to more persistent increases in mortgage defaults, especially for mortgages exposed to lease expiration.

The challenge in establishing a causal link between lease expiration dates and delinquency rates is that these dates can coincide with other shocks that cause delinquency. For example, lease expiration can coincide with regional shocks that lower demand for CRE. Similarly, if mortgages with leases expiring have floating interest rates, increases in reference interest rates that coincide with lease expiration can also cause an increase in delinquency rates. We address these challenges by leveraging the granularity of our data, which allow us to include a rich set of fixed effects that capture several static and time-varying confounding factors that could affect delinquency rates.

Using the beginning of the COVID-19 pandemic as the treatment period of a shock to the demand for office space, we estimate a difference-in-differences specification, and show that lease expiration triggers increases in delinquencies, with a stronger effect after COVID-19. These effects are economically meaningful, with lease expiration leading to about 1.3 percentage points higher delinquency in the baseline period, and an additional 1.2 percentage-point increase in the post-pandemic period. Finally, the lease expiration effect is stronger for properties which are not fully occupied by the largest tenants, suggesting that relatively larger tenants renew their leases more often.

The second step in our empirical analysis consists of understanding how large insurance companies' exposure to offices through their CMBS holdings are, and the extent to which these investors monitor cash flow risk caused by lease expiration. First, we document that insurance companies are indeed a large group of investors in CMBS, holding close to one-fourth of newly issued private-label CMBS between 2017 and 2022. We also find that the amount of insurers' private-label CMBS portfolio *not* exposed to offices peaks in 2020, and decreases afterwards, which is consistent with lower demand for CMBS exposed to offices among those investors. Nonetheless, insurers remain largely exposed to cash flow risks arising from lower office demand. In our sample, the median insurance company has its private-label CMBS with an average exposure of about 26% to offices. This potentially dwarfs banks' exposure to other CRE-related risks, often of indirect nature (Acharya et al., 2024).

We test if insurers monitor cash flow risks in their CMBS portfolio by asking if bonds more sensitive to different cash flow shocks are more likely to be sold following the sudden, unexpected increase in risk caused by COVID-19. Our identification strategy relies on the idea that pandemic-driven lower demand for CRE constitutes an unexpected shock to CMBS cash flows, with different effects across property collateral types. As with mortgage default, we estimate a difference-in-differences specification to assess if CMBS with exposure to office-linked loans whose main leases expire within a specific horizon are more likely to be sold after the pandemic. The richness of our data allows us to include insurer by time and insurer by bond fixed effects, on top of time-varying coupon type and risk classification fixed effects. This addresses concerns that our estimates are contaminated by other time-varying insurer shocks or bond characteristics. Moreover, it allows us to capture changes in trading behavior within an asset class with similar capital costs for insurers.

We find that insurers infer risks from shocks to expected cash flows, affecting their trading behavior. Insurance companies are more likely to sell CMBS which are exposed to offices, especially those with lease expiration in the medium term. Insurers are also more likely to sell retail-exposed CMBS, but this effect is not sensitive to underlying lease expiration. This suggests that insurance companies can identify how different property types are affected by the pandemic, and the nature of cash flow risks caused by lower demand for offices. Furthermore, medium-term lease expiration in four to six years has strong predictive power for sales of office-linked CMBS. For instance, bonds exposed to office lease expiration within six years are over two percentage points more likely to be sold by insurers in the post-COVID period. Their sensitivity to underlying lease expiration in longer horizons indicates that the market expects a whole asset class—commercial real estate—to be affected by the pandemic shock for a longer duration.

Insurers adjust to risks in CMBS also along other margins. First, the share of CMBS acquired by insurers with office exposure falls after 2020, along with the share of CMBS exposed to cash flow shocks via lease expiration. Second, insurers demand higher coupons for holding office-exposed CMBS originated after the pandemic, even when controlling for other determinants of CMBS returns. These findings corroborate the idea that insurers monitor risks to their CMBS portfolio, and learn about structural changes that make certain types of collateral more prone to cash flow-induced losses.

We also consider affected insurers' trading behavior in the remainder of their securities portfolio. As insurers react to immediate losses in retail-exposed CMBS, this could trigger sales of other risky assets (Ellul et al., 2022). Indeed, we find that insurance companies are more likely to sell risky assets if they have a larger exposure to retail collateral. At the same time, insurers put in effort to assess underlying risks in their portfolio of securitized assets as they become more relevant, as was the case for office-linked CMBS during the COVID-19 pandemic. By locking down valuable monitoring efforts, this gives rise to the possibility that insurance companies are subsequently less sensitive to increases in capital requirements or other consequences of holding on to riskier assets in the remainder of their portfolio. Consistent with this, we find that insurers are *less* likely to sell riskier bonds in the post-COVID period if they have a larger exposure to offices in their CMBS portfolio, even when controlling for time-varying unobserved heterogeneity at the insurer and security level. The latter effect points to the limited resources that financial institutions have at their disposal to effectively constrain their exposure to investment with lurking risk (e.g., Chen et al., 2020).

If insurers reduce their exposure to private-label CMBS, other investors are acquiring these risky assets. Since monitoring of securitized assets is costly, it is possible that less sophisticated investors are less sensitive to lurking risk and end up holding larger shares of private-label CMBS after the pandemic. In line with this view, we document a remarkable rise in the holdings of private-label CMBS by banks after 2020, especially by small and medium-sized banks. The number of small banks that hold private-label CMBS *nearly doubles* between 2020 and 2023. Since small banks are in general not exposed to large office-linked loans (Glancy and Kurtzman, 2024), this could be caused by additional risk-bearing capacity. However, to the extent that small banks have lower risk management abilities (Ellul and Yerramilli, 2013), this is also consistent with the idea that better informed insurers offload part of their office-borne CMBS risks to less well informed small banks. Moreover, contrary to insurers, other investors do not seem to demand higher coupons from office-exposed CMBS after the pandemic, suggesting these investors are indeed less sensitive to such risks. Our findings point to how investors' ability to monitor risks in complex assets contributes to the transfer of risks caused by systematic shocks.

Related literature. Our paper contributes to the literature studying securitized assets and mortgage-backed securities in particular.[2] This literature has pointed out to how risks in mortgage-backed securities (MBS) affected institutional investors during the Global Financial Crisis. Several papers investigate how MBS characteristics such as equity retention (Begley and Purnanandam, 2017) and retention structure (Flynn, Ghent and Tchistyi, 2020) are used by originators to signal asset quality. Ghent, Torous and Valkanov (2019) show how more complex CMBS underperform during the Global Financial Crisis, with complexity contributing to both obfuscating collateral quality and allowing for cash flows to be diverted towards residual tranches. Moreover, investors do not price this complexity-induced default risk. These studies emphasize the difficulty in assessing risks in MBS, which requires costly infrastructure to be performed (Hanson and Sunderam, 2013). Our contribution is to show that despite these due-diligence challenges and being typically viewed as less capable of doing so, institutional investors monitor detailed, time-varying property and lease contract characteristics that predict CMBS losses, and divest on the basis of such information.

As such, our paper also relates to a broad literature that studies insurance companies' portfolio decisions, and how they react to risks in their asset portfolio.[3] This literature documents that insurance companies react to changes in observable risk such as downgrades (Ellul, Jotikasthira and Lundblad, 2011), and highlights how regulation affects insurers' behavior facing asset risk (Chen et al., 2020; Becker, Opp and Saidi, 2022; Sen, 2023). We contribute to it by showing how insurers divest from CMBS with larger cash flow risks following the pandemic, even if these risks do not immediately lead to higher capital costs. Moreover, in line with Ellul et al. (2022), we find that insurers divest from risky assets when a large share of their CMBS portfolio suffers a devaluation shock, and that the additional effort undertaken to monitor those cash flow risks seems to limit insurers' ability to react to salient risks in other assets. This finding is particularly relevant given the importance of insurance companies in absorbing fluctuations in asset prices (Chodorow-Reich, Ghent and

[2] See, for example, DeMarzo and Duffie (1999), DeMarzo (2005), Demiroglu and James (2012), Ashcraft, Gooriah and Kermani (2019), and Aiello (2022).

[3] See, among others, Ge and Weisbach (2021), Koijen and Yogo (2022), Bretscher et al. (2022), Bhardwaj, Ge and Mukherjee (2022), and Koijen and Yogo (2023).

Haddad, 2021).

Finally, we relate to the literature exploring the impact of work-from-home adjustments in CRE mortgage default risk. Thus far, this literature had not documented a direct link between lower office demand and CRE mortgage default (Nieuwerburgh, 2022).[4] Moreover, Jiang et al. (2023) explore how losses from CRE loan portfolios affect the solvency of U.S. banks, and Glancy and Kurtzman (2024) considers how differences in small banks' CRE loan portfolios govern reduced exposure to loans whose poor performance was driven by lower office demand. Our contribution is to provide a detailed account of how insurers are affected by CRE risks through their CMBS holdings. Moreover, variation in how insurers react to shocks expected to materialize in different horizons suggests market participants expect the office demand shock to have a long duration. Finally, the exposure of small banks to CRE risks through their holdings of CMBS has been largely ignored so far. As CRE risks shifted across the financial sector, the number of small banks exposed to CMBS has increased substantially. In that sense, any comprehensive analysis of how CRE risks will affect financial stability should account for both banks' and non-banks' CMBS exposures alike.

2. Lease Expiration, Cash Flow Shocks, and CRE Mortgage Default

In this section, we develop hypotheses that will guide our empirical analysis. First, sudden drops in demand for office space lead to fewer occupied offices after leases expire, either by downsizing or lack of renewal, and longer search times for new tenants. This results in lower income from new leases, reducing overall lease revenue. As a result, to the extent that borrowers rely on such income to repay mortgages, mortgage default rates should increase, especially in periods of lower demand for office space.

Hypothesis 1: *Lease expiration persistently increases defaults of mortgages against offices after the COVID-19 cash flow shock, whereas other types of collateral, especially retail, see defaults immediately and are, thus, less sensitive to lease expiration.*

[4] As in our study, Glancy and Wang (2024) highlights the importance of lease expiration in the post-COVID period, showing that it affects office vacancies and loan performance. Both studies provide direct evidence of the importance of cash flow-triggered mortgage default for commercial real estate. Several papers study the relevance of strategic and cash flow motives for default of *residential* mortgages (Ganong and Noel, 2023; Bhutta, Dokko and Shan, 2017; Gerardi et al., 2018), with less attention devoted to *commercial* mortgages.

Since U.S. insurers frequently hold CMBS, any increase in the riskiness of these assets could influence their investment decisions. First, if insurance companies can observe lease expirations, the increased likelihood of future delinquencies due to lease expirations should make CMBS with a higher proportion of soon-to-expire mortgages less attractive to hold. Since lower demand increases the persistence of default triggered by lease expiration, investors are more likely to monitor characteristics associated with cash flow risks following the pandemic-linked shock to CRE demand. Consequently, they are more prone to selling CMBS with a larger exposure to cash flow shocks after the pandemic.

Hypothesis 2: *Conditional on monitoring, insurers should sell CMBS with relatively more mortgages against offices undergoing lease expiration after the COVID-19 cash flow shock, while their propensity to sell CMBS with retail exposure increases immediately and is otherwise invariant to the horizon of lease expiration.*

Mortgage-backed securities are complex assets, assessing risks for these assets is costly and often accessible only to sophisticated institutional investors (Hanson and Sunderam, 2013). Even if insurers possess the ability to monitor the cash flow risks associated with lower CRE demand and lease expiration, as hypothesized, other intermediaries might not. In that case, if insurers sell CMBS with a larger exposure to cash flow risks, and if intermediaries differ in their monitoring capacity, the sale of CMBS by insurers would be accompanied by an increase in the holdings of less sophisticated investors.

Hypothesis 3: *If monitoring capacity is heterogeneous, risky CMBS should, on average, flow from insurers to less sophisticated investors.*

Finally, the demand shock for office space leading to an unexpected increase in cash flow risks to CMBS portfolios can affect insurers' trading activity in *other* assets. This is possible for two reasons. First, facing *immediate* losses—as is the case for retail-exposed CMBS—in their asset portfolio caused by higher delinquencies after the onset of the pandemic, insurers might de-risk by selling other, riskier assets (Ellul et al., 2022). Moreover, if insurance companies' risk assessment capacity is limited (Chen et al., 2020), insurers which exert more effort to monitor cash flow risks—especially those linked to office collateral—to their CMBS portfolio after the onset of the COVID-19 pandemic could become less sensitive to consequences of holding riskier assets. This reduction in the salience of risk characteristics for other bonds in insurers' portfolios would lead to lower sales in response to changes in observable risk, such as rating downgrades or capital surcharges.

Hypothesis 4: *Insurers' holdings of CMBS affect their trading behavior in other risky assets differently depending on the type of collateral.*

3. Data Description

Our data come from two main sources: Trepp and the National Association of Insurance Companies (NAIC). Trepp is a lead provider of commercial real estate collateralized products data, which is established in the existing literature (Flynn, Ghent and Tchistyi, 2020). It collects origination information from CRE mortgages, CMBS deals and bonds, which is obtained from various sources. It includes detailed information such as property type and location, mortgage maturity, amount, interest rates, and delinquency information for each distribution date. We classify loans according to the use of the property which serves as collateral for the loan. We distinguish between *Office*, *Retail*, and further property types.[5] The data also contain information on lease agreements between borrowers and tenants. We focus on the lease information for the largest tenant only. Appendix-Table A.1 shows that the availability of lease expiration data varies by property type, with Office and Retail as the only two property types for which the date of lease expiration of the main tenant is available for more than 50% of the observations. For this reason, we mainly consider these two property types throughout the paper.

We obtain holdings and trades of fixed income assets of all insurance companies in the U.S. from the National Association of Insurance Commissioners (NAIC). The holdings data

[5]These are classified as *Multifamily*, *Mixed Use*, *Healthcare-Nursing*, *Lodging-Restaurants*, *Industrial and Warehouses*, and *Other*. The details of how these types are obtained, along with other details of our data cleaning procedure, can be found in Appendix B.

are based on NAIC Schedule D Part 1, and contain CUSIP-level end-of-year holdings of fixed income securities, including CMBS. The trading information is obtained from NAIC Schedule D, Parts 3 and 4, which contain information on acquisitions and dispositions of fixed income assets by insurance companies, respectively. We identify actual trades (sales and purchases) using a procedure similar as in Becker, Opp and Saidi (2022), which is described in Appendix C.

We restrict our analysis to the post-2017 period.[6] This ensures that we mitigate concerns about the influence of the Global Financial Crisis (GFC), e.g., through elevated delinquency rates responding to demand shocks that originated during the GFC. Table 1 shows the summary statistics of the mortgages in our sample. Panel A focuses on all properties, which have a median lease expiring in 2024 and a median mortgage maturity of 10 years. We classify a loan as delinquent if payments are past due for at least 90 days. On average, less than 1% of all loans are delinquent in our sample period, around 10% of our loans have floating interest rates, and less than 1% are recourse loans.

Finally, since our analysis mostly focuses on offices and retail CRE, we provide a breakdown of the characteristics of the mortgages used to finance these property types in Panels B and C of Table 1, respectively. Relative to retail, offices have floating interest rates more frequently, lower delinquency rates, and similar maturity. Moreover, the mean and the median share of each property occupied by the largest tenant is smaller in offices than in retail.

4. Cash Flow Shocks and Mortgage Delinquencies

4.1. The Role of Lease Expiration

First, focusing on mortgages whose lease expiration dates occur between 2017 and 2021, we evaluate the importance of lease expiration-induced cash flow shocks to borrowers in driving delinquency rates. Using this sample period, we examine delinquency rates in the time window of one year prior and one year after the expiration date of the main lease. Given our definition of a loan being delinquent if it is at least 90 days, or about 3 months, past due, we expect to see delinquency rates to increase comparatively more only after the third month

[6]Our Trepp sample covers CMBS information until June 2022.

in which a lease expires.

Figure 1 shows the average delinquency rates for all property types for which such information is available. As expected, we observe that delinquency rates increase, with the sharpest increase occurring exactly in the fourth month after the lease expiration date. This is in line with the idea that cash flow shocks from a lease expiring induces borrowers to stop making payments on their mortgages. This may be because the existing borrower cannot find a new tenant immediately or the lease generates lower income than the previous one. Moreover, delinquency rates seem to converge back to their pre-lease expiration trend approximately 10 months after the lease expiration, which indicates that borrowers resume their payments once a new tenancy agreement is secured. This further illustrates the importance of cash flow shocks to the default behavior of CRE borrowers.

This preliminary analysis, however, does not account for potential differences in delinquency rates depending on the use of the property. There are reasons to assume that such differences exist. First, the specific use of the property might limit a borrower's ability to find a new tenant. For example, it may be more difficult to re-purpose office space for other uses, which can increase search costs and lower expected revenue after an existing lease expires. Second, firms in different sectors might be more likely to renew their lease contracts, and to the extent that these firms select into different types of properties, this would differentially affect borrowers depending on the property they are financing with their loan. Third, it may be borrower-specific characteristics that matter. For example, some borrowers who take out mortgages against certain types of properties might struggle more to find new tenants, which would be the case if search frictions are different when looking for office or retail tenants. Against this background, we split our sample into two subsamples: offices and other retail properties. Figure 2 shows a remarkable difference in delinquency behavior for these different property types. The plot on the left-hand side shows sharp increases in delinquency rates of offices following the end of the main lease agreement. By contrast, the plot on the right-hand side suggests that increases in delinquency rates of retail properties are more short lived, with shocks introduced by the end of lease agreements being more transitory in nature. Overall, these preliminary results indicate that cash flow shocks are strong predictors of office delinquencies, but less so for retail properties.

So far, we have examined delinquencies focusing on the exact timing of the lease expiration for a specific property, but not explicitly considering the delinquency behavior of mortgages without leases expiring. This difference in exposure to cash flow shocks caused by lease expiration can be particularly relevant in the post-COVID period, as lower demand for offices could interact with these contractual terms and lead to more persistent losses to landlords. To the extent that lower CRE demand magnifies cash flow shocks, one would expect mortgages with leases expiring in the post-COVID period to perform worse than mortgages which are not subject to such cash flow shocks.

We assess differences in delinquency of properties with and without leases expiring by looking at office/retail properties for which we have lease expiration information (i.e., we know if the main lease expires or not), and zoom in on the immediate period before/after the start of the COVID-19 pandemic. We compare the average delinquency rate of loans with leases expiring in 2021-2022 with the average delinquency rates of loans without leases expiring in these two years.

The results are shown in Figure 3. The left-hand side plot shows a remarkable pattern for office mortgages with and without leases expiring in 2021-2022. Delinquency rates for the former group are pretty much stable throughout the entire period, whereas there is a large spike in delinquency rates for mortgages the main leases of which expired in 2021-2022. This further indicates that cash flow shocks are a relevant determinant of office mortgage default, and that aggregate delinquency rates do not capture the extent to which work-from-home arrangements trigger CRE mortgage default given its effect on office demand.

By contrast, the trajectory of retail mortgage delinquencies on the right-hand side of Figure 3 shows a different pattern. Delinquency rates spike immediately at the onset of the COVID-19 pandemic, which coincides with lockdown periods during which retail stores did not generate income to tenants. Following that initial shock, mortgages with leases expiring in 2021-2022 demonstrate persistently higher delinquency rates. which suggests that lease expiration matters for the adjustment to the initial shock. In other words, while cash flow shocks do not seem to *cause* mortgages to go from performing to non-performing in the case of retail, they do seem to affect the *persistence* of the initial increase in delinquency rates.

In what follows, we focus on offices rather than retail properties. This allows us to focus on structural changes in the demand for office space without explicitly considering the implications from the initial lockdowns on businesses. Furthermore, if institutional investors trade before losses materialize, then one would expect their trading behavior to be based on office exposure if these mortgages losses can be predicted by shocks to expected cash flows.

4.2. The Effect of Lease Expiration on Mortgage Delinquency

Our motivating evidence suggests a key role for lease expiration dates in driving delinquency behavior for CRE mortgage borrowers, especially for office properties. Nevertheless, there are a range of other factors that could be driving the delinquency dynamics we observe for properties subject to lease expiration. For example, lease expiration dates could correlate with systematic or region-specific shocks that affect the U.S. economy in specific times, such as the Global Financial Crisis and the onset of the COVID-19 pandemic. Moreover, loans for which we have lease expiration data could also have specific characteristics, such as floating interest rates, which can make them more susceptible to increases in delinquency in times of increases in interest rates.

To evaluate the relationship between lease expiration and mortgage default, we leverage the richness of our data, which allow us to compare otherwise similar mortgages that have leases expiring and not. First, we estimate the following specification:

$$I_{jrt}^{D90} = \alpha_j + \alpha_{rt} + \alpha_{j(floating)t} + \sum_{\iota \in [-15,15] \setminus \{0\}} D_{jt}^{\iota} \delta_{\iota} + \varepsilon_{jrt}, \tag{1}$$

where I_{jrt}^{D90} is an indicator variable equal to 1 if loan j, for a property located in city r, is delinquent for more than 90 days in month t, D_{jt}^{ι} equals 1 if loan j is ι months after lease expiration in month t. α_j and α_{rt} are loan and city-year fixed effects, which allow us to control for time-invariant loan-level and time-varying regional characteristics that might influence default rates. $\alpha_{j(floating)t}$ are interest rate type by year fixed effects to capture differences in delinquency between floating and fixed interest rate loans.

The coefficients of interest δ_{ι} capture the percent difference in delinquency rates ι months before and after lease expiration, relative to the moment in which the lease expires. Importantly, the use of comprehensive fixed effects ensures this variation does not correspond to time-varying regional shocks or to index rate characteristics of the mortgages that could also influence delinquency behavior. We only include loans for which we have lease expiration information[7], and cluster standard errors at the loan level.

Since lower office demand caused by work-from-home (WFH) arrangements might affect CRE mortgage default rates, we estimate (1) separately for the period before and after the COVID-19 pandemic started (where we consider March 2020 as the beginning of the pandemic). Intuitively, if borrowers face lower demand for their properties as a result of structural changes associated with work-from-home preferences, then one would expect the cash flow shocks introduced by lease expiration to be long lasting. Conversely, absent demand shocks, the initial drop in cash flows would cease after the borrower manages to find a new tenant, and delinquency rates would slowly transition back to their pre-lease expiration levels.

The results are shown in the two plots of Figure 4, indicating that WFH demand adjustment did affect the persistence of the effect of cash flow shocks on delinquency rates. While the initial effect is similar in both periods, delinquency rates in the pre-COVID panel on the left show that delinquency rates begin to converge back to their initial level after one year of the lease expiration. Our point estimates indicate that relative to the lease expiration month, a mortgage experiences a one percentage point higher delinquency 15 months after the lease expiration. In contrast, the effects of the cash flow shock induced by lease expiration are more long lasting in the post-COVID period, with delinquency rates gradually becoming larger following a lease expiration. The difference in relative delinquency between the lease expiration month and 15 months after is about three percentage points, almost three times as the same point estimate from the pre-COVID period.

To quantify the differences in post-lease expiration delinquency behavior before and after the onset of the COVID-19 pandemic indicated in Figure 4, we estimate a triple-differences specification:

[7] We do this to avoid including loans with leases expiring in our control group (which could happen for loans for which we do not observe that information, but might experience a lease expiration nonetheless).

$$
\begin{aligned}
I_{jrt}^{D90} = \alpha_j + \alpha_{rt} + \alpha_{j(floating)t} + \gamma_1 Post\ Expiration_{jt} \\
+ \beta_1 Post\ Expiration_{jt} \times Post\ Covid_t + \beta_2 Post\ Expiration_{jt} \times Ind\ Office_j \\
+ \beta_3 Post\ Covid_{jt} \times Ind\ Office_j \\
+ \beta_4 Post\ Expiration_{jt} \times Post\ Covid_t \times Ind\ Office_j + \varepsilon_{jrt}, \qquad (2)
\end{aligned}
$$

where $Post\ Covid_t$ is a dummy equal to 1 after March 2020, $Post\ Expiration_{jt}$ equals 1 if loan j had its main lease expiration before or in month t, and $Ind\ Office_j$ equals 1 if loan j is linked to an office. The coefficient of interest β_4 captures the difference in the effect of lease expiration-induced cash flow shocks on delinquency rates since the onset of the pandemic.

The results are shown in Table 2. Across all specifications, the coeficient on the triple interaction term is positive and statistically significant, and the economic magnitude is relevant. The baseline effect of lease expiration on mortgage delinquency increases by about 1.2 percentage points, meaning the effect of cash flow shocks on delinquency rates is twice as strong after the COVID-19 pandemic. Cash flow shocks increase delinquency rates by more than 2 percentage points when compared to the average delinquency rate of 0.6% for properties without expired leases in the post-COVID period. This is an economically significant effect, with delinquency rates of office mortgages whose main tenancy agreement expired being more than four times as large as delinquency rates of mortgages that do not experience such cash flow shocks. These results reinforce the notion that demand shocks caused by hybrid work arrangements, which became prevalent after the beginning of the COVID-19 pandemic, further exacerbate the effects of cash flow shocks on CRE mortgage delinquency rates.

CMBS exposure to regional work-from-home characteristics. Our analysis hinges on the observation that by being relatively more affected by hybrid work arrangements, demand for office properties is also relatively more affected by the work-from-home shock, thereby leading to more persistent cash flow shocks to rent revenue. Importantly, another dimension of heterogeneity in exposure to work-from-home adjustments refers to regional characteristics. For instance, cities like San Francisco or New York are perceived to be more affected by hybrid work arrangements than others (Gupta, Mittal and Nieuwerburgh, 2023).

While we cannot measure demand for office space, we can nevertheless assess how mortgages in our sample correlate with measures that have been constructed to capture regional sensitivity to work-from-home. We use the measure of jobs that can be performed remotely by Dingel and Neiman (2020), which should broadly indicate which areas are more likely to be affected by work-from-home arrangements. Figure A.3 in the Appendix shows the distribution of the percentage of teleworkable jobs in an MSA, for the office-linked mortgages in our sample and for all MSAs. Relative to the distribution across all MSAs, office-linked mortgages in our sample are located in areas with higher sensitivity to work-from-home shocks.

4.3. Cash Flow Shocks and Relative Tenant Occupancy

Our results so far focus on the sensitivity of default rates along the extensive margin of lease expiration—namely, whether a lease expiring is associated with increases in default—but is silent about the intensive margin—i.e., whether the relative size of an occupant also affects default. On the one hand, tenants which occupy a larger share of a property might also have more bargaining power and obtain better renewal offers, rendering them more likely to renew their contracts. On the other hand, since these tenants also represent a larger share of the rental income obtained from a property, unexpected vacancy would have a larger impact on borrower cash flows.

We investigate these opposing forces by analyzing how our lease expiration results interact with tenant occupancy. Figure A.2 shows that Offices and Retail CRE have similarly shaped distributions of the percentage occupied by a property's largest tenant. In both cases, there is substantial mass at 100%, with around 16% of the tenants occupying the whole rental unit. For that reason, we re-estimate (2) and split our sample between mortgages whose underlying properties are fully occupied by the largest tenant and those with partial (below 100%) occupancy. Additionally, we estimate a version of (2) using the entire sample and adding an additional interaction term with $Full_{jt}$, which equals 1 if a property is fully occupied by its largest tenant in month t.

Table 3 shows the results, with columns 1 to 3 focusing on properties fully occupied by the largest tenant, columns 4 to 6 partially occupied by the largest tenant, and columns 7 to 9 with the additional interaction term using the whole sample. Consistent with the idea that relatively larger tenants have more bargaining power and obtain more favorable conditions for renewing, we observe that both the baseline effect of lease expiration *and* the post-pandemic differential effect of cash flow shocks to Office CRE mortgage default are stronger for properties partially occupied by the largest tenant. This further indicates that characteristics of the underlying tenancy agreements of properties financed by securitized mortgages are important for CMBS cash flows.

5. Do Insurers Monitor Cash Flow Risks?

We have documented a significant link between expected changes in the tenancy agreement of a specific office and default rates of the mortgage linked to that property, which has implications for assets whose cash flows depend on the performance of these CRE mortgages. In particular, insurance companies' cash flows obtained from their holdings of CMBS might be compromised if the underlying mortgages become non-performing. This raises several fundamental questions. What is the extent and dynamics of the exposure of insurance companies to office CRE through their holdings of CMBS? Moreover, given the predictable nature of expected cash flow shocks to mortgage payments, do insurance companies monitor such risks and sell bonds based on such cash flow shocks to mortgage CRE? Finally, does lower office demand introduced by work-from-home preferences in the post-pandemic period affect the trading behavior of these intermediaries? We explore the answers to these questions next.

5.1. Insurer Holdings of WFH-sensitive CMBS

We start by leveraging our data to document the importance of insurance companies for the private-label CMBS market, and to characterize their exposure to shocks linked to office collateral. We are in a unique position to do so, given our access to detailed CMBS information (including origination dates) and granular data on the portfolio of insurance companies.

First, we collect information on end-of-year outstanding balances and amounts issued for all private-label CMBS in our sample, and identify which bonds are held by insurance companies at the end of each year. Figure 5 shows that insurance companies are the main investors in CMBS markets. By the end of 2022, insurance companies hold about $600 billion out of $800 billion outstanding. Similarly, between 2017 and 2019, insurance companies acquired more than 70% of the total amount of new issues of private-label CMBS. Interestingly, the share of new CMBS originations held by NAIC insurers in the same year drops to about 65% between 2020 and 2022. This reduction in the overall amount of CMBS held by insurance companies is indicative of lower insurer demand, which could arise as lower office demand leads to mortgage default rates.

We further explore how the dynamics of CMBS holdings by insurance companies varies over time, by documenting the exposure of insurance companies' CMBS portfolio to office CRE collateral. We classify a bond as exposed if it has *any* mortgages financing office properties within its pool of collateral. We then calculate the share of CMBS that is exposed to offices out of the entire portfolio of private-label CMBS held by insurance companies. Figure 6 shows the share invested in non-exposed bonds for each year. One can see that the share of CMBS exposed to offices increases up until 2020, at which point this trend is reversed. In particular, insurance companies increase the share of CMBS not exposed to offices in 2021 and 2022 by about five percentage points. This further suggests insurers reacted to risks arising from lower demand for office space by adjusting their holdings of CMBS.

Next, we document the exposure of insurance companies to risks related to expiring tenancy agreements of mortgage-financed office properties. We calculate the percent share of mortgages against offices in each deal associated with a CMBS bond in our sample, for all offices, as of June 2022. We also compute the share of this portfolio of office-linked CMBS with underlying leases expiring between 2023 and 2026. Intuitively, this percentage represents how exposed to office mortgages a particular bond is, abstracting from seniority considerations. Figure 7 shows the resulting distributions. The left plot considers exposure to any office properties, while the right plot considers exposure to office properties with at least one underlying mortgage with a tenancy agreement expiring between 2023-2026. The median insurance company has its private-label CMBS with an average exposure of about 26% to office properties, and 4.6% to office properties with tenancy agreements expiring in 2023-2026. Importantly, there is considerable heterogeneity in the size of the average exposure of CMBS bonds to office properties among insurance companies, with the top decile of the distribution of insurers with an average exposure of 39% of their portfolio to offices, and 10% to offices with underlying lease expiration.

5.2. CMBS Exposure to Cash Flow Shocks and Trading Behavior

We next exploit exposure heterogeneity across insurers to estimate its effect on insurers' trading behavior. Insurance companies might anticipate the effect of work-from-home (WFH) shocks on the cash flows and on the value of their CMBS, and attempt to sell these bonds. Moreover, even if insurance companies do not trade CMBS based on office exposure alone, they could still anticipate shocks to their assets caused by upcoming lease expiration.

First of all, it is instructive to understand if investors observe *and* trade based on the underlying characteristics of mortgages included in CMBS. In particular, to the extent that lease expirations *predict* delinquency rates, insurance companies might attempt to offload exposed CMBS in anticipation of losses associated with default. Moreover, this information might be less salient to other market participants, which could put insurance companies in a unique position to trade at more advantageous conditions than when default risk materializes. To test this, we estimate the following specification:

$$I_{ijt}^{sold} = \alpha_{it} + \alpha_{ij} + \alpha_{j(coupon)t} + \alpha_{j(NAIC)t} + \beta_1 I_{jt}^{Y} + \beta_2 I_{jt}^{Y\ Office} + \varepsilon_{jt}, \tag{3}$$

where I_{ijt}^{sold} is a dummy variable which equals 1 if insurer i actively sold any fraction of security j in year t.[8] I_{jt}^{Y} and $I_{jt}^{Y\ Office}$ are indicator variables capturing two measures of exposure Y, lease expiration within one year and delinquency rates, for all properties and only offices, respectively. α_{it} and α_{ij} denote insurer-year and insurer-security fixed effects. We also include interest type by year fixed effects $\alpha_{j(coupon)t}$ and NAIC designation by year fixed effects $\alpha_{j(NAIC)t}$, to capture time-varying willingness to trade bonds with fixed interest rates or different credit ratings. We use exposure to lease expiration in the following year and exposure to underlying delinquency in the current year. Intuitively, these results should indicate whether insurers are more likely to sell bonds which are *currently* underperforming, or are *expected* to underperform, in the following year. Standard errors are clustered at the security level.

The results are shown in Table 4. One can see that only *realized*, but not *expected*, un-

[8]For details on how this variable is constructed, see Appendix C.

derlying losses trigger CMBS sales by insurance companies. Importantly, while most of the variation in realized losses (columns 3 and 4) comes from office properties, the variation in expected losses does not depend on property types. This is consistent with the notion that insurance companies' selling decisions generally depend on losses to the underlying collateral having actually materialized. This suggests that they do not, on average, monitor bond performance as related to pending risks.

The work-from-home shock leads to a revaluation of office properties, however. Therefore, if insurance companies have the capacity to monitor such risks once they become more salient, we would expect them to react to *expected* losses only after the onset of the COVID-19 pandemic.

To explore this possibility, the second step in our analysis is to shed light on whether insurance companies anticipate demand adjustments due to work-from-home shocks, which became prevalent with the pandemic. The WFH transition reduces uncertainty regarding which types of real estate will be affected by realized and expected shocks. This provides insurance companies with the opportunity to anticipate which CRE assets will be most affected by demand-induced cash flow shocks, and to potentially trade before losses materialize. To understand if insurance companies trade based on expected cash flow shocks, we test if they sell private-label CMBS with larger exposure to office mortgages with leases expiring in different time horizons more frequently after the pandemic started. Formally, we estimate the following specification:

$$\begin{aligned} I_{ijt}^{sold} = &\alpha_{it} + \alpha_{ij} + \alpha_{j(coupon)t} + \alpha_{j(NAIC)t} + \beta_1 Post\ Covid_t \times I_{jt}^{Exp(\tau)} \\ &+ \beta_2 Post\ Covid_t \times I_{jt}^{ExpOffice(\tau)} + \beta_3 Post\ Covid_t \times I_{jt}^{Office} + \varepsilon_{ijt}, \end{aligned} \tag{4}$$

where $Post\ Covid_t$ equals 1 after 2019, $I_{jt}^{Exp(\tau)}$ and $I_{jt}^{ExpOffice(\tau)}$ are dummies which equal 1 if bond j is exposed to mortgages whose main lease expires within $t+\tau$ years (excluding year t), for all properties and only offices, respectively. We do not include delinquent loans when creating the lease expiration treatment dummies, as to avoid capturing the effect of concurrent losses. α_{it}, α_{ij}, $\alpha_{j(coupon)t}$, and $\alpha_{j(NAIC)t}$ are, respectively, insurer-year, insurer-security, coupon type by year, and NAIC designation by year fixed effects. $I_{jt}^{Office(\tau)}$ is a dummy which equals 1 for CMBS with exposure to any office CRE in the underlying pool of mortgages, and should capture overall willingness to trade office-exposed CMBS in the post-COVID period. We estimate this specification for six yearly horizons to gauge how much in advance insurance companies react to cash flow risk on their underlying collateral.

It is worth considering the implications of having an unconditional office-exposure dummy $I_{jt}^{Office(\tau)}$ alongside a horizon-sensitive lease-expiration dummy $I_{jt}^{ExpOffice(\tau)}$, for lease expiration within τ years. A positive β_3 would indicate that shocks expected to materialize *beyond* τ years are still relevant for insurers, as shocks happening *within* τ years would be captured by β_2. Thus, if insurance companies only care about the type of collateral, but *not* about the expected timing of the cash flow risks, we would expect β_3 to be positive for all specifications. If expected losses carry greater weight (e.g., if insurers consider the present discounted value of these losses), then for sufficiently large values of τ we would expect β_3 to decrease and β_2 to be positive and significant.

The results are in Table 5, with the column numbering corresponding to τ. The differences in the propensity of insurance companies to sell bonds more exposed to offices that expire in the near future increase monotonically with the length of the expiration horizon. In particular, insurance companies are about one to three percentage points more likely to sell bonds which have office mortgages that expire in the next four to six years after the COVID-19 pandemic than before (columns 4 to 6). For reference, the mean of the dependent variable I_{ijt}^{sold} equals 0.087 for private-label CMBS, indicating a meaningful economic effect arising from exposure to cash flow shocks expected to materialize in the medium term.

Importantly, these effects are significantly different from those on insurance companies' trades in all other office properties (captured by β_3) and in all other non-office properties with imminent lease expirations (captured by β_1). The coefficient on the interaction with the unconditional office-exposure dummy, β_3, is positive and statistically significant only in columns 1 and 2, in part reflecting lease expirations after one or two years. Taken together, these estimates suggest that insurance companies do react to shocks to office collateral in their CMBS, but only if these shocks materialize within 4 to 6 years.

Furthermore, lease expirations and office properties play no role for insurance companies' selling decisions before the onset of the COVID-19 pandemic. This lends support to the idea that insurance companies are learning about the increase in riskiness of the underlying collateral of CMBS posed by work-from-home demand shocks.

To further bolster our identification assumption that insurers react to shocks affecting the cash flow risks of CMBS exposed to offices with leases expiring within a few years from the COVID-19 shock, we also estimate a dynamic difference-in-differences regression:

$$I^{sold}_{ijt} = \alpha_{it} + \alpha_{ij} + \alpha_{j(coupon)t} + \alpha_{j(NAIC)t} + I^{ExpOffice(\tau)}_{jt} + \sum_{\iota \neq 2019} D^{ExpOffice(\tau),\iota}_{jt} \delta_\iota + \theta Controls_{jt} + \varepsilon_{ijt}, \tag{5}$$

where $Controls_{jt}$ include other interaction terms with yearly dummies, as in specification (4).

One can see in Figure A.4 that most of the effect we are capturing takes place in 2020, which sees a spike in sale of CMBS with more exposure to cash flow risks posed by lease expiration. Reassuringly, we find no visual evidence for violation of parallel trends, supporting our identification assumption that office lease expiration becomes a salient feature of CMBS only after the COVID shock.

CMBS exposure to offices and retail. Our preliminary evidence in Section 4 shows contrasting evidence between office and retail loan delinquency rates. Loans linked to retail experience a spike in delinquency right at the onset of the pandemic, which would also pose a risk to holders of CMBS exposed to retail properties. Importantly, this risk is less sensitive to lease expiration, meaning that characteristic would be less relevant for retail-exposed CMBS in comparison with office-exposed CMBS. To test how different collateral types and the underlying lease expiration for these loans affect the likelihood of a CMBS being sold by insurers, we estimate a variant of specification (4) that incorporates sensitivity to different types of collateral:

$$\begin{aligned} I^{sold}_{ijt} =& \alpha_{it} + \alpha_{ij} + \alpha_{j(coupon)t} + \alpha_{j(NAIC)t} + \beta_1 Post\ Covid_t \times I^{ExpOffice(\tau)}_{jt} \\ &+ \beta_2 Post\ Covid_t \times I^{ExpRetail(\tau)}_{jt} + \beta_3 Post\ Covid_t \times I^{ExpOther(\tau)}_{jt} \\ &+ \beta_4 Post\ Covid_t \times I^{Office}_{jt} + \beta_5 Post\ Covid_t \times I^{Retail}_{jt} + \varepsilon_{ijt}. \end{aligned} \tag{6}$$

Each of the variables $I^{ExpCollateral(\tau)}_{jt}$ is defined as before, where *Other* is a residual category for any loans with lease expiration information which is not linked to $Office$ or *Retail* units. Moreover, I^{Retail}_{jt} is a dummy that equals 1 if bond j has exposure to retail units in year t. By further breaking down the lease expiration dummies $I_{jt}^{Exp(\tau)}$ into mutually exclusive property types, we can test for differences in how insurers react to changes in risks in retail mortgages.

The results are in Table 6. As before, we can see that β_1 predicts sales for most τ horizons, indicating insurers are sensitive to cash flow risks in offices after COVID-19. In contrast, while exposure to retail affects CMBS sales positively, as reflected by the positive and significant coefficient on I_{jt}^{Retail}, this is not caused by lease expiration of the underlying retail-linked mortgages. This is in line with the idea that while retail loans experienced rising delinquency rates at the onset of the pandemic, this rise is less sensitive to lease expiration. Overall, our evidence supports the idea that insurers do not only monitor cash flows risks but are also sufficiently sophisticated to disentangle how these risks affect different types of CMBS collateral.

5.3. CMBS Acquisitions by Insurance Companies

Having documented that exposure to underlying cash flow shocks affects insurance companies' trading behavior, and given the dynamics of CMBS portfolio exposure to offices shown in Figures 5 and 6, we next consider insurers' purchasing behavior: are insurance companies also less willing to acquire private-label CMBS exposed to office CRE? Lower willingness to hold office-linked CMBS can manifest itself through smaller acquisition of these assets by insurers after COVID-19. Additionally, to the extent that insurers demand higher returns for holding assets perceived as riskier, newly issued office-exposed CMBS held by insurers should offer higher returns.

We start by looking at how risk characteristics of private-label CMBS acquired by insurers change over the years, focusing on office exposure and cash flow risks represented by lease expiration. Figure 8 shows the distribution of office exposure for all CMBS acquired by insurance companies before and after COVID-19. Importantly, there is a large jump in the share of CMBS acquired in 2020-2022 which have no underlying office-linked collateral, with close to 30% of the bonds acquired in 2022 having no exposure to office CRE. The share of acquired CMBS collateralized by office mortgages falls from 30% in 2017-2019 to around 27.9% in 2022. We observe a similar pattern when looking at exposure to cash flow shocks represented by lease expiration taking place at different horizons. Figure 9 plots the respective distribution, before and after the COVID-19 pandemic. In all cases, there is a shift towards the left of the distribution, with a larger share of the bonds acquired in the post-COVID period having no exposure to immediate cash flow shocks to office CRE. This variation is larger for medium-term lease expiration time windows, with an increase of about 20% in the share of CMBS acquired in the post-COVID period that have no mortgages linked to office CRE whose main lease expires within six years, for example.

The drastic reduction in holdings of cash flow risk-sensitive CMBS by insurers indicates that these investors adjust their exposure to risks along an extensive margin, by acquiring private-label CMBS with smaller exposure to offices. This adjustment can also occur along an intensive margin if lower willingness to hold office-exposed CMBS leads insurers to require higher returns in order to invest in office-linked CMBS after COVID-19.

We test if this adjustment takes place by analyzing how the coupons of newly issued private-label CMBS vary based on their exposure to offices, before and after the pandemic, by estimating the following specification at the bond issuance level:

$$\begin{aligned} Coupon_{jt} =& \alpha_{maturity(j)t} + \beta_1 Post\ Covid_t \times Office_j + \beta_2 Office_j \times NAIC\ Held_{jt} \\ &+ \beta_3 Post\ Covid_t \times Office_j \times NAIC\ Held_{jt} + \beta_4 X_{jt}, \end{aligned} \tag{7}$$

where $Coupon_{jt}$ denotes the coupon offered by bond j issued in quarter t, $Post\ Covid_t$ equals 1 after 2020Q1, $Office_j$ equals 1 if bond j has underlying exposure to offices, and X_{jt} is a vector of bond-level controls. The ownership dummy, $NAIC\ Held_{jt}$, equals 1 if bond j is held by an insurance company at the end of the respective year, and reflects differences in the pricing of risk by insurers relative to other investors. The coefficient β_1 captures how changes in the perceived risk of CMBS exposed to offices impacts coupons after COVID. Moreover, the coefficient β_3 captures any differences in these pricing effects between insurers and other investors. Control variables include a dummy for investment grade bonds, the % share of pool in the largest state, the number of loans the deal to proxy for deal complexity (Ghent, Torous and Valkanov, 2019), a dummy for horizontal risk retention (Flynn, Ghent and Tchistyi, 2020), the weighted average LTV and debt-service coverage ratio of the deal at securitization, and a dummy for conduit loans.

Column 1 of Table 7 shows the results without accounting for differences between CMBS held by insurers vs. other investors, assuming that changes in office risks after the pandemic were not priced in differently by investors. However, the negative estimate masks significant underlying heterogeneity. When we account for CMBS ownership in column 2, we find that bonds from deals with a larger share invested in office loans command a coupon premium, especially after COVID-19, when they are held by insurance companies as compared to bonds held by other investors. A one percentage point increase in the office exposure of a deal translates to approximately 15 basis points larger coupon rates. This effect is robust to the addition of additional bond-level controls in columns 3 and 4.

Higher office percentage in general has a negative effect on coupons for CMBS, including those held by other intermediaries. This could be explained by different risk perception by these investors and ultimately affect the allocation of cash flow risks across intermediaries. We analyze how risk migrates from insurers to other firms in Section 6. Overall, the changes in acquisition behavior by insurers documented in this section further corroborate that they do monitor work-from-home triggered changes in office loan risk.

5.4. Insurer-level Exposure to CMBS Shocks

Variation in CMBS risk introduced by higher delinquency risk in the post-pandemic period can also affect insurer behavior beyond investors' willingness to trade affected bonds themselves. In particular, Ellul et al. (2022) argue that in response to a drop in insurers' asset values, these investors would de-risk by selling illiquid bonds. Similarly, Becker, Opp and Saidi (2022) show that insurers are more likely to sell downgraded assets which would trigger higher capital requirements relative to assets that would not incur such surcharges.

In our context, a sudden increase in mortgage delinquencies at the onset of the pandemic would trigger an immediate drop in CMBS values for bonds more exposed to retail and lodging properties, as illustrated in Figure 3. Moreover, higher delinquency can also lead to rating downgrades and potential added capital surcharges for insurers holding those securitized bonds. In either case, we predict that insurers with larger exposure to such property types would be more likely to sell risky, illiquid bonds.

Importantly, it is unclear how insurers' exposure to offices would affect their trading behavior after COVID-19. On the one hand, the dynamic nature of the materialization of cash flow risks arising from WFH suggests larger exposure to offices should not lead to immediate short-term adjustments. On the other hand, if investors' ability to assess risks is limited, then a large office exposure can lead to inattention to risks in other assets, as these insurers would have to use more of their monitoring capacity to track the materialization of cash flow risks represented by office lease expiration.

To understand how exposure to different types of CMBS collateral affects insurers' trading behavior, we estimate the following specification:

$$
\begin{aligned}
I_{ijt}^{sold} = \alpha_{it} + \alpha_{ij} + \alpha_{jt} &+ \gamma_1 T_{it-1}^{Office} \times I_{jt}^{T} + \beta_1 Post\ Covid_t \times T_{it-1}^{Office} \times I_{jt}^{T} \\
&+ \gamma_2 T_{it-1}^{Retail} \times I_{jt}^{T} + \beta_2 Post\ Covid_t \times T_{it-1}^{Retail} \times I_{jt}^{T} \\
&+ \gamma_3 T_{it-1}^{Lodging} \times I_{jt}^{T} + \beta_3 Post\ Covid_t \times T_{it-1}^{Lodging} \times I_{jt}^{T} + \varepsilon_{ijt}, \qquad (8)
\end{aligned}
$$

where T_{it-1}^{prop} is the lagged exposure of insurer i to properties of type $prop$ in year $t-1$, I_{jt}^{T} is a a time-varying dummy which equals 1 for riskier bonds, and α_{jt} denotes security-year fixed effects. Given that the relevant level of variation is now at the insurer level, we cluster standard errors accordingly.

In particular, we estimate specification (8) using two different variables I_{jt}^{T}: I_{jt}^{Risky}, which is a dummy which equals 1 for bonds with NAIC designation 2 or greater (worse) in year t, and $I_{jt-1}^{Downgrade}$, which equals 1 if bond j has been downgraded in year $t-1$ such that capital buffers have to increase.[9] Our exposure variables are the weighted average percent exposure of insurers' private-label CMBS portfolios to each property type, multiplied with the share of private-label CMBS in their entire bond portfolio. Each β_i term captures the effect of larger exposure to a type of collateral on insurance companies' sales of risky assets. Importantly, we use lagged exposures to address the fact that trading within one year would affect exposure in the same year (as it changes insurers' portfolio composition).

The results for the two risk variables I_{jt}^{T} are in Table 8 (columns 1-3 and columns 4-6). After controlling for time-varying unobserved heterogeneity at the insurer and security level, we yield a negative, albeit statistically insignificant, coefficient on β_1 in columns 1 and 4. This reflects the idea that CMBS exposure to office buildings desensitizes insurance companies

[9]We use NAIC designation to infer downgrading. Effectively, $I_{jt-1}^{Downgrade}$ equals 1 if bond j had a NAIC designation in year $t-1$ greater than its NAIC designation in year $t-2$.

to risky securities with higher capital requirements, which they would otherwise sell upon being downgraded (Ellul, Jotikasthira and Lundblad, 2011).

As post-COVID office exposure is associated with greater delinquencies, insurance companies may be preoccupied with acquiring information regarding office collateral and selling the respective CMBS first. However, in line with higher retail and lodging mortgage delinquencies in Figure A.1, β_1 may be confounded with insurance companies' portfolio rebalancing in the face of retail and lodging mortgage delinquencies, i.e., T_{it-1}^{Office} could be correlated with insurers' respective exposures in their CMBS portfolio. To account for this possibility, we control for such confounding portfolio exposures by estimating (8) in columns 2 and 5 of Table 8.

After doing so, the estimated coefficient on β_1 becomes more negative and statistically significant. Importantly, it carries the opposite sign of the other triple interactions, thereby ruling out that our estimated effect is governed by other, correlated portfolio exposures. Instead, larger exposure to retail leads to more sales of risky assets, which is in line with the idea that facing a devaluation in their asset portfolio, insurers sell illiquid bonds first. Finally, in columns 3 and 6, we additionally control for the triple interaction with insurers' share of corporate bonds more generally, which leaves our coefficient of interest virtually unaltered: larger exposure to offices in insurers' CMBS portfolio is associated with a lower likelihood of selling riskier bonds in the post-COVID period.

6. Migration of CRE Cash Flow Risks from Insurance to other firms

The evidence so far suggests that insurers are able to monitor risks in securitized assets that arise from lower office demand after the pandemic, and reduce their exposure to these private-label CMBS. In this section, we turn to the question of who acquires these assets in an attempt to understand which intermediaries become more exposed to WFH-borne risks and why these other investors are willing and able to acquire more exposed CMBS.

6.1. Who Purchases Private-label CMBS from Insurers?

We first analyze the purchasers of private-label CMBS from insurance companies in our sample period. To this end, we categorize the buyers into three groups: banks, insurance companies, and others (which includes uncategorized buyers and instances where the buyer name is not specified in the data). Figure A.6 illustrates the trends in these categories over time. We notice a dip in the share of insurance buyers in 2021 although it is not persistent.[10] Importantly, while banks are prominent purchasers throughout, they are even more important for offices (Figure A.7).

To test more formally whether insurance companies sell off CRE-related cash flow risks to banks, we re-estimate the same specifications as in Table 5, but replace the dependent variable with a sales indicator that is equal to one only for the subset of sales to banks. That is, the dependent variable equals zero if insurer i sold any fraction of security j in year t to any non-bank purchaser or nothing at all.

In Table 9, the coefficient on CMBS with exposure to office lease expirations, β_2 in (4), is positive—as in Table 5—and statistically significant at least for the two longest horizons. This indicates that sales are more likely to banks if the CMBS is related to office properties with expiring leases in the post-COVID period. Generally, up until the COVID period, insurance companies are more likely to sell CMBS to banks, independent of the type of collateral and lease expiration. This effect is, however, muted since the COVID period, but only for non-office exposures, e.g., retail. This implies that insurance companies' selling activity to banks is more concentrated on CMBS exposure to office lease expirations in the post-COVID period.

For completeness, Appendix-Table A.2 examines sales from insurance companies to other insurance companies by adjusting the dependent variable accordingly. The results suggest some effects for sales to insurers if the CMBS in question is related to office properties with expiring leases but only for the last period considered. Moreover, we show in Figure A.5 the share of the portfolio of private-label CMBS held by insurers exposed to lease expirations of different horizons, as captured by $I_{jt}^{ExpOffice(\tau)}$. There is a sharp drop in the share of insurers' CMBS portfolio exposed to cash flow shocks materializing within four to six years after 2019, consistent with the idea that insurers reduce their exposure to cash flow risks by selling exposed bonds to other investors, as indicated in Table 9.

Overall, these results can be seen as suggestive of a transfer of this particular risk from

[10] We exclude three major buyers: FA REINSURANCE, RESOLUTION LIFE, COINSURANCE TALCOTT-ALLIANZ.

insurance companies to banks.[11]

6.2. Bank Holdings of Private-label CMBS

Purchaser information reported by insurers suggest most of the buyers of private-label CMBS with office exposure are banks, as shown in Figure A.7. Nonetheless, these banks might be acting as dealers on behalf of other buyers, which limits the conclusions we can draw from reported buyer information on NAIC files.

To better understand the extent to which banks acquire more CMBS after the pandemic, we use Call Reports data and construct bank-level holdings of private-label CMBS. Using that information, we first document how aggregate holdings of private-label CMBS evolve over time for banks of different size.

Figure 10 shows a remarkable increase in holdings of CMBS by small and medium-sized banks (i.e., those with assets under $100 billion) from 2021 onwards. This pattern is more striking relative to 2017 and 2018, when the aggregate amount of private-label CMBS holdings by banks was at similar levels, but with a substantially smaller role played by medium and small-sized banks. This bigger role could be explained by a larger exposure to private-label CMBS by those institutions that held CMBS in the past, or by a larger number of banks investing in these assets. Figure 11 shows that the latter is the main driving force. In Panel (A), we see that the number of small banks (total assets under $ 10 billion) that hold private-label CMBS nearly doubles between March 2020 and December 2023. Moreover, these "new entrants" are holding meaningful shares of private-label CMBS: the median small bank has more than 1% of their assets invested in private-label CMBS, as shown in Panel (B).

To understand how this unprecedented increase in the number of small banks investing in CMBS is related to the characteristics of these banks, we divide our sample of small banks into three types: banks that held private-label CMBS between 2017 and March 2020, banks that held private-label CMBS **only after** March 2020, and banks that do not hold private-label CMBS between 2017 and 2023. Table A.3 shows mean values of selected characteristics for these three different bank types. Banks that began investing in private-label CMBS after COVID-19 are smaller than those that invested in CMBS before the pandemic, but have

[11] Note, however, that our data do not allow us to identify the ultimate holder of the CMBS as banks might be merely operating as brokers on behalf of other investors.

similar leverage, exposure to CRE loans, and have a similar share of their total assets and securities invested in private-label CMBS. Banks that do not invest in CMBS (third column) are smaller, have lower exposure to non-owner occupied CRE loans, and are more levered than banks that do invest in private-label CMBS between 2017 and 2023.

Banks increasing their holdings of private-label CMBS suggests that risks in CMBS with office-linked mortgages flow from the insurance sector to the banking sector. What explains this shift in CMBS ownership from insurers to banks, especially small banks? To the extent that small banks make smaller loans (Ghent and Valkanov, 2015; Glancy et al., 2022), they are unlikely to originate loans that can be used to finance office properties, meaning they are not exposed to risks related to the effects of hybrid work arrangements on office vacancies.[12] This has two implications: first, by investing in office-exposed CMBS, these small banks would effectively diversify their CRE exposure, so these banks could have additional risk-bearing capacity. Additionally, small banks' ability to perform due diligence in CMBS might be limited, which would facilitate the sale of office-exposed CMBS by insurance companies to small banks. While both forces could be at play, we have provided evidence of insurers' ability to monitor risks in securitized assets, which in turn contributes to a transfer of these risks to the banking sector.

7. Financial Stability and Policy Implications

The results in this paper shed light on the ability of institutional investors' to assess underlying risks to MBS. Given the importance of insurers and CRE loans for financial markets, these findings potentially inform relevant dimensions of policymaking, as we outline below.

7.1. Institutional Investors and Risk in Securitized Assets

The prominent role played by asset-backed securities during the Global Financial Crisis (GFC) prompted regulators to revisit securitization regulation, aiming for more aligned incentives for originators and better risk assessment by investors. One example are due diligence requirements, which require investors to assess risk characteristics of the underlying

[12] For example, this article suggests that small banks did not experience substantial losses in their CRE loans due to reduced exposure to offices.

exposures of securitized positions.[13] These due diligence requirements address the perceived failure by investors to observe and monitor risks in securitized positions in the run-up to the GFC. Our findings on trading of CMBS by insurance companies in the aftermath of the pandemic indicate that certain institutional investors are capable of assessing risks to their securitization positions and monitoring changes to these risks over time. This strongly suggests that at least the largest, most systemically important banks always had this ability to start with. These results also highlight how access to time-varying loan level information could be beneficial for continuous risk assessment of asset-backed securities, both by investors and by policymakers.

However, the adjustment made by insurance companies in response to the build-up of these risks is accompanied by a dramatic rise in the holdings of private-label CMBS by small banks. This evidence is suggestive of heterogeneity in financial intermediaries' risk management capabilities, and raises concerns about the fact that less sophisticated investors become exposed to private-label CMBS at the same time as risks in these assets rise. Moreover, given the slow materialization of default risks arising from hybrid work, which depends on cash flow shocks, insurers and banks could still face large losses to their portfolios arising from CRE mortgage default. The bottomline is that investors' ability to assess risks is no substitute for adequate capital requirements, which ensure that investors can absorb losses to their asset portfolios, thereby internalizing threats to financial stability.

7.2. Commercial Real Estate Mortgage Default Risk

The COVID-19 pandemic led to an unprecedented shift in work conditions, with hybrid work arrangements becoming prevalent and affecting real estate valuation. These changes in asset prices raised concerns about financial stability, as CRE serves as collateral for loans held by banks and these loans are included in CMBS. Until recently little evidence had been documented about how the sudden fall in demand for office space affects commercial mortgage default. Our study addresses this gap by showing how sensitivity to borrower income and the timing of cash flow shocks to the borrower matter for the transmission of lower office demand to credit risk.

[13] See, for example, Chapter 2, Article 5 EBA (2017).

There are several policy implications of the evidence of changes in default rates in response to CRE demand adjustments to depend on cash flow shocks to borrowers caused by contractual lease termination. First, our results inform the implementation of the revised banking standards ("Basel 3.1") that is currently being undertaken by prudential regulators around the world. These revised standards distinguish mortgages by whether they are "*materially dependent on cash flows generated by the property*" (CRE20 in BCBS, 2022) for the purposes of capitalizing their credit risk. For example, in its recent public consultation on implementing Basel 3.1, the UK's Prudential Regulation Authority (PRA) "proposes assign risk weights to mortgage exposures depending on whether repayment of the loan is materially dependent on the cash flows generated by the property."[14]

According to this view, our results provide evidence that supports this proposal of imposing such an exposure classification based on cash flows. Furthermore, they highlight the value of property-specific contract information, in particular lease expiration dates, which can help policymakers identify mortgages materially dependent on cash flows. Second, our results suggest that examining aggregate delinquencies is not sufficient for gauging credit risk in CRE loans as they insufficiently reflect post-COVID lower office demand. This highlights the need for granular data for proper credit risk assessment. Specifically, our results point to the value of tenancy agreement characteristics, in particular lease expiration dates, as a relevant determinant of borrower cash flow shocks. Third, our findings are also relevant from a macroprudential perspective. Since many tenancy agreements are due to expire in the next years (Table 1), the full effect of work-from-home adjustments on aggregate mortgage default is yet to materialize, which might come with financial stability consequences. In short, monitoring of tenancy contractual characteristics should be useful for policymakers assessing credit risks in real estate mortgages.

8. Conclusion

In this paper, we examine the role of cash flows shocks from renting out commercial properties for mortgage delinquencies, assessing the extent to which insurance companies monitor

[14]See https://www.bankofengland.co.uk/prudential-regulation/publication/2022/november/implementation-of-the-basel-3-1-standards.

these risks in securitized assets. Using rich data on commercial mortgages included in CMBS deals and insurers' asset portfolios and trading behavior, we document a link between borrower cash flow shocks and CRE loan default following the COVID-19 pandemic. For offices, we document an effect between lease expiration and defaults which is stronger during the COVID-19 pandemic, caused by lower office demand due to work-from-home arrangements. Moreover, we show that insurers react to such collateral shocks in their CMBS portfolio by selling more exposed bonds before delinquency materializes. This suggests that—contrary to commonly held views—institutional investors do actively monitor underlying asset risk. Finally, this monitoring effort also makes insurers less reactive to observable risks in other assets, suggesting limited monitoring capacity.

Our findings indicate that there is a build-up of materialized default risk once existing leases need to be rolled over, providing information as to which features of CRE loans are relevant to track such risks. Our findings also illustrate the limitations of policies requiring due diligence by institutional investors as a means of promoting active risk management. While we make use of CMBS data from the U.S., these mechanisms should also take place in other markets and countries. Given the key role of insurers and mortgages for financial markets, our findings warrant further scrutiny, and monitoring, of the risks caused by lower office demand.

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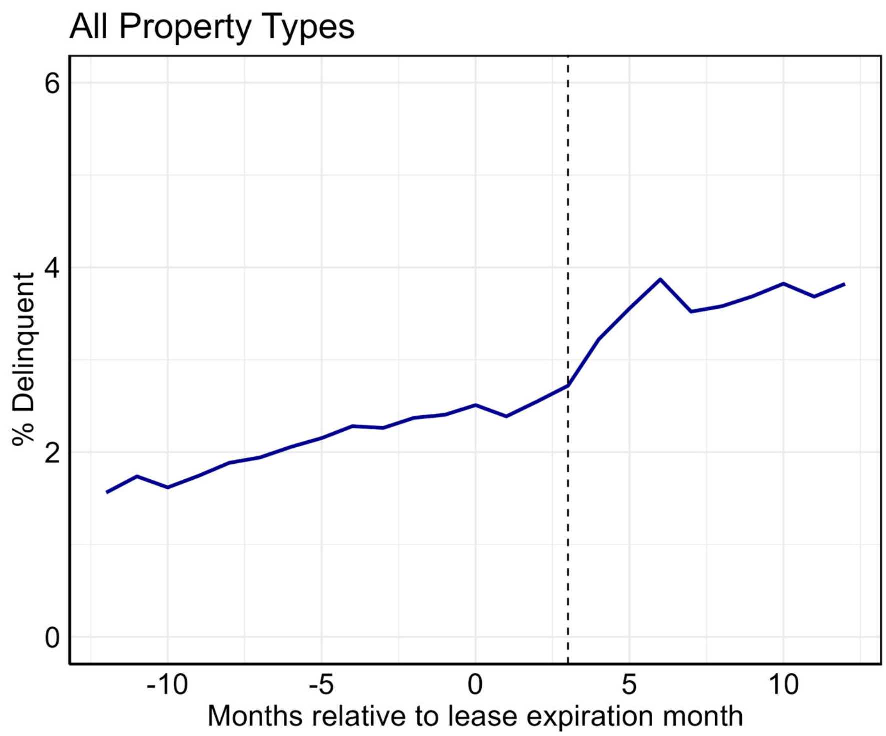
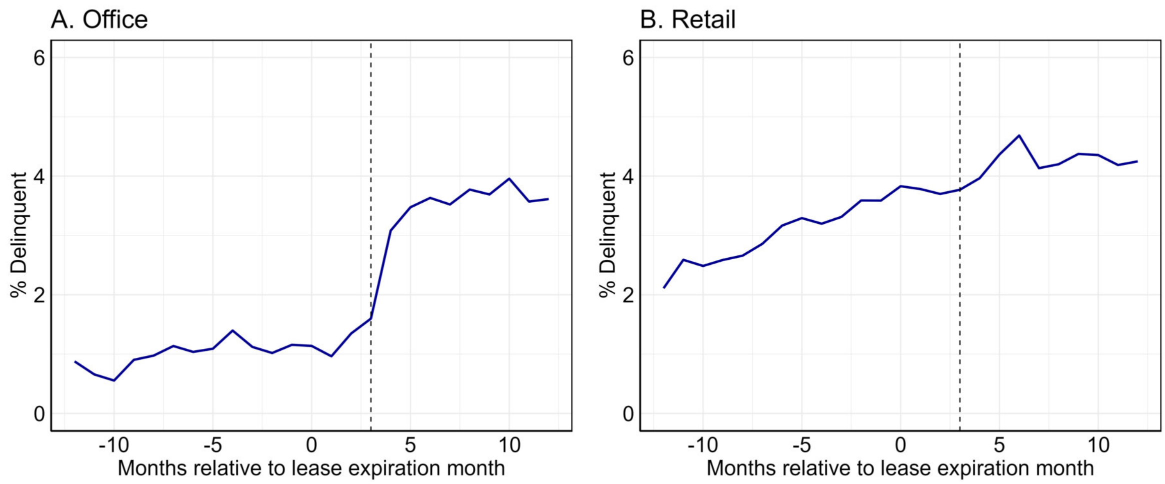
FIGURES

Figure 1: Changes in Delinquency around Lease Expiration Dates



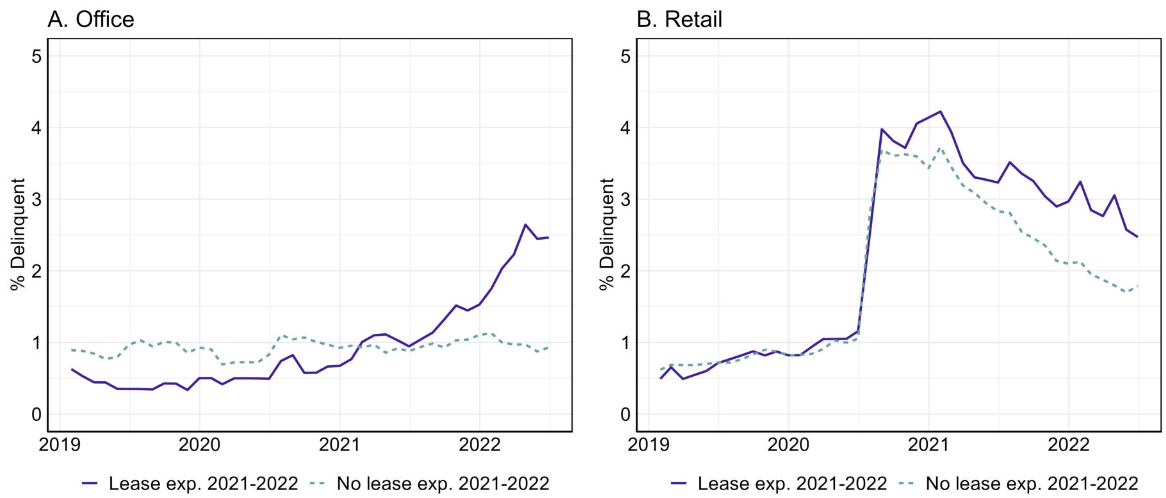
Notes: This figure shows average delinquency rates in each month relative to lease expiration, for properties with leases expiring between 2017 and June 2022. Delinquency is a dummy variable which equals 1 if a mortgage is at least 90 days past due. Sources: Trepp loan data and authors' calculations.

Figure 2: Changes in Delinquency around Lease Expiration Dates for Office and Retail



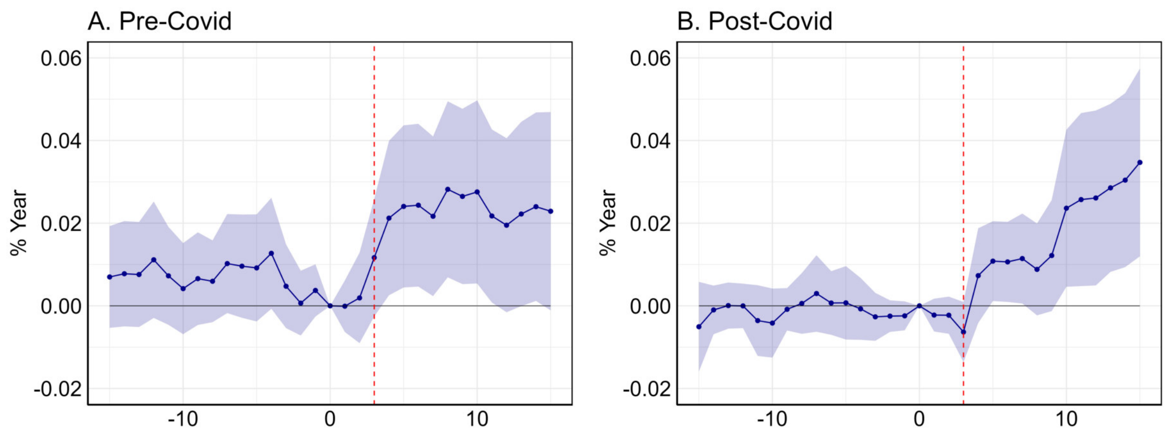
Notes: This figure shows average delinquency in each month relative to lease expiration, for properties with leases expiring between 2017 and June 2022. **Panel A** shows delinquency rates for properties classified as *Office*. **Panel B** shows delinquency rates for properties classified as *Retail*. Delinquency is a dummy variable which equals 1 if a mortgage is at least 90 days past due. The vertical line marks three months after lease expiration. Sources: Trepp loan data and authors' calculations.

Figure 3: Delinquency Rates of Mortgages With and Without Leases Expiring in 2021-2022



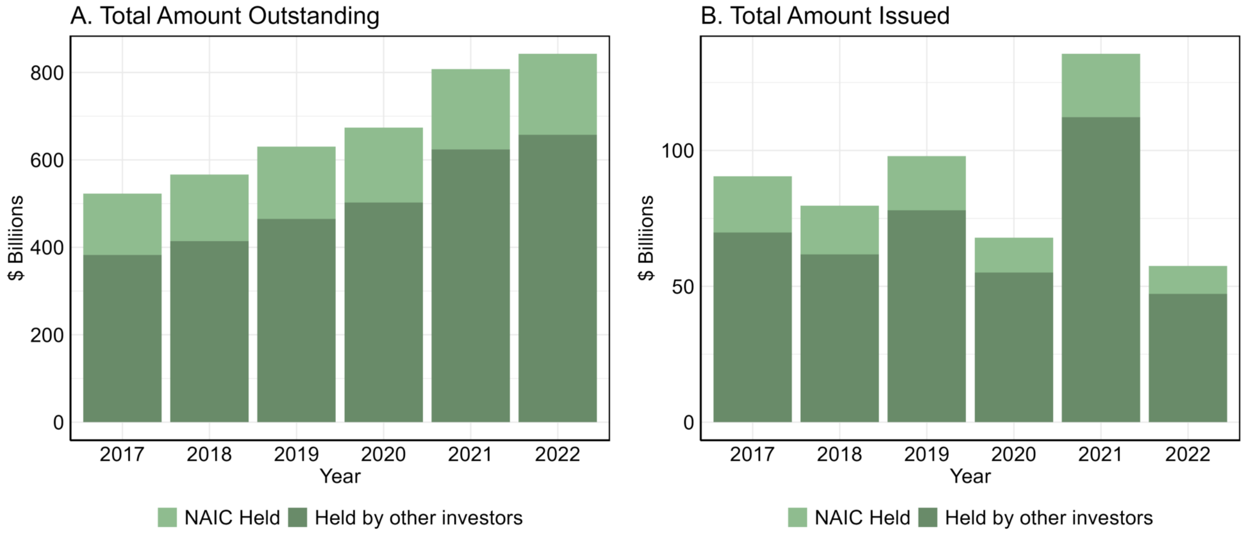
Notes: This figure shows average delinquency rates for mortgages *with* leases expiring in 2021-2022, and mortgages *without* leases expiring in these two years. **Panel A** shows delinquency rates for properties classified as *Office*. **Panel B** shows delinquency rates for properties classified as *Retail*. Delinquency is a dummy variable which equals 1 if a mortgage is at least 90 days past due. Sources: Trepp loan data and authors' calculations.

Figure 4: Delinquency Rates around Lease Expiration Dates—Office WFH Sensitivity



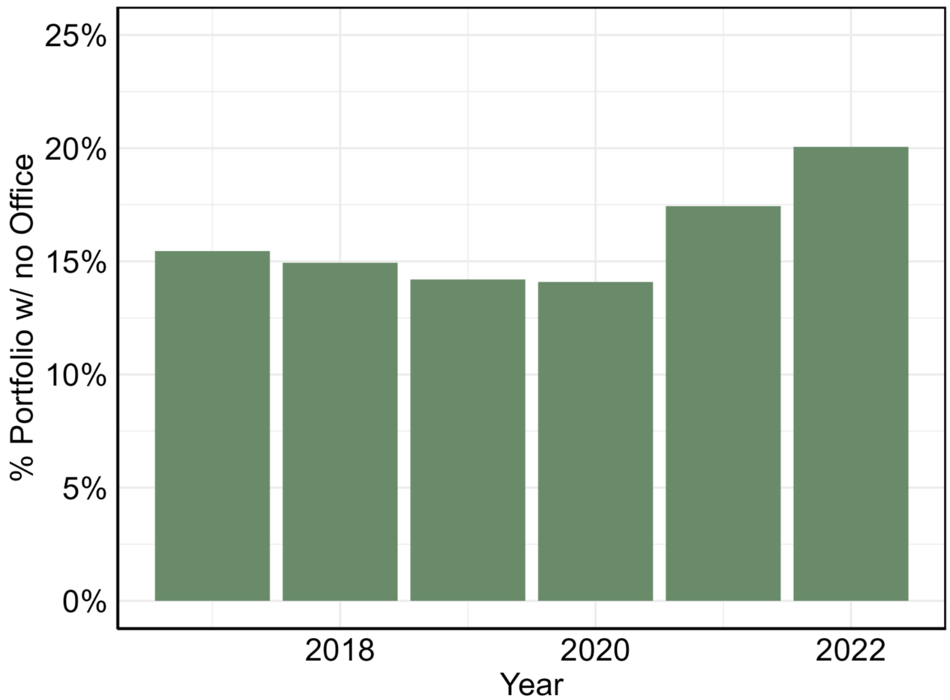
Notes: This figure shows the effects of lease expiration on delinquency rates of properties classified as *Office*. The level of observation is loan j in city r in month t, where month denotes the distribution month of each securitized mortgage. The sample period is Jan/2017 to Jun/2022. The dependent variable I^{D90}_{jrt} is a dummy variable which equals 1 if a loan is at least 90 days past due. The δ_t estimates from specification (1) show delinquency rates relative to the lease expiration month. The vertical line marks three months after lease expiration. **Panel A** includes all months before March 2020. **Panel B** includes all months after March 2020 (exclusive). Shaded areas correspond to the 95 percent confidence intervals around point estimates. Standard errors clustered at the loan level. Sources: Trepp and authors' calculations.

Figure 5: Insurance Holdings of CMBS



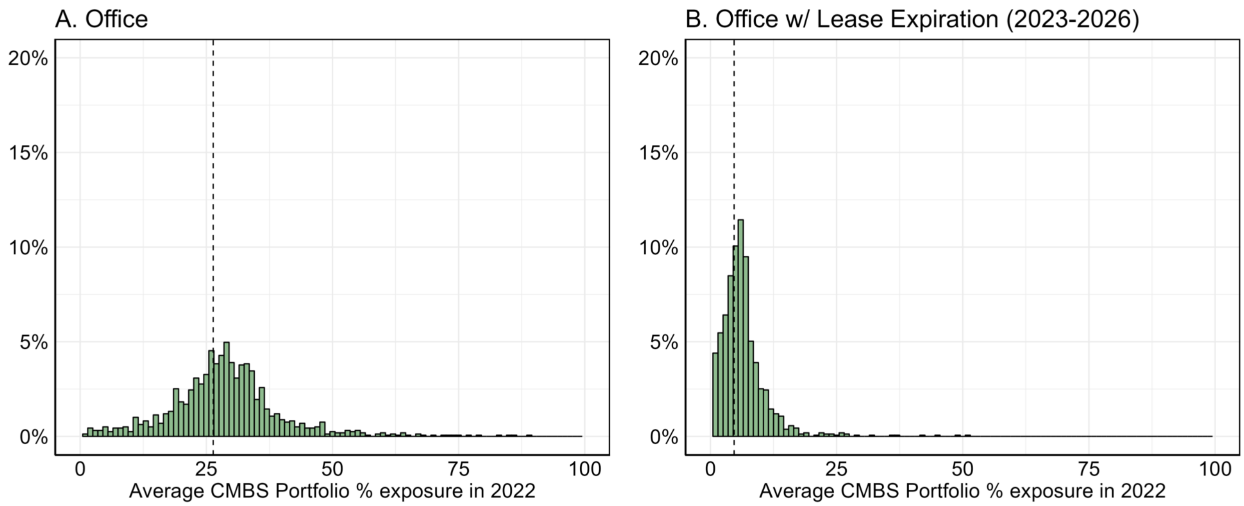
Notes: This figure shows the total amount outstanding (Panel A) and amount originated (Panel B) of private-label CMBS per year, differentiating between the amount held by insurance companies and that held by other investors. We identify holdings of insurance companies using NAIC Schedule D, Part 1. Insurer-held amounts are calculated as the sum of the BACV of the CMBS held by insurers. Amount held by other investors is the residual value relative to the total original balance outstanding/originated in a given year. Both plots exclude interest-only and agency CMBS. Source: Trepp, NAIC, and authors' calculations.

Figure 6: % CMBS Portfolio without Office Exposure



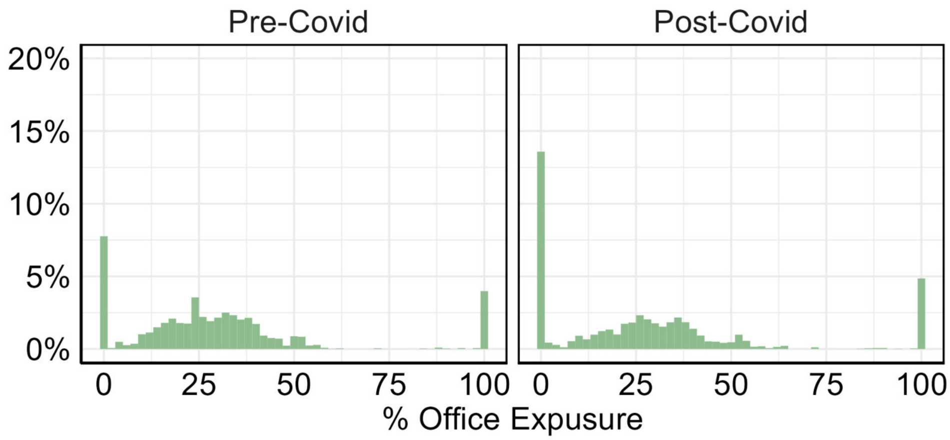
Notes: This figure shows the share of insurance companies' private-label CMBS portfolio not exposed to *any* CRE mortgages linked to properties classified as *Office*. Shares are calculated aggregating BACV for exposed and non-exposed CMBS, where exposure is defined as any percentage of the pool of mortgages used to finance office CRE. Source: Trepp, NAIC, and authors' calculations.

Figure 7: CMBS Bonds Held by Insurance Companies—Exposure to Offices



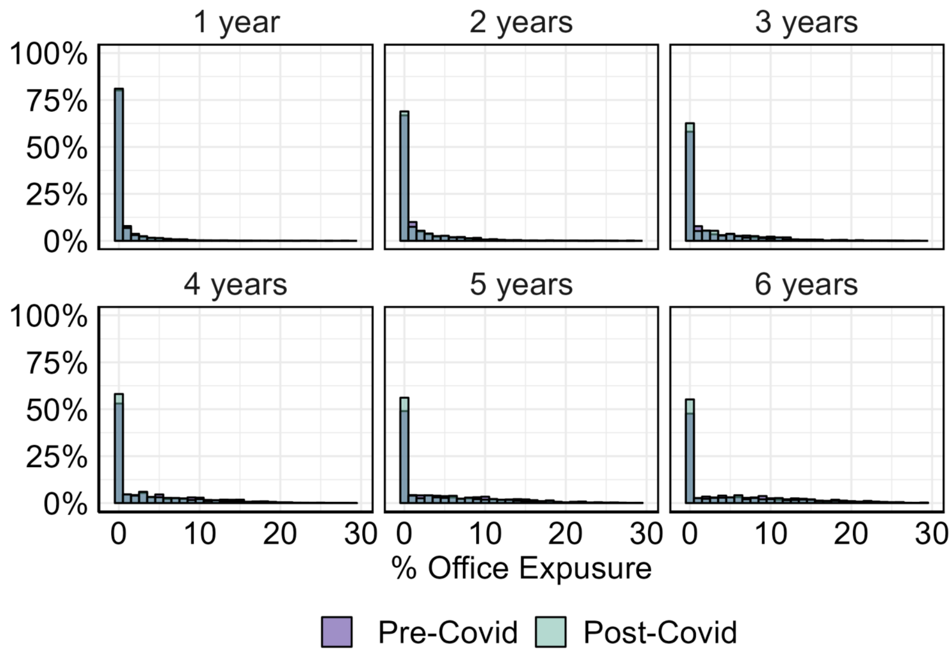
Notes: This figure shows the distribution of office-exposed shares of insurance companies' private-label CMBS portfolio. The left panel shows the distribution for any office exposure, and the right panel shows the distribution conditional on any mortgages having main leases expiring between 2023-2026. Source: Trepp, NAIC, and authors' calculations.

Figure 8: Distribution of Office Exposure—CMBS Acquired Before and After COVID-19



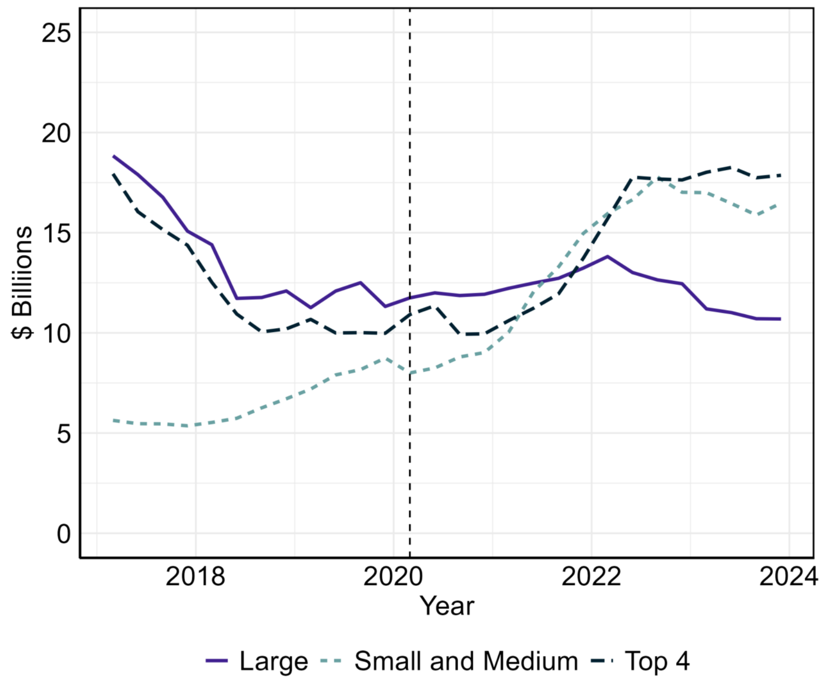
Notes: This figure shows the distribution of office exposures of CMBS acquired by insurance companies, before and after COVID-19. Percent exposure equals the amount of the pool of mortgages linked to office CRE. The left panel plots the distribution of office exposure for CMBS acquired between 2017-2019. The right panel plots the distribution of office exposure for CMBS acquired between 2020-2022. The width of each distribution bar equals 2%. Source: Trepp, NAIC, and authors' calculations.

Figure 9: Distribution of Office Exposure with Leases Expiring—CMBS Acquired Before and After COVID-19



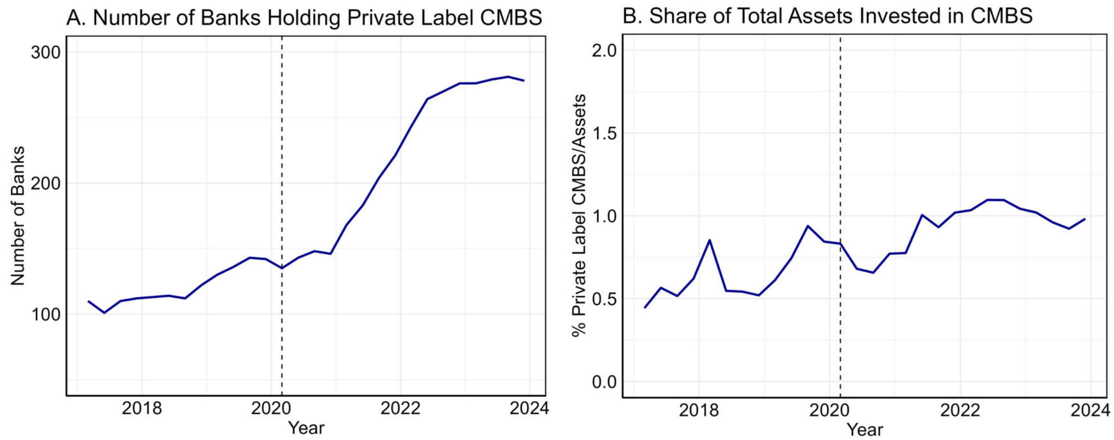
Notes: This figure shows the distribution of office exposures with leases expiring within a certain time window of CMBS acquired by insurance companies, before and after COVID-19. Percent exposure equals the amount of the pool of mortgages linked to office CRE whose main lease agreement expires within that time window. Each panel plots the distribution of security exposures of CMBS acquired before and after COVID-19, for each time window. Source: Trepp, NAIC, and authors' calculations.

Figure 10: Bank Holdings of Private-label CMBS



Notes: This figure shows the total amount of private-label CMBS holdings of U.S. banks, including held-to-maturity and available-for-sale assets. Top 4 banks are J.P. Morgan Chase, Bank of America, Citigroup, and Wells Fargo. Large banks are institutions with total assets above $ 100 billion, medium banks are institutions with total assets between $10 billion and $100 billion, and small banks are institutions with total assets under $10 billion. We also exclude TD Bank from the plots as it shows discontinuity in holdings of private CMBS in 2018 that is not present on the aggregate series. Source: Call Reports and authors' calculations.

Figure 11: Small Banks' Exposure to Private-Label CMBS



Notes: This figure shows the number of small U.S. banks which hold private-label CMBS (Panel A) and the median % share of private-label CMBS out of total assets for small banks with CMBS exposure (Panel B). Small banks are defined as institutions with total assets under $10 billion. Source: Call Reports and authors' calculations.

TABLES

Table 1: Summary Statistics

Panel A. All Properties	Mean	Median	Min	Max	N
Outstanding Balance	12,126,498.41	4,665,665.69	535.94	9,016,115,069.00	7,081,912
Floating Interest Rate	0.12	0.00	0.00	1.00	7,081,912
Delinquency (90 days)	0.01	0.00	0.00	1.00	7,081,912
Recourse Loan	0.01	0.00	0.00	1.00	7,081,912
Loan Term	228.39	120	1	515	7,010,744
Lease Expiration Year	2026	2024	2016	2099	747,189
Largest Tenant % Sqr Ft	45.11	33.44	0.00	100.00	748,523
Panel B. Office	Mean	Median	Min	Max	N
Outstanding Balance	35,592,214.49	17,545,061.17	6,760.18	3,000,000,000.00	276,561
Floating Interest Rate	0.08	0.00	0.00	1.00	276,561
Delinquency (90 days)	0.01	0.00	0.00	1.00	276,561
Recourse Loan	0.02	0.00	0.00	1.00	276,561
Loan Term	112.87	120	1	363	275,307
Lease Expiration Year	2025	2024	2016	2099	209,965
Largest Tenant % Sqr Ft	42.20	29.71	0.00	100.00	211,306
Panel C. Retail	Mean	Median	Min	Max	N
Outstanding Balance	17,123,979.19	7,331,549.50	797.55	2,400,000,000.00	516,328
Floating Interest Rate	0.02	0.00	0.00	1.00	516,328
Delinquency (90 days)	0.02	0.00	0.00	1.00	516,328
Recourse Loan	0.01	0.00	0.00	1.00	516,328
Loan Term	123.63	120	1	360	506,734
Lease Expiration Year	2027	2024	2016	2099	415,663
Largest Tenant % Sqr Ft	45.68	34.52	0.00	100.00	417,838

Notes: This table shows summary statistics from our sample of commercial real estate mortgages. The sample period is from Jan/2017 to Jun/2022. **Panel A** includes summary statistics for all property types in the sample. **Panel B** includes summary statistics for properties classified as *Office*. **Panel C** includes summary statistics for properties classified as *Retail*. Source: Trepp and authors' calculations.

Table 2: Triple Differences—Lease Expiration Before and After COVID-19

	I_{jrt}^{D90}		
	(1)	(2)	(3)
$Post\ Expiration_{jt}$	0.0131***	0.0132***	0.0140***
	(0.0029)	(0.0029)	(0.0034)
$Post\ Covid_t \times Post\ Expiration_{jt}$	-0.0029	-0.0029	-0.0013
	(0.0033)	(0.0033)	(0.0040)
$Post\ Covid_t \times Ind\ Office_j$	-0.0162***	-0.0160***	-0.0216***
	(0.0019)	(0.0019)	(0.0031)
$Post\ Expiration_{jt} \times Ind\ Office_j$	0.0013	0.0014	0.0004
	(0.0062)	(0.0062)	(0.0068)
$Post\ Covid_t \times Post\ Expiration_{jt} \times Ind\ Office_j$	0.0122*	0.0121*	0.0132*
	(0.0064)	(0.0064)	(0.0074)
Observations	751,294	751,294	751,294
R^2	0.42319	0.42324	0.57382
Within R^2	0.00208	0.00206	0.00300
Month-year fixed effects	✓		
Loan ID fixed effects	✓	✓	✓
Month-year × Floating fixed effects		✓	✓
Month-year × City fixed effects			✓

Notes: This table shows the effects of lease expiration on delinquency rates for mortgages linked to different property types, before and after COVID-19, as in (2). The level of observation is loan j in city r in month t, where month denotes the distribution month of each securitized mortgage. The sample period is Jan/2017 to Jun/2022. The dependent variable I_{jrt}^{D90} is a dummy variable which equals 1 if a loan is at least 90 days past due. $Post\ Covid_t$ equals 1 after March 2020, $Post\ Expiration_{jt}$ equals 1 if loan j had its main lease expiration before or in month t, and $Ind\ Office_j$ equals 1 if loan j is linked to an office. Standard errors clustered at the loan level in parentheses. Sources: Trepp and authors' calculations.

Table 3: Triple Differences and Occupancy %—Lease Expiration Before and After COVID-19

					I_{jrt}^{D90}				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$Post\ Expiration_{jt}$	0.0185	0.0185	-0.0038	0.0129***	0.0130***	0.0128***	0.0119***	0.0120***	0.0118***
	(0.0175)	(0.0176)	(0.0340)	(0.0029)	(0.0029)	(0.0036)	(0.0030)	(0.0030)	(0.0037)
$Post\ Covid_t \times Post\ Expiration_{jt}$	0.0535*	0.0535*	0.0809	-0.0059*	-0.0059*	-0.0055	-0.0050	-0.0051	-0.0041
	(0.0294)	(0.0295)	(0.0638)	(0.0034)	(0.0034)	(0.0041)	(0.0034)	(0.0034)	(0.0041)
$Post\ Covid_t \times Ind\ Office_j$	-0.0156***	-0.0156***	-0.0264**	-0.0155***	-0.0154***	-0.0210***	-0.0157***	-0.0155***	-0.0223***
	(0.0030)	(0.0030)	(0.0113)	(0.0025)	(0.0025)	(0.0042)	(0.0025)	(0.0025)	(0.0040)
$Post\ Expiration_{jt} \times Ind\ Office_j$	0.0488	0.0490	0.0720	-0.0046	-0.0046	-0.0056	-0.0035	-0.0034	-0.0044
	(0.0366)	(0.0367)	(0.0558)	(0.0064)	(0.0064)	(0.0070)	(0.0064)	(0.0064)	(0.0071)
$Post\ Covid_t \times Post\ Expiration_{jt} \times Ind\ Office_j$	-0.0725**	-0.0727**	-0.1139	0.0169**	0.0168**	0.0207**	0.0162**	0.0161**	0.0205**
	(0.0363)	(0.0363)	(0.0721)	(0.0071)	(0.0071)	(0.0082)	(0.0071)	(0.0071)	(0.0082)
$Full_j$							-0.0058	-0.0057	-0.0036
							(0.0119)	(0.0119)	(0.0163)
$Post\ Covid_t \times Full_j$							-0.0084**	-0.0084**	-0.0035
							(0.0034)	(0.0034)	(0.0056)
$Post\ Expiration_{jt} \times Full_j$							0.0131	0.0131	0.0079
							(0.0146)	(0.0146)	(0.0158)
$Ind\ Office_j \times Full_j$							-0.0016	-0.0015	-0.0093
							(0.0131)	(0.0131)	(0.0180)
$Post\ Covid_t \times Post\ Expiration_{jt} \times Full_j$							0.0544*	0.0544*	0.0626
							(0.0298)	(0.0298)	(0.0406)
$Post\ Covid_t \times Ind\ Office_j \times Full_j$							-8.32×10^{-6}	-0.0002	0.0038
							(0.0039)	(0.0040)	(0.0066)
$Post\ Expiration_{jt} \times Ind\ Office_j \times Full_j$							0.0416	0.0415	0.0538
							(0.0325)	(0.0325)	(0.0364)
$Post\ Covid_t \times Post\ Expiration_{jt} \times Ind\ Office_j \times Full_j$							-0.0838**	-0.0839**	-0.1170**
							(0.0360)	(0.0360)	(0.0465)
Observations	135,346	135,346	135,346	611,679	611,679	611,679	747,025	747,025	747,025
R^2	0.44563	0.44565	0.71391	0.43901	0.43908	0.60674	0.43801	0.43807	0.58513
Within R^2	0.01021	0.01021	0.01239	0.00153	0.00150	0.00233	0.00283	0.00282	0.00373
Month-year fixed effects	✓			✓			✓		
Loan ID fixed effects	✓	✓	✓	✓	✓	✓	✓	✓	✓
Month-year × Floating fixed effects		✓	✓		✓	✓		✓	✓
Month-year × City fixed effects			✓			✓			✓

Notes: This table shows the effects of lease expiration on delinquency rates of mortgages linked to different property types, before and after COVID-19, for partial and full tenant occupancy. We estimate (2) for the sample of full (columns (1)-(3)) and partial (columns (4)-(6)) occupancy mortgages, and for the whole sample, adding an interaction with the $Full_j$ dummy (columns (7)-(9)). The level of observation is loan j in city r in month t, where month denotes the distribution month of each securitized mortgage. The sample period is Jan/2017 to Jun/2022. The dependent variable I_{jrt}^{D90} is a dummy variable which equals 1 if a loan is at least 90 days past due. $Post\ Covid_t$ equals 1 after March 2020, $Post\ Expiration_{jt}$ equals 1 if loan j had its main lease expiration before or in month t, $Ind\ Office_j$ equals 1 if loan j is linked to an office, and $Full_j$ is a dummy which equals 1 for full tenant occupancy. Standard errors clustered at the loan level in parentheses. Sources: Trepp and authors' calculations.

Table 4: CMBS Bond Trading—Underlying Lease Expiration and Mortgage Delinquency

	I_{ijt}^{sold}			
	(1)	(2)	(3)	(4)
I_{jt}^{Exp}	0.0029	0.0017		
	(0.0029)	(0.0031)		
$I_{jt}^{Exp\ Office}$		0.0023		
		(0.0021)		
I_{jt}^{D}			0.0086***	0.0086***
			(0.0027)	(0.0028)
$I_{jt}^{D\ Office}$				0.0093**
				(0.0046)
Observations	176,824	176,824	176,824	176,176
R^2	0.63398	0.63399	0.63403	0.63366
Within R^2	1.7×10^{-5}	3.27×10^{-5}	0.00016	0.00025
Year × Insurer ID fixed effects	✓	✓	✓	✓
CUSIP × Insurer ID fixed effects	✓	✓	✓	✓
Year × Coupon Type fixed effects	✓	✓	✓	✓
Year × NAIC Designation fixed effects	✓	✓	✓	✓

Notes: This table shows the effect of exposure to underlying lease expiration and delinquent loans (for all properties and for offices) on the likelihood of sales of private-label CMBS by insurance companies, as in (3). The level of observation is bond j held by insurer i at the end of year t. The sample period is 2017 to 2022. The dependent variable I_{ijt}^{sold} is a dummy which equals 1 if bond j was sold by insurer i in year t. I_{jt}^{Y} and $I_{jt}^{Y\ Office}$ (with $Y \in \{Exp, D\}$) are dummies equal to 1 if bond j is exposed to mortgages whose main lease expires up until one year ahead (Exp) or have underlying delinquent mortgages (D), for all properties and only offices, respectively. Coupon Type is the type of coupon payment for bond j (e.g. fixed rate, floating rate, interest only). Standard errors clustered at the security level in parentheses. Sources: Trepp, NAIC, and authors' calculations.

Table 5: CMBS Trading Difference-in-Differences—Exposure to Lease Expiration

	I_{ijt}^{sold}					
Lease expiration horizon	(τ = 1)	(τ = 2)	(τ = 3)	(τ = 4)	(τ = 5)	(τ = 6)
$I_{jt}^{Exp(\tau)}$	0.0015	0.0006	0.0033	-0.0008	0.0034	0.0038
	(0.0033)	(0.0045)	(0.0052)	(0.0059)	(0.0069)	(0.0072)
$I_{jt}^{Exp\ Office(\tau)}$	0.0019	0.0029	0.0040	0.0054	0.0023	0.0026
	(0.0028)	(0.0031)	(0.0037)	(0.0045)	(0.0058)	(0.0066)
I_{jt}^{Office}	-0.0171	-0.0126	-0.0115	-0.0130	-0.0139	-0.0152
	(0.0207)	(0.0209)	(0.0209)	(0.0209)	(0.0207)	(0.0207)
$Post\ Covid_t \times I_{jt}^{Exp(\tau)}$	0.0012	0.0101*	0.0166**	0.0071	0.0019	-0.0066
	(0.0048)	(0.0060)	(0.0070)	(0.0075)	(0.0085)	(0.0089)
$Post\ Covid_t \times I_{jt}^{Exp\ Office(\tau)}$	-0.0009	0.0062	0.0068	0.0128**	0.0181**	0.0254***
	(0.0037)	(0.0043)	(0.0053)	(0.0061)	(0.0079)	(0.0087)
$Post\ Covid_t \times I_{jt}^{Office}$	0.0237***	0.0140*	0.0094	0.0107	0.0097	0.0084
	(0.0070)	(0.0074)	(0.0075)	(0.0075)	(0.0077)	(0.0078)
Observations	219,731	219,731	219,731	219,731	219,731	219,731
R^2	0.60744	0.60754	0.60762	0.60757	0.60755	0.60757
Within R^2	0.00024	0.00049	0.00069	0.00057	0.00053	0.00058
Year × Insurer ID fixed effects	✓	✓	✓	✓	✓	✓
CUSIP × Insurer ID fixed effects	✓	✓	✓	✓	✓	✓
Year × Coupon Type fixed effects	✓	✓	✓	✓	✓	✓
Year × NAIC Designation fixed effects	✓	✓	✓	✓	✓	✓

Notes: This table shows the effect of exposure to underlying lease expiration and offices on the likelihood of sales of private-label CMBS by insurance companies, as in (4). The level of observation is bond j held by insurer i at the end of year t. The sample period is 2017 to 2022. The dependent variable I_{ijt}^{sold} is a dummy which equals 1 if bond j was sold by insurer i in year t. $Post\ Covid_t$ equals 1 after 2019, $I_{jt}^{Exp(\tau)}$ and $I_{jt}^{Exp\ Office(\tau)}$ are dummies which equal 1 if bond j is exposed to mortgages whose main lease expires up until year $t+\tau$ (excluding year t), for all properties and only offices, respectively. I_{jt}^{Office} is a dummy which equals 1 for any exposure to offices. Coupon Type is the type of coupon payment for bond j (e.g. fixed rate, floating rate, interest only). Standard errors clustered at the security level in parentheses. Sources: Trepp, NAIC, and authors' calculations.

Table 6: CMBS Trading Difference-in-Differences—Exposure to Lease Expiration of Offices vs. Other Properties

	I_{ijt}^{sold}					
Lease expiration horizon	($\tau = 1$)	($\tau = 2$)	($\tau = 3$)	($\tau = 4$)	($\tau = 5$)	($\tau = 6$)
$I_{jt}^{Exp\ Office(\tau)}$	0.0034	0.0035	0.0031	0.0036	0.0021	0.0020
	(0.0025)	(0.0028)	(0.0033)	(0.0040)	(0.0049)	(0.0054)
$I_{jt}^{Exp\ Retail(\tau)}$	0.0030	0.0012	0.0042	0.0043	0.0059	0.0067
	(0.0025)	(0.0033)	(0.0043)	(0.0053)	(0.0064)	(0.0066)
$I_{jt}^{Exp\ Other(\tau)}$	0.0003	0.0044	0.0104***	0.0076**	0.0072*	0.0074
	(0.0027)	(0.0028)	(0.0032)	(0.0036)	(0.0040)	(0.0047)
I_{jt}^{Retail}	-0.0269	-0.0246	-0.0247	-0.0242	-0.0217	-0.0242
	(0.0316)	(0.0315)	(0.0314)	(0.0313)	(0.0312)	(0.0311)
I_{jt}^{Office}	-0.0096	-0.0090	-0.0088	-0.0086	-0.0081	-0.0086
	(0.0213)	(0.0213)	(0.0212)	(0.0211)	(0.0211)	(0.0212)
$Post\ Covid_t \times I_{jt}^{Exp\ Office(\tau)}$	-0.0028	0.0061	0.0099**	0.0101*	0.0074	0.0123*
	(0.0033)	(0.0039)	(0.0047)	(0.0054)	(0.0065)	(0.0072)
$Post\ Covid_t \times I_{jt}^{Exp\ Retail(\tau)}$	-0.0048	0.0019	0.0072	0.0072	0.0161*	0.0047
	(0.0035)	(0.0048)	(0.0068)	(0.0076)	(0.0090)	(0.0094)
$Post\ Covid_t \times I_{jt}^{Exp\ Other(\tau)}$	0.0007	-0.0057*	-0.0078**	-0.0031	-0.0005	0.0022
	(0.0036)	(0.0034)	(0.0038)	(0.0043)	(0.0047)	(0.0050)
$Post\ Covid_t \times I_{jt}^{Retail}$	0.0291***	0.0242***	0.0193**	0.0171**	0.0101	0.0155*
	(0.0064)	(0.0069)	(0.0077)	(0.0080)	(0.0083)	(0.0086)
$Post\ Covid_t \times I_{jt}^{Office}$	0.0201***	0.0157**	0.0121	0.0104	0.0082	0.0075
	(0.0069)	(0.0071)	(0.0074)	(0.0075)	(0.0077)	(0.0079)
Observations	219,731	219,731	219,731	219,731	219,731	219,731
R^2	0.60756	0.60761	0.60771	0.60767	0.60769	0.60768
Within R^2	0.00054	0.00068	0.00092	0.00083	0.00089	0.00086
Year × Insurer ID fixed effects	✓	✓	✓	✓	✓	✓
CUSIP × Insurer ID fixed effects	✓	✓	✓	✓	✓	✓
Year × Coupon Type fixed effects	✓	✓	✓	✓	✓	✓
Year × NAIC Designation fixed effects	✓	✓	✓	✓	✓	✓

Notes: This table shows the effect of exposure to underlying lease expiration and offices on the likelihood of sales of private CMBS by insurance companies, as in (6). The level of observation is bond j held by insurer i at the end of year t. The sample period is 2017 to 2022. The dependent variable I_{ijt}^{sold} is a dummy which equals 1 if bond j was sold by insurer i in year t. $Post\ Covid_t$ equals 1 after 2019 and $I_{jt}^{Exp\ Retail(\tau)}$, $I_{jt}^{Exp\ Office(\tau)}$ and $I_{jt}^{Exp\ Other(\tau)}$ are dummies which equal 1 if bond j is exposed to mortgages whose main lease expires up until year $t+\tau$ (excluding year t), for retail, offices, and other properties, respectively. I_{jt}^{Retail} and I_{jt}^{Office} equal 1 for any exposure to retail and offices, respectively. Coupon Type is the type of coupon payment for bond j (e.g. fixed rate, floating rate, interest only). Standard errors clustered at the security level in parentheses. Sources: Trepp, NAIC, and authors' calculations.

Table 7: Bond Pricing

	$Coupon_{jt}$			
	(1)	(2)	(3)	(4)
$Office_j$ %	-0.0043***	-0.0115***	-0.0117***	-0.0068**
	(0.0016)	(0.0037)	(0.0040)	(0.0035)
$Office_j$ % × $Post\ Covid_t$	-0.0015	-0.0124**	-0.0113**	-0.0136***
	(0.0023)	(0.0051)	(0.0051)	(0.0050)
$Office_j$ % × $NAIC\ Held_{jt}$		0.0099***	0.0085**	0.0042
		(0.0036)	(0.0036)	(0.0032)
$Office_j$% × $Post\ Covid_t$ × $NAIC\ Held_{jt}$		0.0147***	0.0148***	0.0175***
		(0.0049)	(0.0047)	(0.0045)
$Retail_j$ %				-0.0109**
				(0.0053)
$Post\ Covid_t$ × $Retail_j$ %				-0.0005
				(0.0076)
$Retail_j$ % × $NAIC\ Held_{jt}$				0.0115**
				(0.0051)
$Retail_j$ % × $Post\ Covid_t$ × $NAIC\ Held_{jt}$				0.0137*
				(0.0077)
$Prime\ rating_j$			-0.6106***	-0.0996*
			(0.0404)	(0.0546)
$Main\ state\ (share\ in\ \%)_j$			0.0003	0.0077***
			(0.0015)	(0.0020)
$Num\ Loans\ at\ Securitization_j$			-0.0062***	-0.0065***
			(0.0017)	(0.0018)
$Horizontal\ Risk\ Retention_j$			0.0495	0.0076
			(0.0369)	(0.0407)
$Weighted\ Avg\ LTV\ at\ Securitization_j$				0.0396***
				(0.0078)
$Weighted\ Avg\ DSCR\ at\ Securitization_j$				0.1950**
				(0.0850)
$Conduit_j$				-0.3504**
				(0.1367)
Observations	3,302	3,302	3,302	2,529
R^2	0.58652	0.61258	0.64864	0.67202
Within R^2	0.02036	0.08209	0.15321	0.23219
Year-quarter × Maturity fixed effects	✓	✓	✓	✓
Lead Underwriter fixed effects			✓	✓

Notes: This table shows a regression of fixed rate bond coupons of private-label CMBS on the office collateral and insurance ownership before and after COVID-19, as in (7). The level of observation is bond j originated in quarter t. The sample period is 2017 to 2022. The dependent variable $Coupon_{jt}$ is the coupon rate of fixed rate bond j originated in quarter t. $Post\ Covid_t$ equals 1 after 2019. $NAIC\ Held_{jt}$ equals 1 if bond j is held by any insurer in the end of the year of origination of the respective quarter t. $Office_j$ % and $Retail_j$ % are the percent shares of the deal linked to office and retail loans. $Prime\ rating_j$ equals 1 if the bond is rated at least BBB by S&P or by Fitch or at least Baa3 by Moody's. $Main\ State\ (share\ in\ \%)_j$ is the share of the deal invested in the main state. $Num\ of\ Loans\ at\ Securitization_j$ is the number of loans in the deal at origination. $Horizontal\ Risk\ Retention_j$ and $Conduit_j$ are dummies for deals of each type, respectively. $Weighted\ Avg\ LTV\ at\ Securitization_j$ and $Weighted\ Avg\ DSCR\ at\ Securitization_j$ are average LTV and DSCR weighted by loan volume within each deal. Standard errors clustered at the security level in parentheses. Sources: Trepp, NAIC, and authors' calculations.

Table 8: Insurer CMBS Portfolio Exposure and Asset Sales

	I^{sold}_{ijt}					
		I^{Risky}_{jt}			$I^{Downgrade}_{jt-1}$	
	(1)	(2)	(3)	(4)	(5)	(6)
$I^T_{jt} \times T^{Office}_{it-1}$	-0.0008	-0.0016	-0.0017	0.0015	0.0102***	0.0103***
	(0.0021)	(0.0035)	(0.0035)	(0.0021)	(0.0040)	(0.0039)
$I^T_{jt} \times T^{Retail}_{it-1}$		0.0007	0.0006		-0.0070**	-0.0071**
		(0.0024)	(0.0024)		(0.0029)	(0.0029)
$I^T_{jt} \times T^{Lodging}_{it-1}$		0.0023	0.0040		-0.0051	-0.0057
		(0.0071)	(0.0070)		(0.0067)	(0.0068)
$Post\ Covid_t \times I^T_{jt} \times T^{Office}_{it-1}$	-0.0022	-0.0095***	-0.0093***	-0.0007	-0.0117**	-0.0117**
	(0.0021)	(0.0035)	(0.0034)	(0.0027)	(0.0046)	(0.0046)
$Post\ Covid_t \times I^T_{jt} \times T^{Retail}_{it-1}$		0.0078**	0.0076**		0.0094**	0.0095**
		(0.0031)	(0.0031)		(0.0038)	(0.0037)
$Post\ Covid_t \times I^T_{jt} \times T^{Lodging}_{it-1}$		0.0056	0.0042		0.0069	0.0085
		(0.0069)	(0.0069)		(0.0094)	(0.0093)
$I^T_{jt} \times T^{\%CorpBonds}_{it-1}$			0.0401***			-0.0076
			(0.0137)			(0.0115)
$Post\ Covid_t \times I^T_{jt} \times T^{\%CorpBonds}_{it-1}$			-0.0282*			0.0241
			(0.0146)			(0.0150)
Observations	7,091,153	7,091,153	7,091,153	5,605,453	5,605,453	5,605,453
R^2	0.71081	0.71082	0.71083	0.78171	0.78171	0.78171
Within R^2	0.00086	0.00090	0.00093	6.25×10^{-6}	1.55×10^{-5}	1.95×10^{-5}
Year × CUSIP fixed effects	✓	✓	✓	✓	✓	✓
CUSIP × Insurer ID fixed effects	✓	✓	✓	✓	✓	✓
Year × Insurer ID fixed effects	✓	✓	✓	✓	✓	✓

Notes: This table shows the effect of exposure to different types of collateral via CMBS holdings on the likelihood of sales of risky assets by insurance companies, as in (8). The level of observation is bond j originated in quarter t. The sample period is 2017 to 2022, and the sample includes all bonds. The dependent variable I^{sold}_{ijt} is a dummy which equals 1 if bond j was sold by insurer i in year t. $Post\ Covid_t$ equals 1 after 2019, T^{Prop}_{it-1} is the size of the exposure of insurance company i to property type $Prop \in \{Office, Retail, Lodging\}$ in year $t-1$, and I^T_{jt} is a dummy which equals 1 if the bond is classified as *Risky* or if it was downgraded in year $t-1$. $T^{\%CorpBonds}_{it-1}$ is the share of insurance company i fixed income portfolio invested in corporate bonds in year $t-1$. Standard errors clustered at the insurer level in parentheses. Sources: Trepp, NAIC, and authors' calculations.

Table 9: CMBS Bank Buyer Difference-in-Differences—Exposure to Lease Expiration

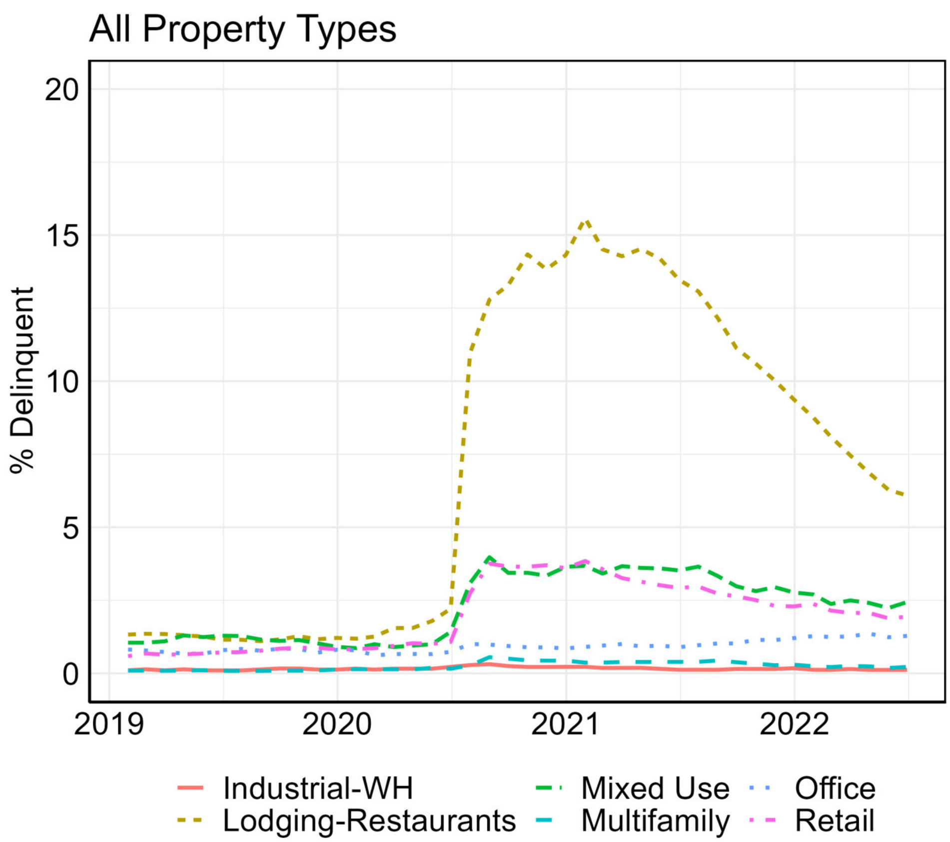
	$I_{ijt}^{sold\ to\ bank}$					
Lease expiration horizon	($\tau = 1$)	($\tau = 2$)	($\tau = 3$)	($\tau = 4$)	($\tau = 5$)	($\tau = 6$)
$I_{jt}^{Exp(\tau)}$	0.0023*	0.0046***	0.0057***	0.0068***	0.0061***	0.0055**
	(0.0012)	(0.0017)	(0.0019)	(0.0021)	(0.0023)	(0.0022)
$I_{jt}^{Exp\ Office(\tau)}$	0.0015	0.0016	0.0020	0.0021	0.0025	0.0035
	(0.0011)	(0.0012)	(0.0015)	(0.0019)	(0.0022)	(0.0021)
I_{jt}^{Office}	-0.0012	-0.0016	-0.0022	-0.0031	-0.0029	-0.0026
	(0.0068)	(0.0068)	(0.0068)	(0.0069)	(0.0069)	(0.0068)
$Post\ Covid_t \times I_{jt}^{Exp(\tau)}$	-0.0018	-0.0025	-0.0037	-0.0062**	-0.0064**	-0.0057**
	(0.0016)	(0.0021)	(0.0024)	(0.0026)	(0.0026)	(0.0027)
$Post\ Covid_t \times I_{jt}^{Exp\ Office(\tau)}$	-0.0011	0.0006	0.0020	0.0032	0.0046**	0.0051**
	(0.0014)	(0.0015)	(0.0018)	(0.0021)	(0.0024)	(0.0025)
$Post\ Covid_t \times I_{jt}^{Office}$	0.0050**	0.0047*	0.0044	0.0049*	0.0037	0.0027
	(0.0024)	(0.0026)	(0.0027)	(0.0028)	(0.0027)	(0.0028)
Observations	203,987	203,987	203,987	203,987	203,987	203,987
R^2	0.39349	0.39355	0.39361	0.39363	0.39362	0.39366
Within R^2	0.00012	0.00022	0.00031	0.00036	0.00034	0.00040
Year × Insurer ID fixed effects	✓	✓	✓	✓	✓	✓
CUSIP × Insurer ID fixed effects	✓	✓	✓	✓	✓	✓
Year × Coupon Type fixed effects	✓	✓	✓	✓	✓	✓
Year × NAIC Designation fixed effects	✓	✓	✓	✓	✓	✓

Notes: This table shows the effect of exposure to underlying lease expiration and offices on the likelihood of sales of private-label CMBS by insurance companies to banks. The level of observation is bond j held by insurer i at the end of year t. The sample period is 2017 to 2022. The dependent variable $I_{ijt}^{sold\ to\ bank}$ is a dummy which equals 1 if bond j was sold by insurer i in year t to a bank. We excluded CMBS holdings where the following firms are buyers: FA REINSURANCE, Resolution Life Insurance, Coinsurance Talcott-Allianz. $Post\ Covid_t$ equals 1 after 2019, $I_{jt}^{Exp(\tau)}$ and $I_{jt}^{ExpOffice(\tau)}$ are dummies which equal 1 if bond j is exposed to mortgages whose main lease expires up until year $t+\tau$ (excluding year t), for all properties and only offices, respectively. I_{jt}^{Office} is a dummy which equals 1 for any exposure to offices. Standard errors clustered at the security level in parentheses. Coupon Type is the type of coupon payment for bond j (e.g. fixed rate, floating rate, interest only). Sources: Trepp, NAIC, and authors' calculations.

Appendix

A. Additional Figures and Tables

Figure A.1: Delinquency Rates by Property Type

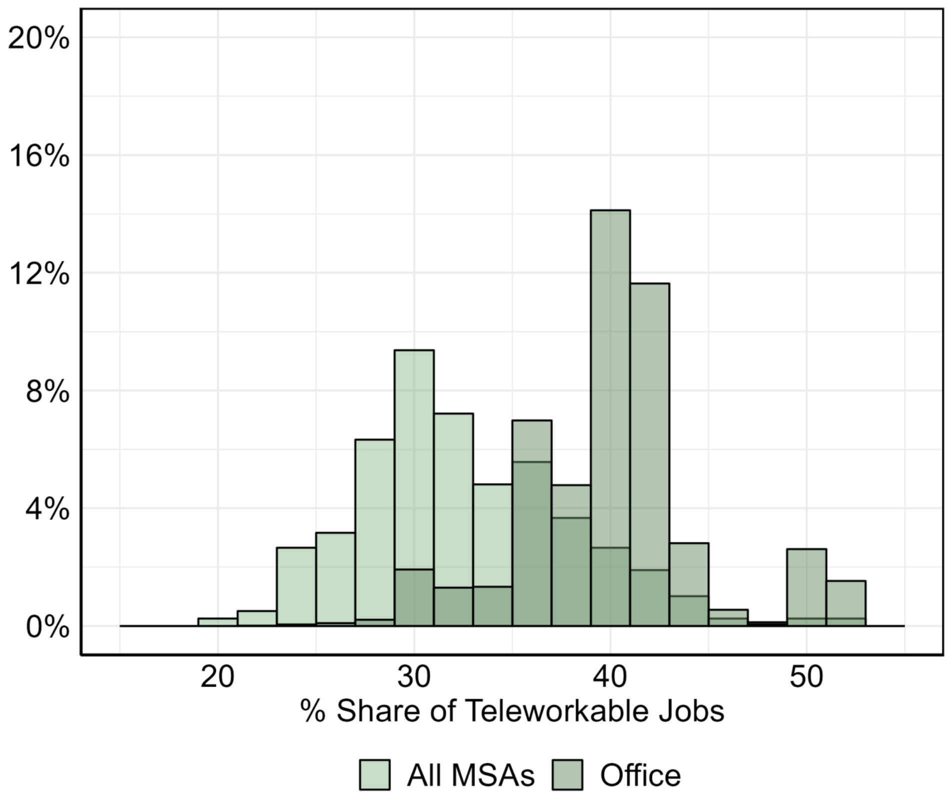


Notes: This Figure reports average delinquency for mortgages linked to different property types. Property types are defined as in Appendix B. Delinquency is a dummy variable which equals 1 if a mortgage is more than 90 days past due. Source: Trepp and authors' calculations.

Figure A.2: Distribution of % Occupancy by Largest Tenant

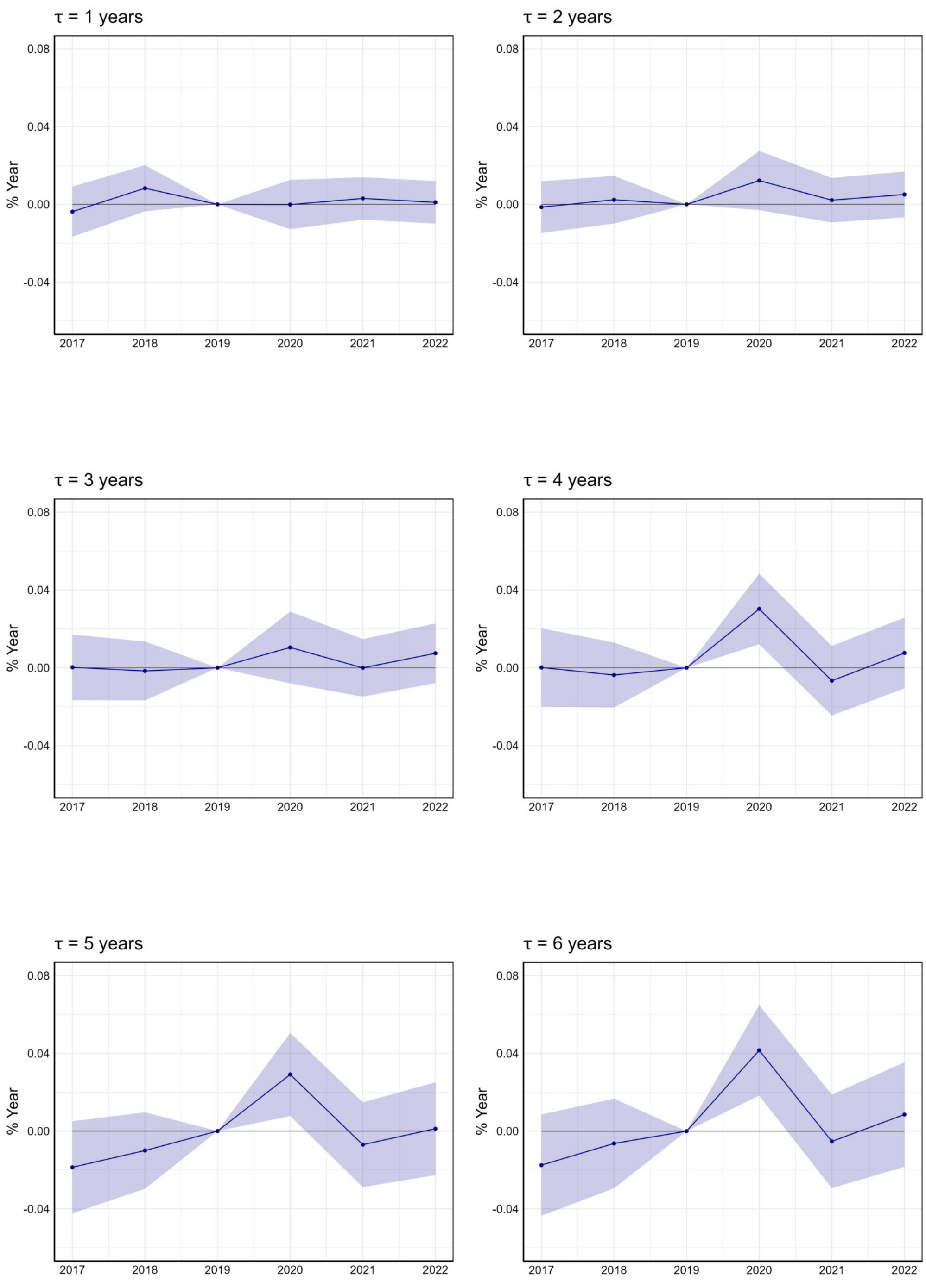
Notes: This figure shows the distribution of the % occupied by the largest tenant in the properties linked to CRE mortgages, separately for *Retail* and *Office*. The width of each distribution bar is 4%. Source: Trepp and authors' calculations.

Figure A.3: Distribution of % Teleworkable Jobs—All MSAs and Office Mortgages



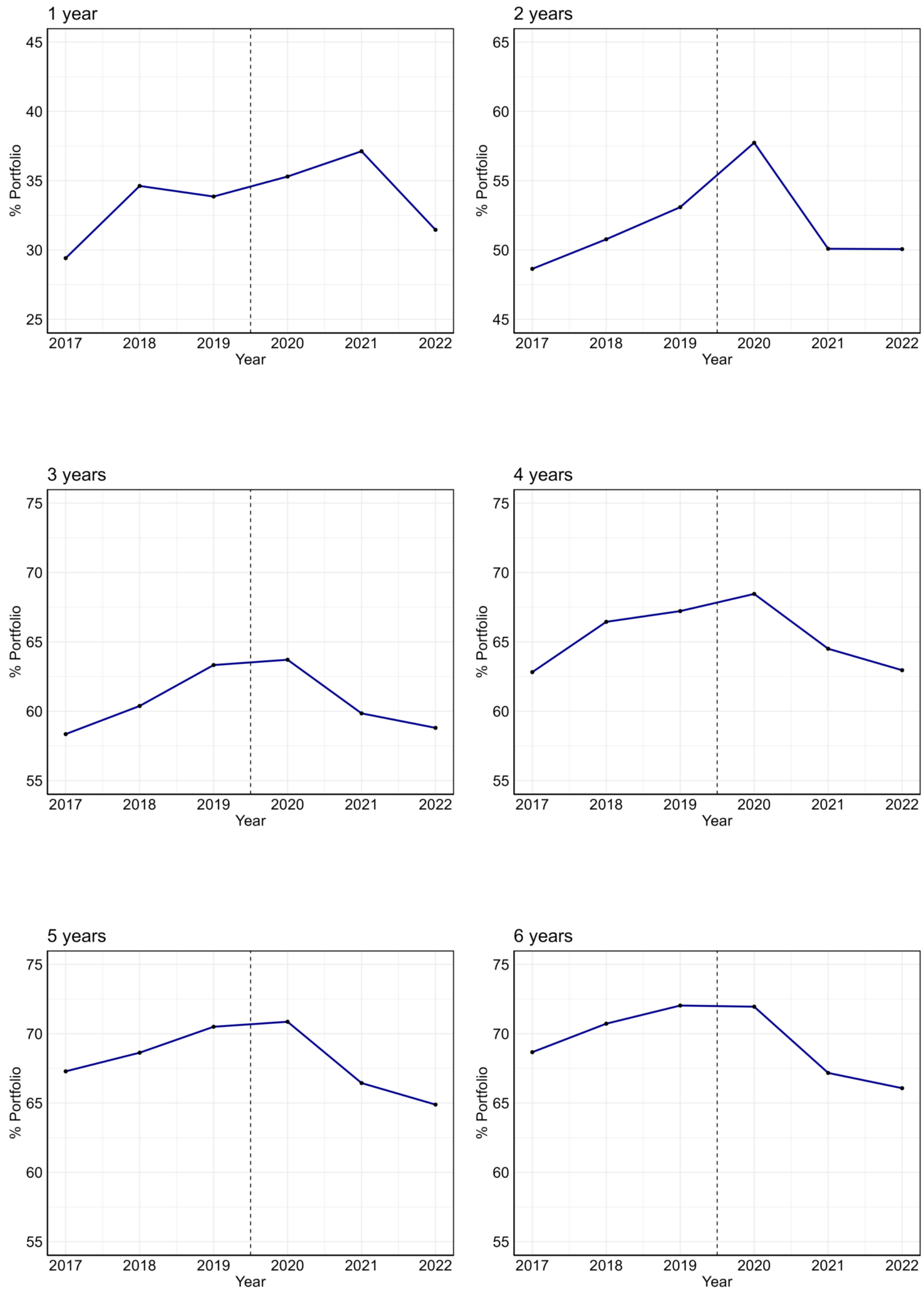
Notes: This figure shows the distribution of the share of jobs in each MSA that can be performed from home, using the measure proposed by Dingel and Neiman (2020). We plot the distribution of all MSAs in the Dingel and Neiman (2020) dataset, and the distribution of the MSAs from the mortgages in the Trepp data, focusing on properties classified as *Office*. The width of each distribution bar is 2%. Source: Trepp and authors' calculations.

Figure A.4: Dynamic Difference-in-Differences: Trading of CMBS Exposed to Cash Flow Risks



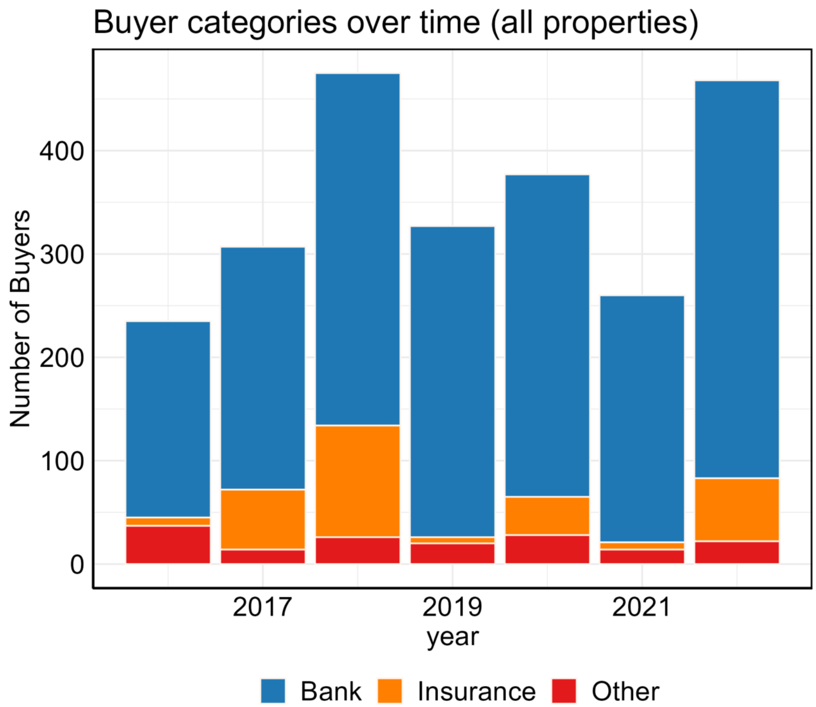
Notes: Each plot shows the dynamic effect of exposure to underlying office lease expiration on the likelihood of sales of private-label CMBS by insurers, as in specification (5). The level of observation is bond j held by insurer i at the end of year t. The dependent variable I_{ijt}^{sold} is a dummy which equals 1 if bond j was sold by insurer i in year t. The sample period is 2017 to 2022. $I_{jt}^{ExpOffice(\tau)}$ is defined as in the main paper, and $D_{jt}^{ExpOffice(\tau)}$ are dummies equal to 1 if bond j is exposed to mortgages whose main lease expires up until one year ahead and $\iota = t$. Source: Trepp, NAIC, and authors' calculations.

Figure A.5: Share Insurers CMBS Portfolio Exposed to Lease Expiration Within τ years



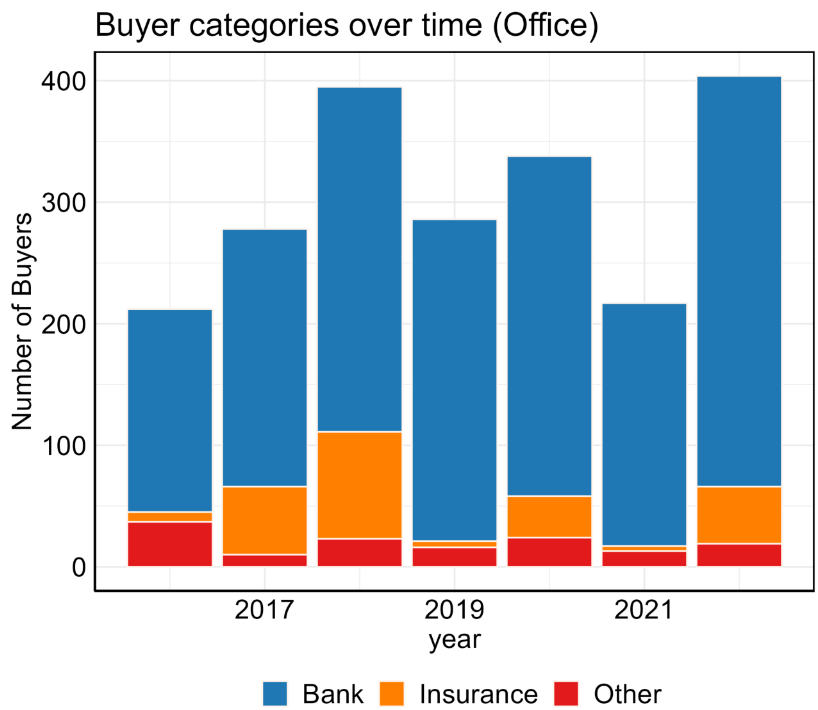
Notes: Each plot shows the share of the private-label CMBS portfolio of insurance companies at the end of each year, for bonds which have $I_{jt}^{ExpOffice(\tau)}$ equal 1, that is, bond j has any underlying office-linked mortgages whose leases expire within τ years in year t. Source: Trepp, NAIC, and authors' calculations.

Figure A.6: Buyers of CMBS by Category over Time (All Properties)



Notes: This figure reports the share of buyers of all private-label CMBS against all properties sold by insurance firms by categories over time. We exclude three major buyers (FA REINSURANCE, RESOLUTION LIFE, COINSURANCE TALCOTT-ALLIANZ). Property types are defined as in Appendix B. Source: Trepp, NAIC, and authors' calculations.

Figure A.7: Buyers of CMBS by Category over Time (Offices)



Notes: This figure reports the share of buyers of all private-label CMBS against offices sold by insurance firms by categories over time. We exclude three major buyers (FA REINSURANCE, RESOLUTION LIFE, COINSURANCE TALCOTT-ALLIANZ). Property types are defined as in Appendix B. Source: Trepp, NAIC, and authors' calculations.

Table A.1: Property Types and Lease Expiration Information

Property Category	# without lease expiration	# with lease expiration	% with lease expiration
Healthcare-Nursing	464727	51	0.01
Industrial-WH	147055	53515	26.68
Lodging-Restaurants	208574	180	0.09
Mixed Use	66103	56571	46.11
Multifamily	5057710	831	0.02
Office	66596	209965	75.92
Other	223293	10413	4.46
Retail	100665	415663	80.50

Notes: This table shows the number of observations in our CRE mortgage sample for which the lease expiration information is included, and the number of observations for which the lease expiration information is missing. Sample is from Jan/2017 to Jun/2022. Breakdown is provided by property type. Source: Trepp and authors' calculations.

Table A.2: CMBS Insurance Buyer Difference-in-Differences—Exposure to Lease Expiration

			$I_{ijt}^{sold\ to\ insurance}$			
Lease expiration horizon	$(\tau = 1)$	$(\tau = 2)$	$(\tau = 3)$	$(\tau = 4)$	$(\tau = 5)$	$(\tau = 6)$
$I_{jt}^{Exp(\tau)}$	0.0002	0.0009*	8.62×10^{-5}	0.0002	8.82×10^{-5}	0.0004
	(0.0004)	(0.0005)	(0.0006)	(0.0006)	(0.0006)	(0.0007)
$I_{jt}^{Exp\ Office(\tau)}$	0.0003	-4.85×10^{-5}	0.0008	0.0004	0.0007	0.0005
	(0.0004)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0006)
I_{jt}^{Office}	-0.0017	-0.0015	-0.0017	-0.0017	-0.0018	-0.0019
	(0.0013)	(0.0013)	(0.0013)	(0.0013)	(0.0013)	(0.0013)
$Post\ Covid_t \times I_{jt}^{Exp(\tau)}$	-8.79×10^{-5}	0.0004	0.0004	-0.0004	-0.0005	-0.0013
	(0.0006)	(0.0008)	(0.0007)	(0.0007)	(0.0008)	(0.0009)
$Post\ Covid_t \times I_{jt}^{Exp\ Office(\tau)}$	1.5×10^{-5}	8.1×10^{-5}	-0.0002	0.0007	0.0008	0.0018**
	(0.0006)	(0.0006)	(0.0005)	(0.0006)	(0.0006)	(0.0009)
$Post\ Covid_t \times I_{jt}^{Office}$	-0.0004	-0.0007	-0.0006	-0.0008	-0.0009	-0.0011
	(0.0008)	(0.0008)	(0.0008)	(0.0008)	(0.0009)	(0.0009)
Observations	203,987	203,987	203,987	203,987	203,987	203,987
R^2	0.41865	0.41866	0.41866	0.41866	0.41866	0.41868
Within R^2	2.41×10^{-5}	5.25×10^{-5}	5.34×10^{-5}	4.11×10^{-5}	5.18×10^{-5}	8.35×10^{-5}
Year × Insurer id fixed effects	✓	✓	✓	✓	✓	✓
CUSIP × Insurer id fixed effects	✓	✓	✓	✓	✓	✓
Year × Coupon Type fixed effects	✓	✓	✓	✓	✓	✓
Year × NAIC Designation fixed effects	✓	✓	✓	✓	✓	✓

Notes: This table shows the effect of exposure to underlying lease expiration and offices on the likelihood of sales of private-label CMBS by insurance companies to insurance companies. The level of observation is bond j held by insurer i at the end of year t. The sample period is 2017 to 2022. The dependent variable $I_{ijt}^{sold\ to\ insurance}$ is a dummy which equals 1 if bond j was sold by insurer i in year t to another insurance company. We excluded CMBS holdings where the following firms are buyers: FA REINSURANCE, Resolution Life Insurance, Coinsurance Talcott-Allianz. $Post\ Covid_t$ equals 1 after 2019, $I_{jt}^{Exp(\tau)}$ and $I_{jt}^{ExpOffice(\tau)}$ are dummies which equal 1 if bond j is exposed to mortgages whose main lease expires up until year $t+\tau$ (excluding year t), for all properties and only offices, respectively. I_{jt}^{Office} is a dummy which equals 1 for any exposure to offices. Coupon Type is the type of coupon payment for bond j (e.g. fixed rate, floating rate, interest only). Standard errors clustered at the security level in parentheses. Sources: Trepp, NAIC, and authors' calculations.

Table A.3: Small Bank Characteristics by CMBS Ownership

	CMBS Before COVID-19	CMBS Only After COVID-19	No CMBS
Total Assets (000s)	1,751,887	1,267,447	707,091
% Non-owner occ CRE loans	16.35	17.16	13.28
% Private CMBS over total assets	1.18	1.26	0
% Private CMBS	1.98	2.37	0
% Short term securities	2.93	2.76	5.55
% US Treasury	8.22	9.56	16.39
% State and Municipal Bonds	28.64	28.67	27.51
% Other Debt Securities	3.28	3.42	1.95
% Foreign Debt Securities	0.13	0.10	0.09
% Agency MBS	10.43	9.83	7.53
Tier 1 Leverage	10.85	10.81	11.57

Notes: This table shows average values for selected characteristics for three types of small banks over the four quarters of 2023. The first column includes all banks that hold private-label CMBS between 2017 and March 2020. The second column includes all banks that hold private-label CMBS only after March 2020. The last column includes all remaining banks, i.e., banks that do not hold any private-label CMBS between 2017 and 2023. Source: Call Reports and authors' calculations.

B. Data Construction

Our data comes from two main sources, Trepp and NAIC, and are complemented by Call Reports data for our bank level analysis. In what follows, we document the data cleaning procedures for each of the two data sources, and show how we obtain measures of exposure to cash flow shocks at the CMBS level.

Trepp CRE mortgage data. Mortgage data is informed at the loan level with frequency dictated by distribution dates (*ddate*). We use these distribution dates as our main date variables in the loan level analysis. In constructing our sample for the analysis, we exclude:

- Observations without *city* information;
- Observations with an outstanding balance lower than $ 500;
- Observations for which lease expiration is patchy, that is, when lease expiration information exists for certain months, ceases to be included, and is again included afterwards;
- Observations which have more than one broad property type associated with it in the year in our sample.

Furthermore, we use information from the variable *proptype*, informed by Trepp, to construct the broad property types which we use in our analysis. The variable *proptype* has a large number of stringers indicating the use of the property serving as collateral for each mortgages. We aggregate these strings into eight different property types: *Office*, *Retail*, *Multifamily*, *Mixed Use*, *Healthcare-Nursing*, *Lodging-Restaurants*, *Industrial and Warehouses*, and the residual category *Other*. Examples of how we bin different *proptype* into our broader property type category are:

- **Office** includes *proptype* strings such as "Office" "Office/Hdqr","Office Building" and "office properties";
- **Retail** includes *proptype* strings such as "Retail", "Retail Unanchored", "Retail Anchored" and "Retail Mall";

- **Multifamily** includes *proptype* strings such as "Multi-Tenant", "Multifamily" and "Multi-family";
- **Mixed Use** includes *proptype* strings such as "Mixed-Use", "Office/Warehouse", "Multifamily/Retail" and "Offc/Retail/Mltfmly";
- **Healthcare-Nursing** includes *proptype* strings such as "Nursing Home", "Medical Office", "Assisted Living" and "Medical Office";
- **Lodging-Restaurants** includes *proptype* strings such as "Hospitality", "Lodging Full Service", "Restaurant" and "Hotel";
- **Industrial and Warehouses** includes *proptype* strings such as "Industrial", "Self-Storage", "Warehouse" and "Industrial/warehouse".

The full list of strings and their respectively classification can be obtained upon request. Following this procedure, we obtain the loan level monthly panel summarized in Table 1.

Call Reports. We obtain bank level data at quarterly frequency from the Reports of Condition and Income (call reports), available here. We construct our series of holdings of private CMBS by following the construction of the LM763063653.Q and LM763063693.Q variables at the bank level. Detailed instructions for the construction of these two series can be found here and in here.[15]

B.1. CMBS and Insurer Level Exposure to Underlying Loan Characteristics

Since NAIC data is at annual frequency and Trepp data is at distribution date frequency (monthly), we follow an aggregation procedure to plug loan information into CMBS. Specifically, we collect deal level information corresponding to December of each year (and June for 2022, the last month in our sample from Trepp), and add this information to the bonds linked to each deal.

[15] We exclude TD Bank from the analysis as its holdings of private-label CMBS suddenly drop in 2018, and no discontinuous drop is observed in either of the aggregate series. Our small bank analysis is identical as TD Bank would not be classified as a small bank.

Specifically, let $TotAmt_{djt}$ denote the total amount outstanding of the pool of loans of deal d which is linked to bond j and $TotAmt_{djt}^{Offices}$ denote the same amount for loans linked to office properties. Then bond j's exposure to offices in year t is defined as $T_{jt}^{Office} \equiv \frac{TotAmt_{djt}^{Offices}}{TotAmt_{djt}}$. This exposure variable is used to construct dummy variables for positive exposure to offices using variables analogous to $TotAmt_{djt}^{Offices}$ that only include amount for loans with leases expiring within each τ horizon.

To obtain insurer level exposures, we calculate a weighted average exposure at the bond level (weighted by BACV), times the size of the portfolio of private-label CMBS for each insurer.

C. Identifying Active Sales and Acquisitions

The results in Section 5 rely on measures of active asset sales and acquisitions by insurers, obtained from NAIC Schedule D, parts 3 and 4. We identify active sales using a procedure similar to Becker, Opp and Saidi (2022). First, we use the information contained in the variable *name of the purchaser* to exclude entries with keywords associated with *maturity*, *redemption*, *repayment* and *default*, for example. We also impose the requirement of strict positive or negative value in the variable *realized gain(loss) on disposal*. Finally, we further exclude observations for which maturity dates coincide with the report date.

To classify active acquisitions, we identify a series of keywords for the *vendor* variable which contain information not associated with active acquisitions. These keywords include references to *exchange*, *capitalization*, *merger* and *transfer*, for example. The full list of keywords, alongside the R code, can be obtained from the authors upon request.