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

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Abstract

This paper examines how insurance companies monitor and react to cash flow shocks in commercial mortgage-backed securities (CMBS). Using detailed micro data around the onset of the COVID-19 pandemic, we show that lease expiration predicts commercial real estate mortgage delinquency, particularly for offices due to lower demand. Insurers monitor these risks and sell more exposed CMBS—mirrored by a surge in small banks holding CMBS. This monitoring effort also affects insurers' trading in other assets, indicating limited risk assessment capacity. Our findings reveal that institutional investors actively monitor underlying asset risk and can even gain informational advantages over some banks.

JEL codes: G20, G21, G22, G23

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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. While monitoring these cash flows is particularly challenging due to the complex structure of CMBS and their multiple underlying assets (Ghent, Torous and Valkanov, 2019), studying investor reactions to salient cash flow shocks can reveal whether and how they monitor risks in these complex securities. Understanding how investors differ in their due diligence and risk-bearing capabilities is especially relevant today, as it determines how commercial real estate (CRE) risks from declining office demand are distributed across financial intermediaries.

In this paper, we study these questions by exploiting cash flow shocks during the COVID-19 pandemic that vary by the type of property serving as mortgage collateral. We examine how insurers—one of the largest investor groups in mortgage-backed securities—react to increases in CRE mortgage risks induced by these 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 lease contracts between borrowers and their core tenants. We find that lease expiration significantly increases CRE loan default risk for offices, particularly following COVID-19 when hybrid work arrangements reduced office demand.

Our evidence shows that insurers actively monitor collateral characteristics like property type and lease expiration dates, reducing their holdings of exposed CMBS after the onset of the pandemic. This monitoring behavior also influences how insurers manage salient risks in the remainder of their asset portfolio. As insurers reduce their CMBS exposure, we document a significant increase in private-label CMBS holdings by small banks, suggesting important shifts in the distribution of CRE risks across the financial system.

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, as well as rental contract characteristics such as lease expiration dates for different 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 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

[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.

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.

A challenge in establishing a causal link between lease expiration dates and delinquency rates is that these dates could coincide with other shocks that cause delinquency, e.g., regional shocks that lower demand for CRE. Similarly, if mortgages with leases expiring have floating interest rates, concurrent increases in reference interest rates 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. In addition, our identification strategy exploits lease expiration dates set well before the COVID-19 shock, so that the timing of lease termination is plausibly exogenous to pandemic-induced structural change in CRE demand.

Using the COVID-19 pandemic as 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.

The second step in our empirical analysis consists of understanding how large insurance companies' exposure to offices through their CMBS holdings is, 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 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. We document how most CMBS have the majority of their cash flow shocks induced by lease expiration occurring within six years. We use this threshold to estimate a difference-in-differences specification to assess if CMBS with exposure to office-linked loans whose main leases expire within six years 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 with leases expiring in the short to 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. Treated bonds (those 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. This sensitivity to underlying lease expiration in the medium term 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 these risks 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 issued 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 Haddad, 2021).

Finally, we relate to the literature exploring the impact of work-from-home adjustments

[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).

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 the medium term 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.*

Since U.S. insurers frequently hold CMBS, any increase in the riskiness of these assets

[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.

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 underlying 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 Commissioners (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 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 Sched-

[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.

ule 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 we describe 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 12% 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 2022, 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 in which a lease expires.

Figure 1 shows the average delinquency rates for all property types for which such in-

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

formation 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 necessarily capture the extent to which work-from-home arrangements trigger CRE mortgage default given their 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.

By zooming in on offices rather than retail properties, we can focus on structural changes in the demand for office space without explicitly considering the implications from the 2020 lockdowns on businesses. Furthermore, if institutional investors trade CMBS holdings before losses materialize, then one would expect their trading behavior to be based on office exposure if these mortgage 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, allowing us to compare otherwise similar mortgages that have leases expiring and not. First, we estimate the following specification:

$$I_{jrt}^{D90} = \alpha_j + \alpha_{rt} + \alpha_{j(floating)t} + \sum_{\iota \in [-15,15] \setminus \{3\}} D_{jt}^{\iota} \delta_{\iota} + \varepsilon_{jrt}, \tag{1}$$

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 three months after 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.

[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).

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 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 post-COVID period start to diverge further ten months after lease expiration. Our point estimates indicate that relative to three months following lease expiration, a mortgage experiences a one percentage point higher delinquency 15 months after the lease expiration before the pandemic. 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 3 months after lease expiration and 15 months after lease expiration is about four percentage points, almost four 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 pandemic indicated in Figure 4, we estimate a triple-differences specification:

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

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 in Table 2. Across all specifications, the coefficient 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 directly 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.2 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 indeed located in areas with higher sensitivity to work-from-home shocks.

5. Do Insurers Monitor Cash Flow Risks?

We have documented a 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 one of the main investors in CMBS markets. By the end of 2022, insurance companies hold about $200 billion out of $800 billion outstanding. Similarly, between 2017 and 2019, insurance companies acquired around 20% of the total amount of new issues of private-label CMBS in a given year. Interestingly, the share of new CMBS originations held by insurers in the same year drops to about 17% in 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 insurers to risks related to expiring tenancy agreements of mortgage-financed offices. We calculate the percent share of mortgages against offices in each deal associated with a CMBS 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 to offices 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 CMBS and insurers to estimate the effect of expected cash flow shocks 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 how shocks to their assets

caused by upcoming lease expiration could lead to losses caused by mortgage default.

Each CMBS can be composed of multiple mortgages, whose underlying leases might expire in different years. This gives rise to a dynamic structure in which a share of the expected losses due to default following lease expiration occurs in a given future year. For example, consider a CMBS with four underlying equal sized mortgages, all of which finance offices occupied by a single tenant. Assume that two leases expire in two years' time, one lease expires in three years' time, and one lease expires in six years' time. Such a CMBS would have 50% of its expected cash flow shocks materializing in two years, 75% of its expected cash flow shocks materializing within three years, and all expected cash flow shocks would materialize within six years. Thus, the time sensitive nature of the expected cash flow shocks we have uncovered, along with the structure of CMBS, leads to heterogeneity in exposure to expected losses due to office mortgage default across different bonds.

To illustrate this point, we construct the distribution of average expected cash flow shock over future lease expiration years for all CMBS held by insurance companies. For each deal in our sample, we calculate the share of its largest underlying leases that expires τ years in the future. Formally, for a given deal d, we calculate:

$$Share(\%)_{dt}^{\tau} = \sum_{j \in J_t^d} \frac{\omega_{jt}^{\tau} \times Balance_{jt}}{\sum_{\tau} \omega_{jt}^{\tau} \times Balance_{jt}} \times 100, \tag{3}$$

where $\omega_{jt}^{\tau} \in [0, 100]$ denotes the share of mortgage j's contract at the end of year t that expires in year τ, $Balance_{jt}$ is mortgage j's outstanding balance at the end of year t, and J_t^d is the set of underlying mortgages in deal d at the end of year t. We calculate $Share(\%)_{dt}^{\tau}$ separately for offices and retail mortgages, and calculate average $Share(\%)_{dt}^{\tau}$ for each $\tau \in [1, 30]$, for all years t in our sample.

Figure 8 shows the resulting distribution after averaging $Share(\%)_{dt}^{\tau}$ across all years in our sample, separately for offices and retail. A large share of expected cash flow shocks materializes only within three to six years relative to each year in which we obtain outstanding balances. The average bond in our sample experiences only around 16% of its cash flow shocks within two years. Hence, it would be incorrect to measure a bond's exposure to expected cash flow shocks limiting the analysis to bonds with leases expiring in the following

one or two years, since, on average, a large share of the shocks is yet to materialize.

The average bond in our sample has around 50% of its expected cash flow shocks to office mortgages materializing *within six years*. This provides us with a natural threshold against which to compare individual bonds. 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 the near future more frequently after the pandemic started. We define a bond j in year y as *treated* if it has leases expiring within six years relative to year t. Hence, our control group consists of bonds whose expected cash flow shocks materialize only after most cash flow shocks have *already materialized for the average CMBS*. Intuitively, if insurers discount future cash flows (at any rate), they would value losses in the short to medium term more than losses in the long run.

We then estimate the following specification:

$$I_{ijt}^{sold} = \alpha_{it} + \alpha_{ij} + \alpha_{j(coupon)t} + \alpha_{j(NAIC)t} + \beta_1 Post\ Covid_t \times Treat_{jt}^{Exp\ Office} + \theta Controls_{jt} + \varepsilon_{ijt}, \tag{4}$$

where $Post\ Covid_t$ equals 1 after 2019, and $Treat_{jt}^{Exp\ Office}$ equals 1 if bond j is exposed to office-linked mortgages whose main lease expires within six years (excluding year t). 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. We also add a series of bond level time-varying controls across specifications (denoted by $Controls_{jt}$), to separate the effect of underlying office lease expiration from other bond characteristics that can influence sales.

The results are in Table 3, and indicate that insurers do take into account how bonds are affected by cash flow shocks in the short to medium term when selling CMBS. In column 1, we find that insurance companies are more than 2 percentage points more likely to sell bonds which have office mortgages that expire in the next six years after the COVID-19 pandemic than before. 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 short to medium term.

This effect is robust to other characteristics of the pool of mortgages of a given CMBS that could affect the likelihood of selling the bond. In particular, we account for the fact that $Treat_{jt}^{Exp\ Office}$ reflects de facto an interaction between any office exposure and lease expiration within six years, which we control for in turn.

In column 2, we include a dummy for the existence of any offices in the underlying pool of mortgages of bond j in year t. In spite of incorporating this control variable along with its interaction with the post-COVID indicator, our estimate remains virtually unaltered. This implies that the presence of office collateral affects the likelihood of sales only for those mortgages with cash flow shocks that are expected to materialize in the short to medium term.

In the same way, we account for lease expirations more generally. In column 3, we include a dummy variable that equals 1 for CMBS with *any* mortgage with a lease expiring within six years, I_{jt}^{Exp}. In line with the idea that insurers are sophisticated enough to understand how collateral type and lease characteristics jointly determine expected mortgage default, we find that underlying lease expiration affects only the post-COVID sales probability for bonds associated with office collateral. Furthermore, lease expiration and office properties play no role for insurance companies' selling decisions before the onset of the COVID-19 pandemic either. 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.

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.

Column 4 of Table 3 tests this idea by further breaking down the collateral and the lease-expiration dummies into mutually exclusive property types. In particular, the dummies $I_{jt}^{Exp\ Retail}$ and $I_{jt}^{Exp\ Other}$ equal 1 if bond j has underlying retail or other mortgages, respectively, with leases expiring within six years, where *Other* is a residual category for any loans with lease expiration information which is not linked to $Office$ or *Retail* units. Moreover,

I_{jt}^{Retail} is a dummy that equals 1 if bond j has any exposure to retail units in year t.

The coefficient of interest, β_1, drops after adding these refined controls but remains statistically significant, confirming that insurers are sensitive to cash flow risks for offices after COVID-19. In contrast, while exposure to retail affects post-COVID CMBS sales, as reflected by the positive and significant coefficient on $Post\ Covid_t \times I_{jt}^{Retail}$, 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 flow risks, but are also sufficiently sophisticated to disentangle how these risks affect different types of CMBS collateral.

The results in Table 3 rely on the dynamic nature of our shocks, which uncovers how heterogeneity across bonds that have cash flow shocks expected to materialize in the short to medium run leads to different trading behavior. To understand how our results are sensitive to using a six-year cutoff to define our treatment, we re-estimate (4), defining $Treat_{jt}^{Exp\ Office}$ as equal to 1 for exposures within three or four, rather than six, years. These thresholds represent moments after which roughly 25% and 33% of the office-borne cash flow shocks have materialized for the average CMBS.

Appendix-Table A.2 shows that our results are robust to using these alternative thresholds. Moreover, the point estimates of β_1 are across all specifications larger for the longer horizon in columns 5 to 8. The reason is that thresholds implied by shorter horizons lead the *control group* to include bonds exposed to some medium-term shocks (those occurring in five and six years' time) as well. This lends further support to the idea that insurance companies monitor the timing of potential cash flow shocks to office-linked mortgages.

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 six years from the COVID-19 shock, we also estimate a dynamic difference-in-differences regression:

$$I_{ijt}^{sold} = \alpha_{it} + \alpha_{ij} + \alpha_{j(coupon)t} + \alpha_{j(NAIC)t} + Treat_{jt}^{Exp\ Office} + \sum_{\iota \neq 2019} D_{j\iota}^{Exp\ Office}\delta_\iota + \theta Controls_{jt} + \varepsilon_{ijt}, \tag{5}$$

where $Controls_{jt}$ include other interaction terms with yearly dummies, as in column 3 of Table 3.

One can see in Figure A.3 that most of the effect we capture takes place in 2020, which sees a spike in sales 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 onset of the pandemic.

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 considering 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 9 shows the distribution of office exposure for all private-label 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. We observe a similar pattern when looking at exposure to cash flow shocks represented by lease expiration taking place within six years, our treatment measure. Figure 10 plots the corresponding distribution, before and after the COVID-19 pandemic. 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 short and medium-term cash flow shocks to office CRE. In particular, there is an increase of about 10% 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.

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:

$$\begin{aligned} Coupon_{jt} =& \alpha_{maturity(j)t} + \beta_1 Post\ Covid_t \times Office_j + \beta_2 Office_j \times NAIC\ Held_{jt} \\ &+ \beta_3 Post\ Covid_t \times Office_j \times NAIC\ Held_{jt} + \beta_4 X_{jt}, \end{aligned} \tag{6}$$

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 4 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

inclusion 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:

$$
\begin{aligned}
I_{ijt}^{sold} = \alpha_{it} + \alpha_{ij} + \alpha_{jt} + \gamma_1 T_{it-1}^{Office} \times I_{jt}^{T} + \beta_1 Post\ Covid_t \times T_{it-1}^{Office} \times I_{jt}^{T} \\
+ \gamma_2 T_{it-1}^{Retail} \times I_{jt}^{T} + \beta_2 Post\ Covid_t \times T_{it-1}^{Retail} \times I_{jt}^{T} \\
+ \gamma_3 T_{it-1}^{Lodging} \times I_{jt}^{T} + \beta_3 Post\ Covid_t \times T_{it-1}^{Lodging} \times I_{jt}^{T} + \varepsilon_{ijt}, \qquad (7)
\end{aligned}
$$

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 (7) 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.[8] 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 5 (columns 1-3 and columns 4-6, respectively). 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 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 rebalanc-

[8] 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 $t-2$.

ing 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 (7) in columns 2 and 5 of Table 5.

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.5 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.[9] Importantly, while banks are prominent purchasers throughout, they are also very important

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

for offices (Figure A.6).

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 3, 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 6, the coefficient on treated CMBS, β_1 in (4), is positive—as in Table 3—and statistically significant once one accounts for differential sales behavior based on other collateral characteristics (columns 3 and 4). The estimated coefficient in the most conservative regression specification (column 4), where we explicitly control for differential sales behavior for any other type of collateral and lease expiration separately, amounts to half of the respective coefficient in column 4 of Table 3. This indicates that sales are more likely to banks if the CMBS is related to office properties with leases expiring within six years in the post-COVID period.

For completeness, Appendix-Table A.3 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 within six years, but with much smaller magnitude. Moreover, we show in Figure A.4 the share of the portfolio of private-label CMBS held by insurers exposed to lease expiration within six years as captured by $Treat_{jt}^{Exp\ Office}$. There is a sharp drop in the share of insurers' CMBS portfolio exposed to cash flow shocks after 2019, consistent with the idea that insurers reduce their exposure to cash flow risks by selling exposed bonds to other types of investors, as indicated in Table 6.

Overall, these results can be seen as suggestive of a transfer of this particular risk from insurance companies to banks.[10]

6.2. Bank Holdings of Private-label CMBS

Purchaser information reported by insurers suggests most of the buyers of private-label CMBS with office exposure are banks, as shown in Figure A.6. Nonetheless, these banks

[10]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.

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 11 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 12 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.

Between 2020 and 2022, holdings of private-label CMBS by small and medium-sized banks nearly doubled from $9 billion to $17 billion. This increase closely mirrors changes in insurers' portfolio behavior. Prior to the pandemic, insurers had steadily increased their holdings of CMBS exposed to offices with leases expiring within six years, adding approximately $8 billion annually. However, this pattern reversed during 2020-2022, with exposed CMBS holdings decreasing by $0.1 billion (Figure A.4). This decline reflects insurers' reduced appetite for assets vulnerable to cash flow shocks from office lease expiration. The matching magnitudes and timing of these shifts lends further support to a redistribution of exposed CMBS from insurers back to the banking sector.

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.4 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 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.[11] 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 in-

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

centives for originators and better risk assessment by investors. One example are due diligence requirements, which require investors to assess risk characteristics of the underlying exposures of securitized positions.[12] 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

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

the timing of cash flow shocks to the borrower matter for the transmission of lower office demand to credit risk.

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 assessed 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."[13]

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.

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

8. Conclusion

In this paper, we examine the role of cash flow shocks from renting out commercial properties for mortgage delinquencies, assessing the extent to which insurance companies monitor 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 a relationship between lease expiration and defaults that 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 implies that—contrary to commonly held views—(some) 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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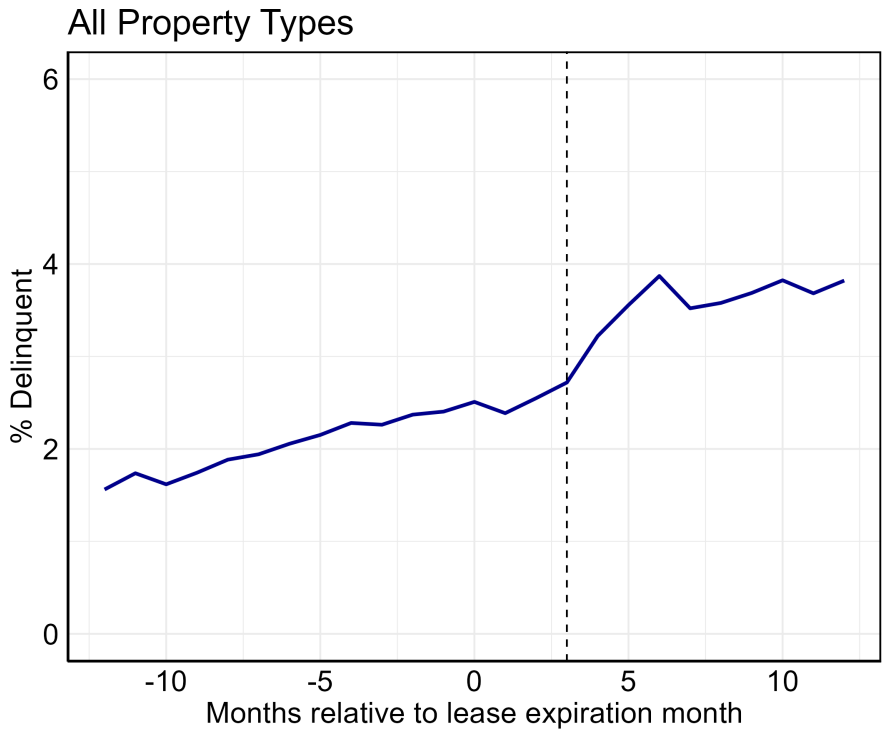
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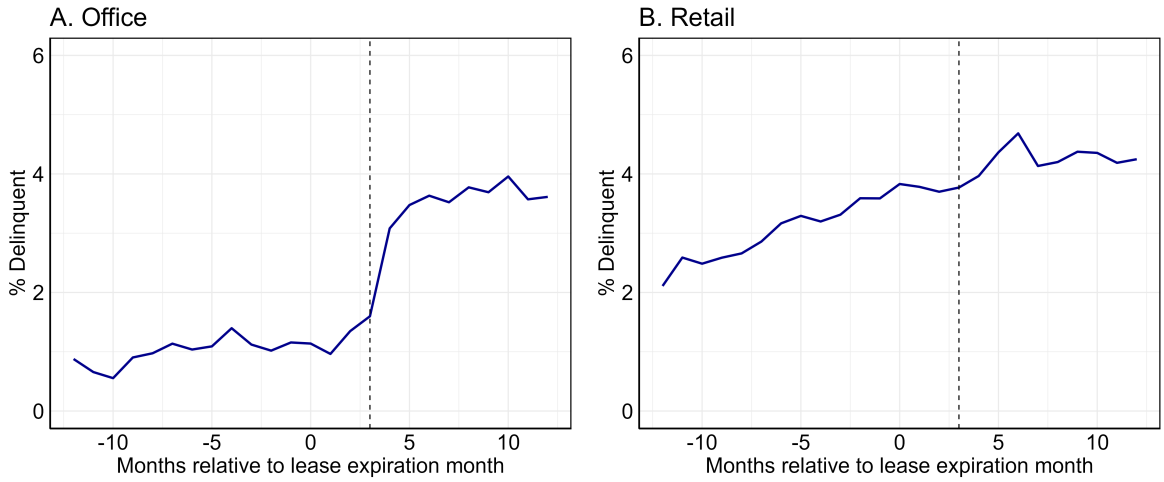
FIGURES

Figure 1: Changes in Delinquency Around Lease Expiration Dates



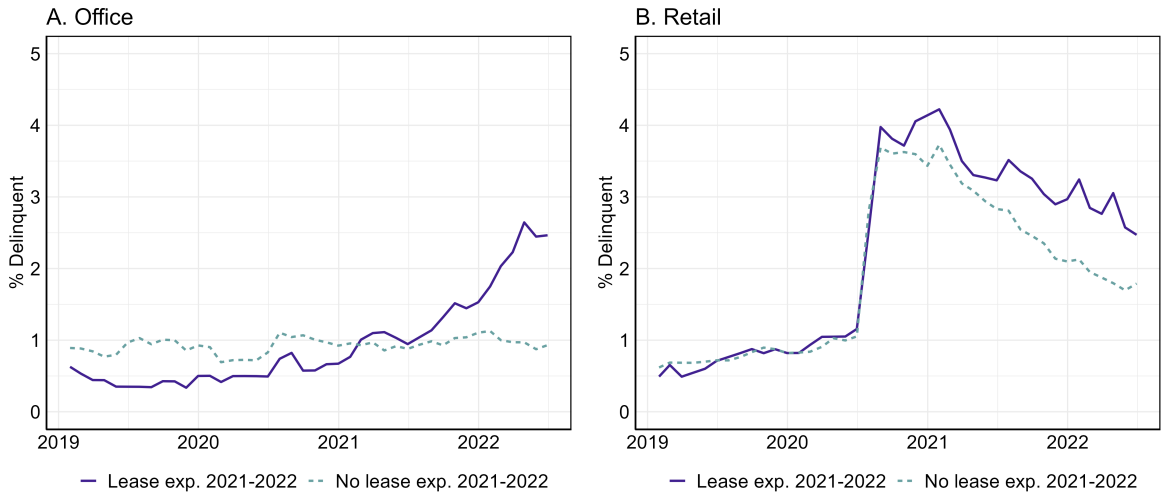
Notes: This figure shows average delinquency rates in each month relative to lease expiration, for properties with leases expiring between 2017 and June 2022. Delinquency is a dummy variable which equals 1 if a mortgage is at least 90 days past due. Sources: Trepp loan data and authors' calculations.

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



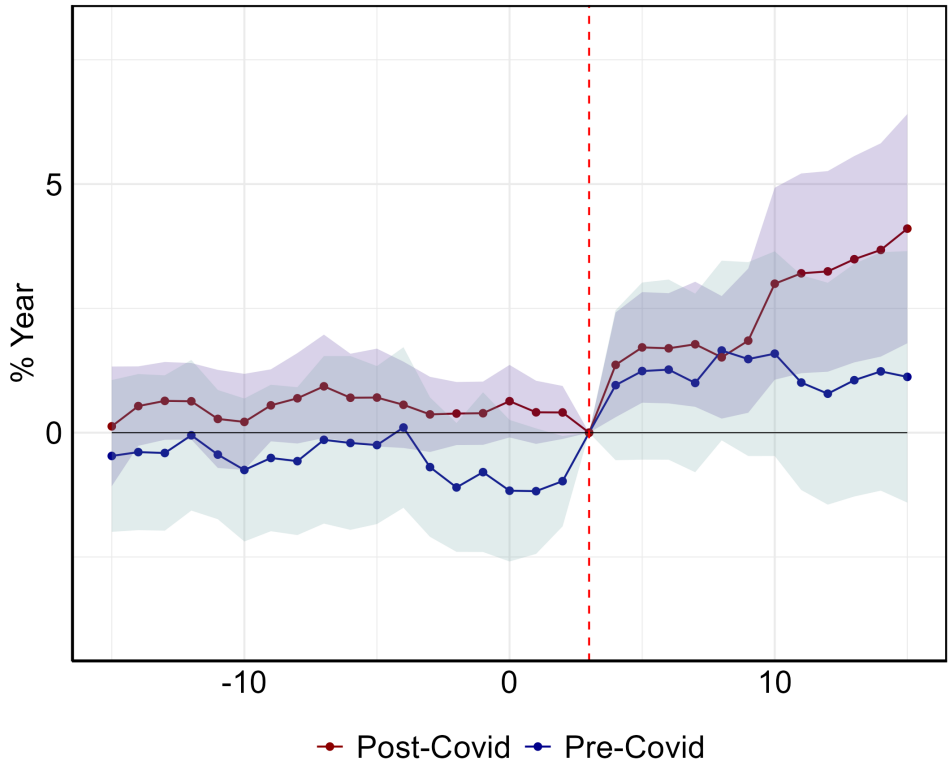
Notes: This figure shows average delinquency in each month relative to lease expiration, for properties with leases expiring between 2017 and June 2022. **Panel A** shows delinquency rates for properties classified as *Office*. **Panel B** shows delinquency rates for properties classified as *Retail*. 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



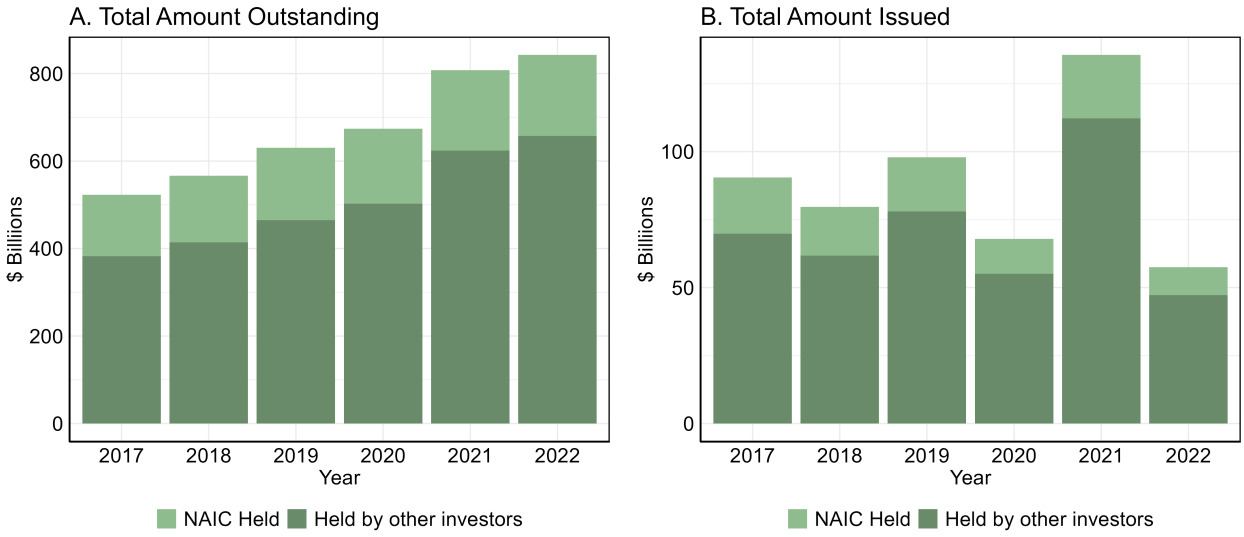
Notes: This figure shows average delinquency rates for mortgages *with* leases expiring in 2021-2022, and mortgages *without* leases expiring in these two years. **Panel A** shows delinquency rates for properties classified as *Office*. **Panel B** shows delinquency rates for properties classified as *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



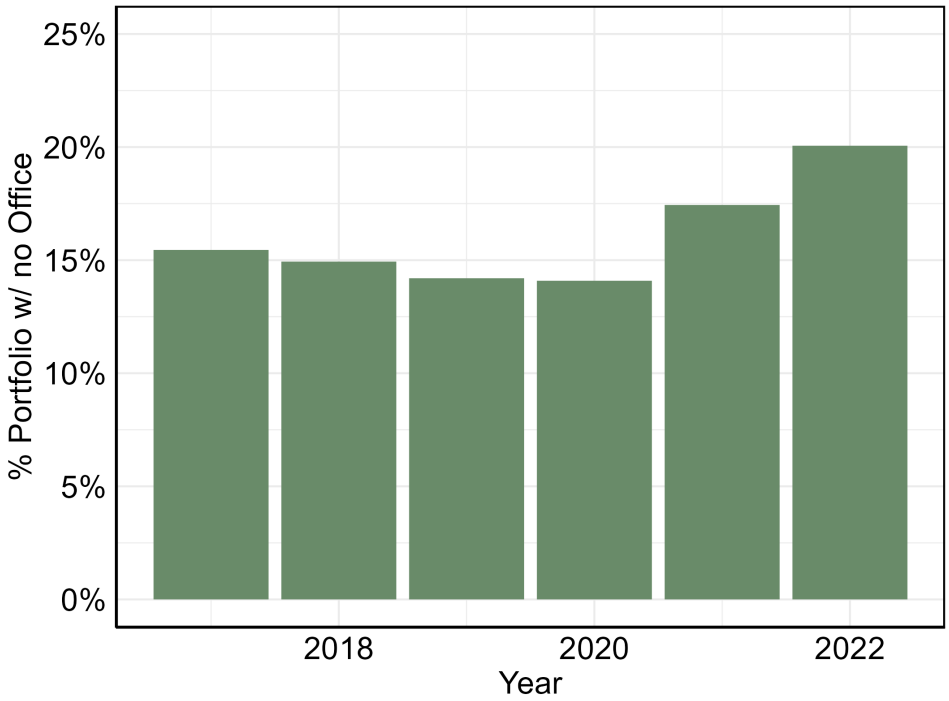
Notes: This figure shows the effects of lease expiration on delinquency rates of properties classified as *Office*. The level of observation is loan j in city r in month t, where month denotes the distribution month of each securitized mortgage. The sample period is Jan/2017 to Jun/2022. The dependent variable I_{jrt}^{D90} 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. "Pre-Covid" includes all months before March 2020, and "Post-Covid" 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



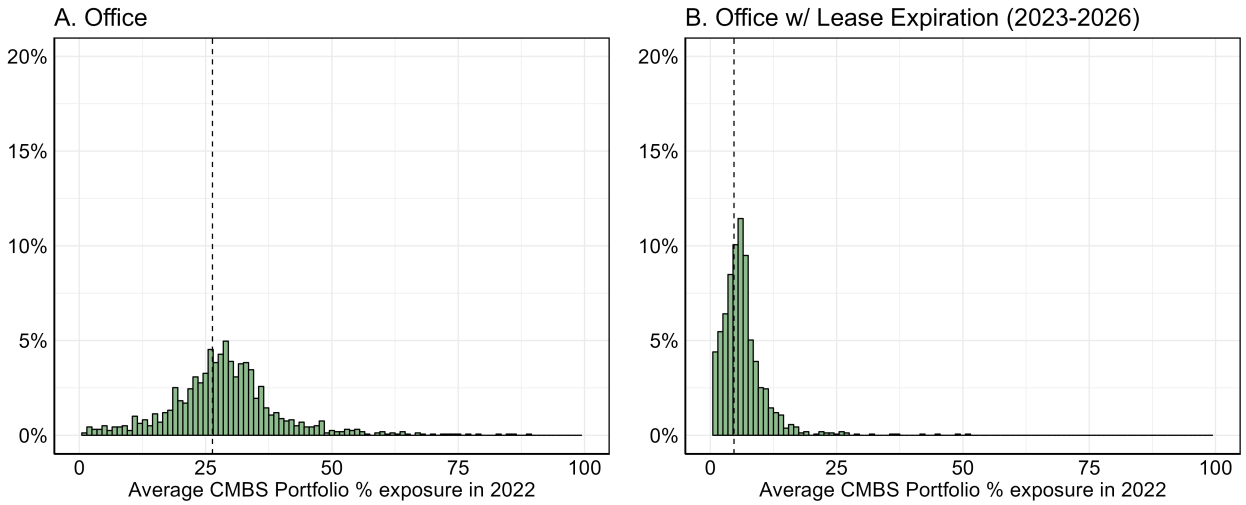
Notes: This figure shows the total amount outstanding (**Panel A**) and amount originated (**Panel B**) of private-label CMBS per year, differentiating between the amount held by insurance companies and that held by other investors. We identify holdings of insurance companies using NAIC Schedule D, Part 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



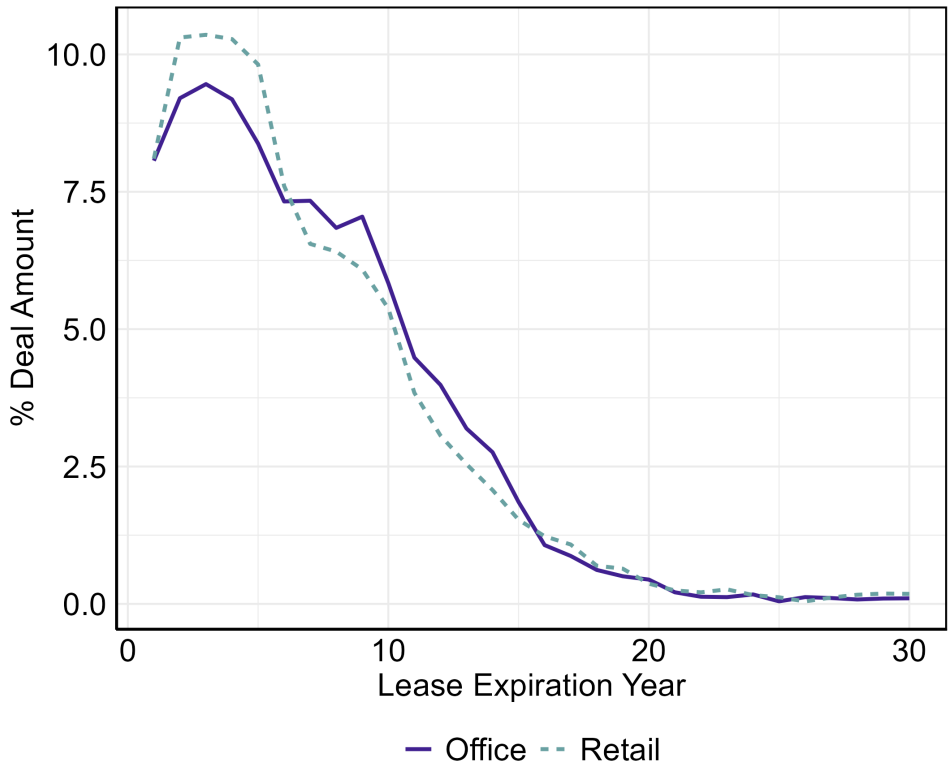
Notes: This figure shows the share of insurance companies' private-label CMBS portfolio not exposed to *any* mortgages linked to properties classified as *Office*. Shares are calculated aggregating BACV for exposed and non-exposed CMBS, where exposure is defined as any percentage of the pool of mortgages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

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



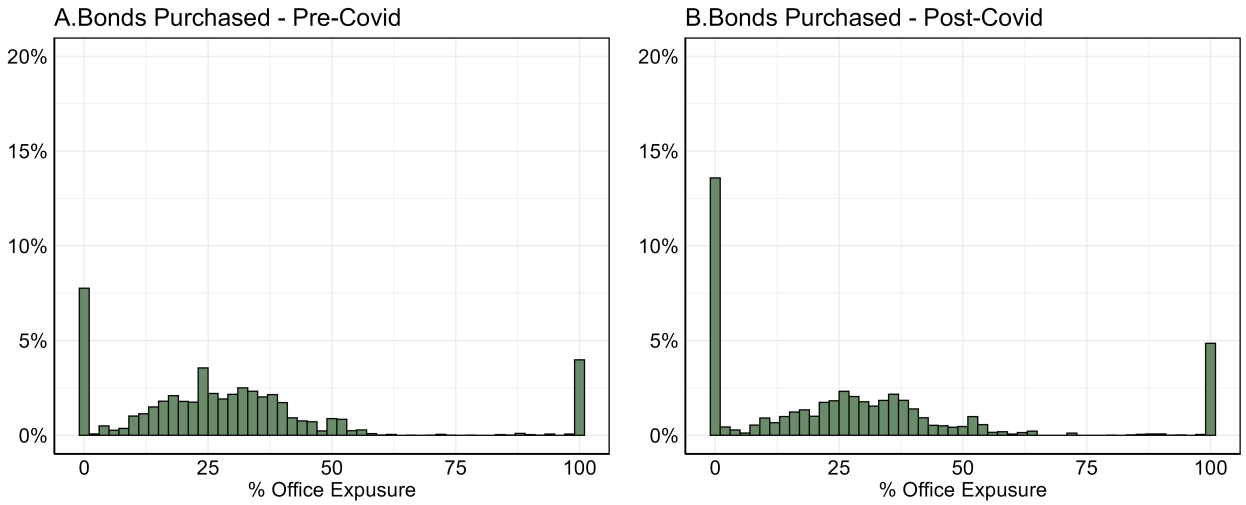
Notes: This figure shows the distribution of office-exposed shares of insurance companies' private-label CMBS portfolio. **Panel A** shows the distribution for any office exposure. **Panel B** shows the distribution conditional on any mortgages having main leases expiring between 2023-2026. Source: Trepp,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

Figure 8: CMBS Cash Flow Shock Dynamics



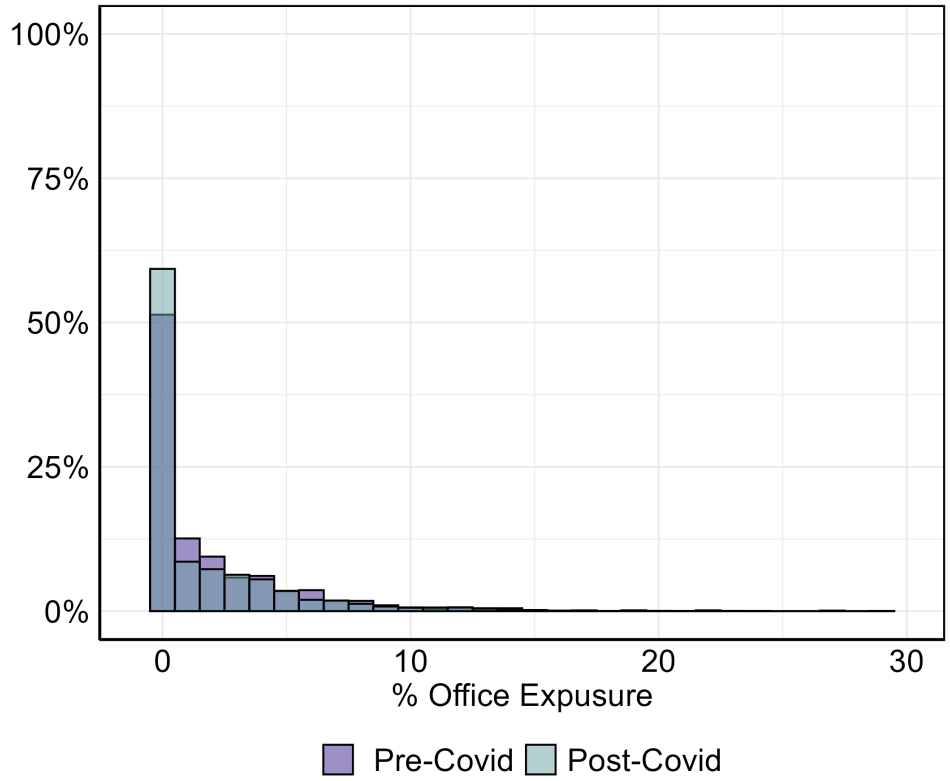
Notes: This figure shows the average distribution of expected cash flow shocks for deals in our sample in each lease expiration year after the reference year. We first calculate, for each deal in a given year, what share of mortgages have leases expiring in τ years. Then, we average these shares, first across bonds of a given property type in a given year, then across years, separately for offices and retail. Source: Trepp, NAIC, and authors' calculations.

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



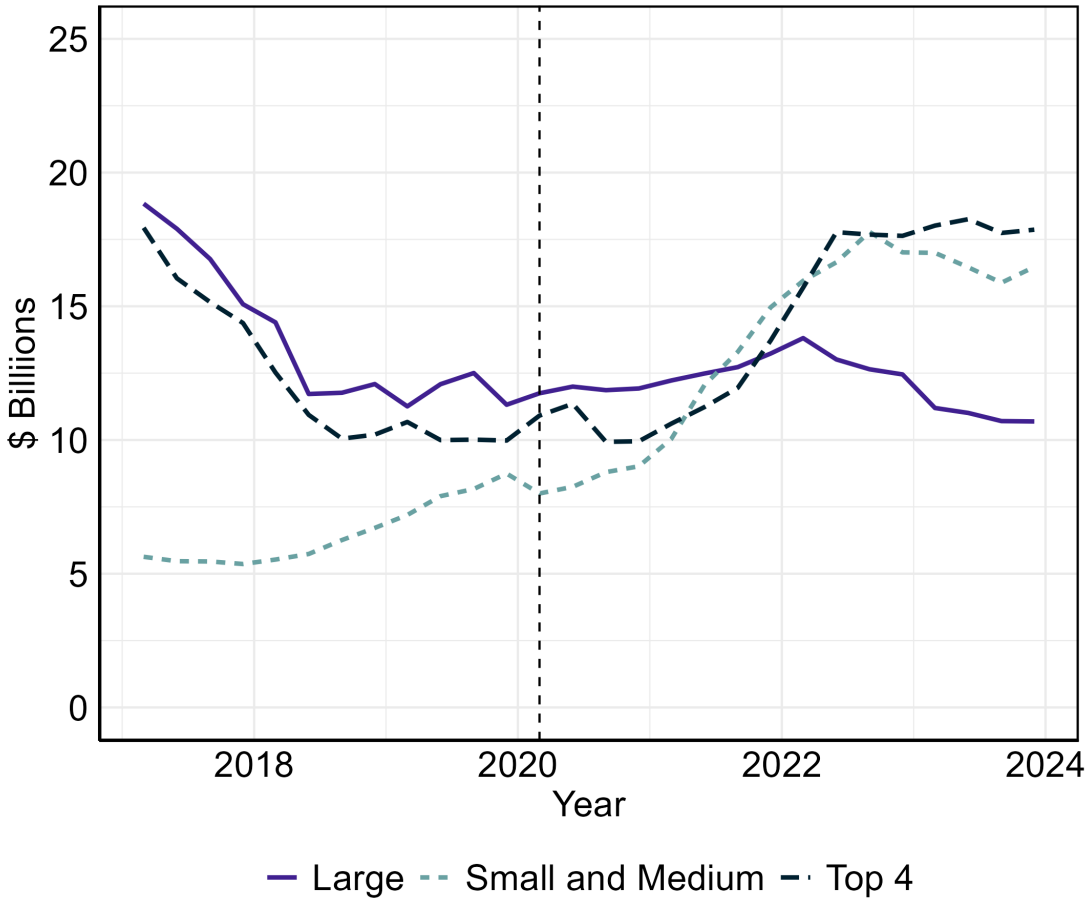
Notes: This figure shows the distribution of office exposures of private-label CMBS acquired by insurance companies, before and after COVID-19. Percent exposure equals the amount of the pool of mortgages linked to office CRE. **Panel A** panel plots the distribution of office exposure for CMBS acquired between 2017-2019. **Panel B** 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 10: Distribution of Office Exposure with Leases Expiring—CMBS Acquired Before and After COVID-19



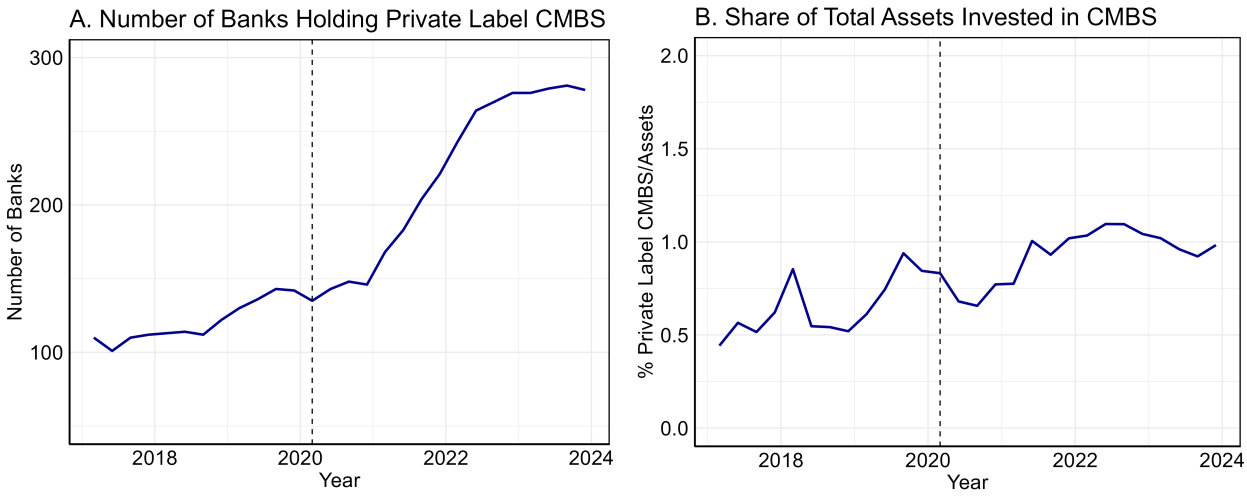
Notes: This figure shows the distribution of treatment exposure of private-label CMBS acquired by insurance companies, before and after COVID-19, based on underlying office-linked lease expiration. Percent exposure equals the amount of the pool of mortgages linked to office CRE whose main lease agreement expires within six years. Source: Trepp, NAIC, and authors' calculations.

Figure 11: 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 12: 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: The Effect of Lease Expiration on Mortgage Default 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. ***, **, and * indicate significance at the 1%, 5%, and 10% levels. Sources: Trepp and authors' calculations.

Table 3: CMBS Trading Difference-in-Differences—Exposure to Lease Expiration

	I_{ijt}^{sold}			
	(1)	(2)	(3)	(4)
$Treat_{jt}^{Exp\ Office}$	0.0040	0.0055	0.0026	0.0020
	(0.0043)	(0.0045)	(0.0066)	(0.0054)
$Post\ Covid_t \times Treat_{jt}^{Exp\ Office}$	0.0242***	0.0205***	0.0254***	0.0123*
	(0.0048)	(0.0059)	(0.0087)	(0.0072)
I_{jt}^{Office}		-0.0140	-0.0152	-0.0086
		(0.0207)	(0.0207)	(0.0212)
$Post\ Covid_t \times I_{jt}^{Office}$		0.0085	0.0084	0.0075
		(0.0078)	(0.0078)	(0.0079)
I_{jt}^{Exp}			0.0038	
			(0.0072)	
$Post\ Covid_t \times I_{jt}^{Exp}$			-0.0066	
			(0.0089)	
$I_{jt}^{Exp\ Retail}$				0.0067
				(0.0066)
$I_{jt}^{Exp\ Other}$				0.0074
				(0.0047)
I_{jt}^{Retail}				-0.0242
				(0.0311)
$Post\ Covid_t \times I_{jt}^{Exp\ Retail}$				0.0047
				(0.0094)
$Post\ Covid_t \times I_{jt}^{Exp\ Other}$				0.0022
				(0.0050)
$Post\ Covid_t \times I_{jt}^{Retail}$				0.0155*
				(0.0086)
Observations	219,731	219,731	219,731	219,731
R^2	0.60756	0.60757	0.60757	0.60768
Within R^2	0.00055	0.00057	0.00058	0.00086
Year x Insurer ID fixed effects	✓	✓	✓	✓
CUSIP x Insurer ID fixed effects	✓	✓	✓	✓
Year x Coupon Type fixed effects	✓	✓	✓	✓
Year x 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. $Treat_{jt}^{Exp\ Office}$ is a dummy which equals 1 if bond j is exposed to office mortgages whose main lease expires within six years (excluding year t). I_{jt}^{Exp}, $I_{jt}^{Exp\ Retail}$, and $I_{jt}^{Exp\ Other}$ are dummy variables which equal 1 if bond j is exposed to mortgages whose main lease expires within six years (excluding year t), for all properties, retail only, and properties that are neither retail nor offices. I_{jt}^{Office} and I_{jt}^{Retail} are dummies which equal 1 for any exposure to offices and retail. 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. ***, **, and * indicate significance at the 1%, 5%, and 10% levels. Sources: Trepp, NAIC, and authors' calculations.

Table 4: 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 (6). 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 at 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. ***, **, and * indicate significance at the 1%, 5%, and 10% levels. Sources: Trepp, NAIC, and authors' calculations.

Table 5: Insurer CMBS Portfolio Exposure and Asset Sales

	I_{ijt}^{sold}					
	I_{jt}^{Risky}				$I_{jt-1}^{Downgrade}$	
	(1)	(2)	(3)	(4)	(5)	(6)
$I_{jt}^{T} \times T_{it-1}^{Office}$	-0.0008	-0.0016	-0.0017	0.0015	0.0102***	0.0103***
	(0.0021)	(0.0035)	(0.0035)	(0.0021)	(0.0040)	(0.0039)
$I_{jt}^{T} \times T_{it-1}^{Retail}$		0.0007	0.0006		-0.0070**	-0.0071**
		(0.0024)	(0.0024)		(0.0029)	(0.0029)
$I_{jt}^{T} \times T_{it-1}^{Lodging}$		0.0023	0.0040		-0.0051	-0.0057
		(0.0071)	(0.0070)		(0.0067)	(0.0068)
$Post\ Covid_t \times I_{jt}^{T} \times T_{it-1}^{Office}$	-0.0022	-0.0095***	-0.0093***	-0.0007	-0.0117**	-0.0117**
	(0.0021)	(0.0035)	(0.0034)	(0.0027)	(0.0046)	(0.0046)
$Post\ Covid_t \times I_{jt}^{T} \times T_{it-1}^{Retail}$		0.0078**	0.0076**		0.0094**	0.0095**
		(0.0031)	(0.0031)		(0.0038)	(0.0037)
$Post\ Covid_t \times I_{jt}^{T} \times T_{it-1}^{Lodging}$		0.0056	0.0042		0.0069	0.0085
		(0.0069)	(0.0069)		(0.0094)	(0.0093)
$I_{jt}^{T} \times T_{it-1}^{\%CorpBonds}$			0.0401***			-0.0076
			(0.0137)			(0.0115)
$Post\ Covid_t \times I_{jt}^{T} \times T_{it-1}^{\%CorpBonds}$			-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 (7). 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_{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, T_{it-1}^{Prop} is the size of the exposure of insurance company i to property type $Prop \in \{Office, Retail, Lodging\}$ in year $t-1$, and I_{jt}^{T} is a dummy which equals 1 if the bond is classified as *Risky* or if it was downgraded in year $t-1$. $T_{it-1}^{\%CorpBonds}$ 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. ***, **, and * indicate significance at the 1%, 5%, and 10% levels. Sources: Trepp, NAIC, and authors' calculations.

Table 6: CMBS Bank Buyer Difference-in-Differences—Exposure to Lease Expiration

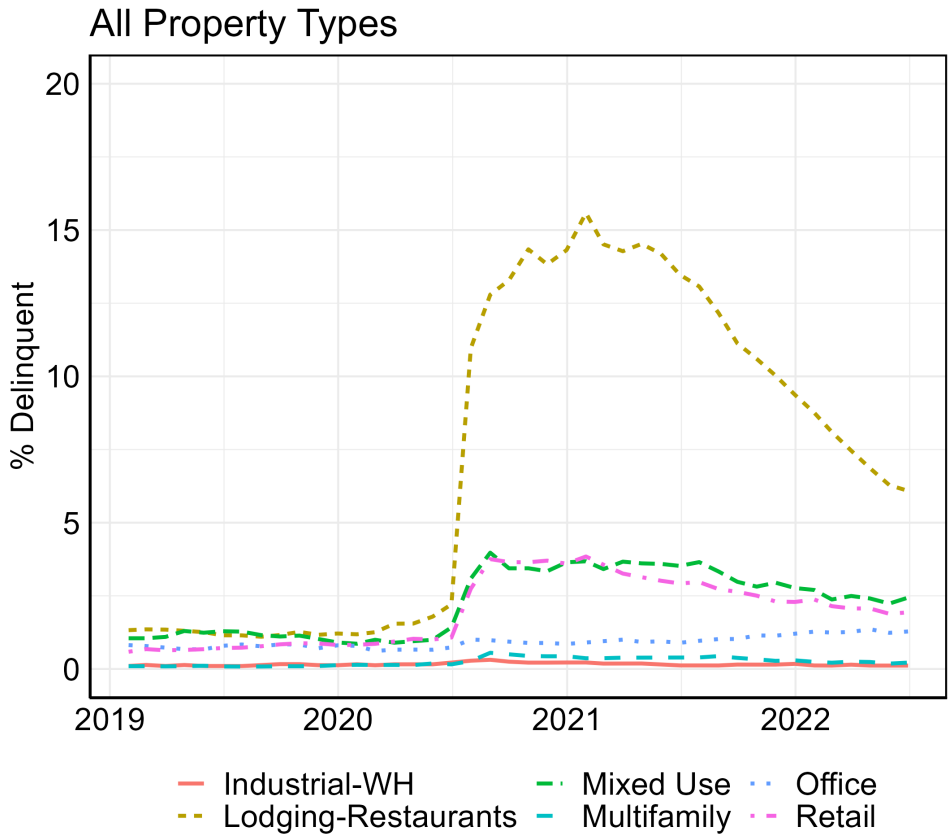
	$I_{ijt}^{sold\ to\ bank}$			
	(1)	(2)	(3)	(4)
$Treat_{jt}^{Exp\ Office}$	0.0069***	0.0074***	0.0034	0.0033*
	(0.0013)	(0.0014)	(0.0021)	(0.0018)
$Post\ Covid_t \times Treat_{jt}^{Exp\ Office}$	0.0020	0.0007	0.0051**	0.0054**
	(0.0016)	(0.0020)	(0.0025)	(0.0026)
I_{jt}^{Office}		-0.0017	-0.0025	-0.0020
		(0.0068)	(0.0068)	(0.0070)
$Post\ Covid_t \times I_{jt}^{Office}$		0.0028	0.0026	0.0023
		(0.0028)	(0.0028)	(0.0029)
I_{jt}^{Exp}			0.0056**	
			(0.0022)	
$Post\ Covid_t \times I_{jt}^{Exp}$			-0.0057**	
			(0.0027)	
$I_{jt}^{Exp\ Retail}$				0.0029
				(0.0019)
$I_{jt}^{Exp\ Other}$				0.0039**
				(0.0017)
I_{jt}^{Retail}				-0.0072
				(0.0094)
$Post\ Covid_t \times I_{jt}^{Exp\ Retail}$				-0.0048
				(0.0031)
$Post\ Covid_t \times I_{jt}^{Exp\ Other}$				-0.0002
				(0.0017)
$Post\ Covid_t \times I_{jt}^{Retail}$				-0.0017
				(0.0031)
Observations	203,987	203,987	203,987	203,987
R^2	0.39362	0.39363	0.39366	0.39373
Within R^2	0.00034	0.00035	0.00040	0.00051
Year x Insurer ID fixed effects	✓	✓	✓	✓
CUSIP x Insurer ID fixed effects	✓	✓	✓	✓
Year x Coupon Type fixed effects	✓	✓	✓	✓
Year x 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 insurers 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 with the following buyers: FA REINSURANCE, Resolution Life Insurance, Coinsurance Talcott-Allianz. $Post\ Covid_t$ equals 1 after 2019. $Treat_{jt}^{Exp\ Office}$ is a dummy which equals 1 if bond j is exposed to office mortgages whose main lease expires within six years (excluding year t). I_{jt}^{Exp}, $I_{jt}^{Exp\ Retail}$, and $I_{jt}^{Exp\ Other}$ are dummy variables which equal 1 if bond j is exposed to mortgages whose main lease expires within six years (excluding year t), for all properties, retail only, and properties that are neither retail nor offices. I_{jt}^{Office} and I_{jt}^{Retail} are dummies which equal 1 for any exposure to offices and retail. 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. ***, **, and * indicate significance at the 1%, 5%, and 10% levels. Sources: Trepp, NAIC, and authors' calculations.

Appendix

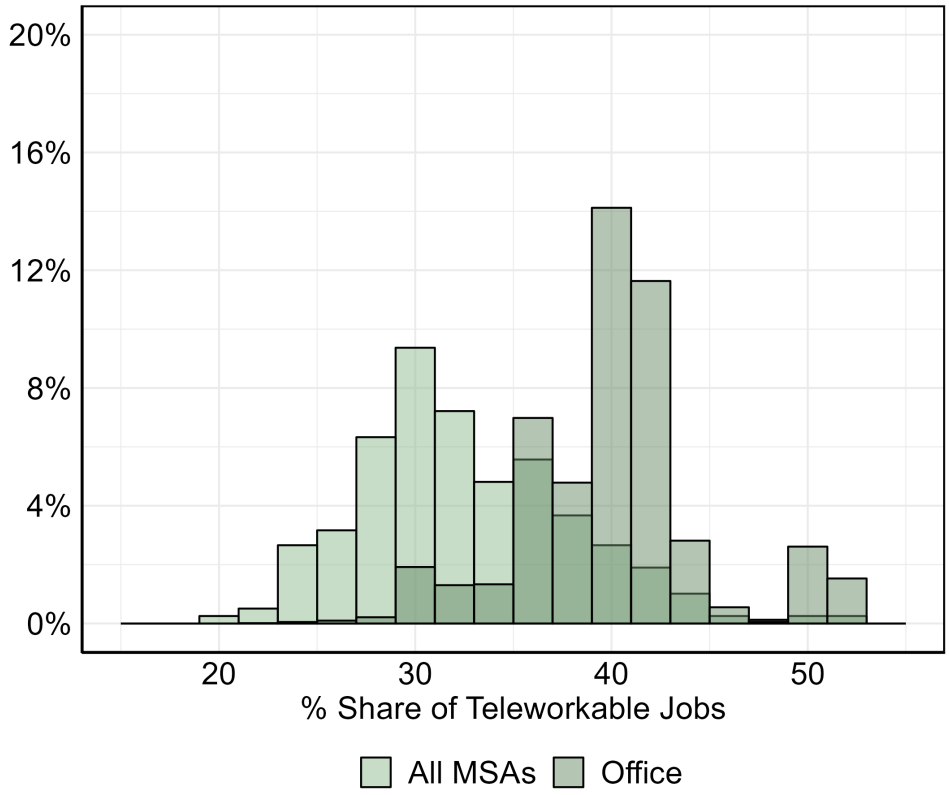
A. Additional Figures and Tables

Figure A.1: Delinquency Rates by Property Type



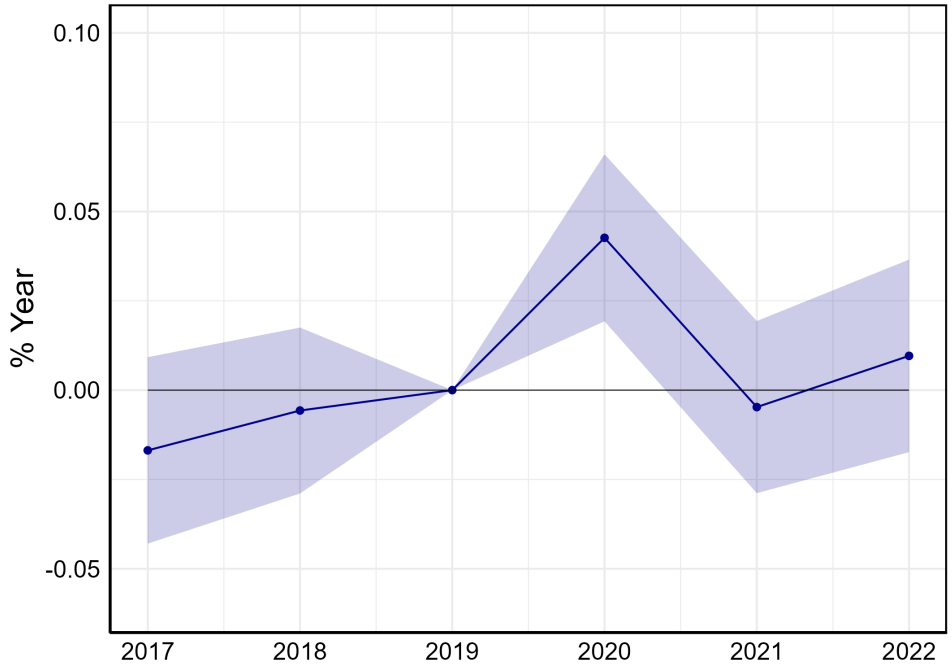
Notes: This Figure reports average delinquency for mortgages linked to different property types. Property types are defined as in Appendix B. Delinquency is a dummy variable which equals 1 if a mortgage is more than 90 days past due. Source: Trepp and authors' calculations.

Figure A.2: Distribution of % Teleworkable Jobs—All MSAs and Office Mortgages



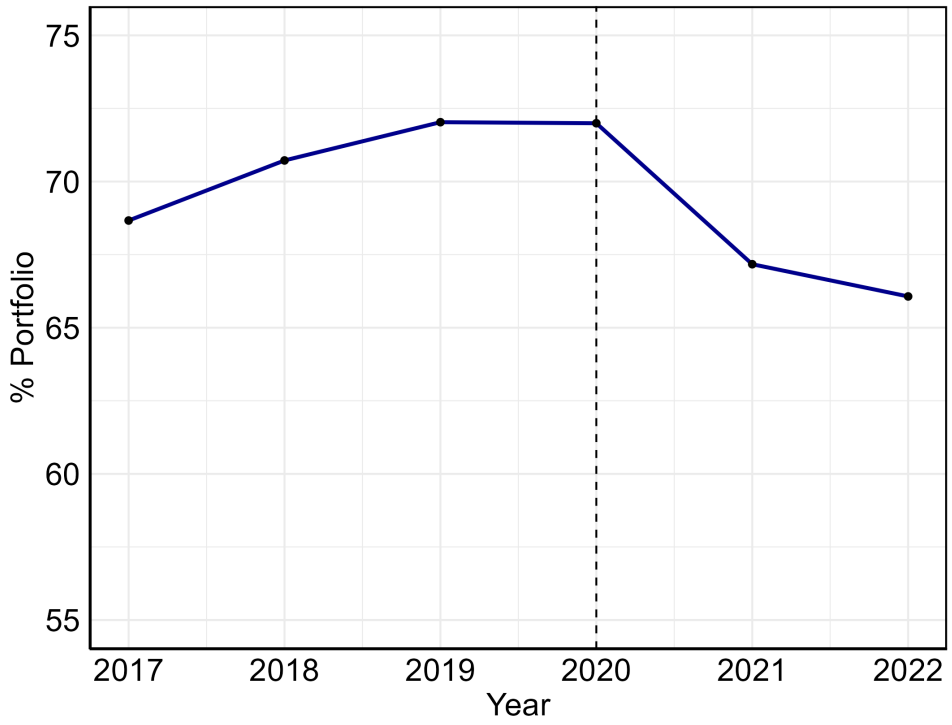
Notes: This figure shows the distribution of the share of jobs in each MSA that can be performed from home, using the measure proposed by Dingel and Neiman (2020). We plot the distribution of all MSAs in the Dingel and Neiman (2020) dataset, and the distribution of the MSAs from the mortgages in the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

Figure A.3: Dynamic Difference-in-Differences: Trading of CMBS Exposed to Cash Flow Risks



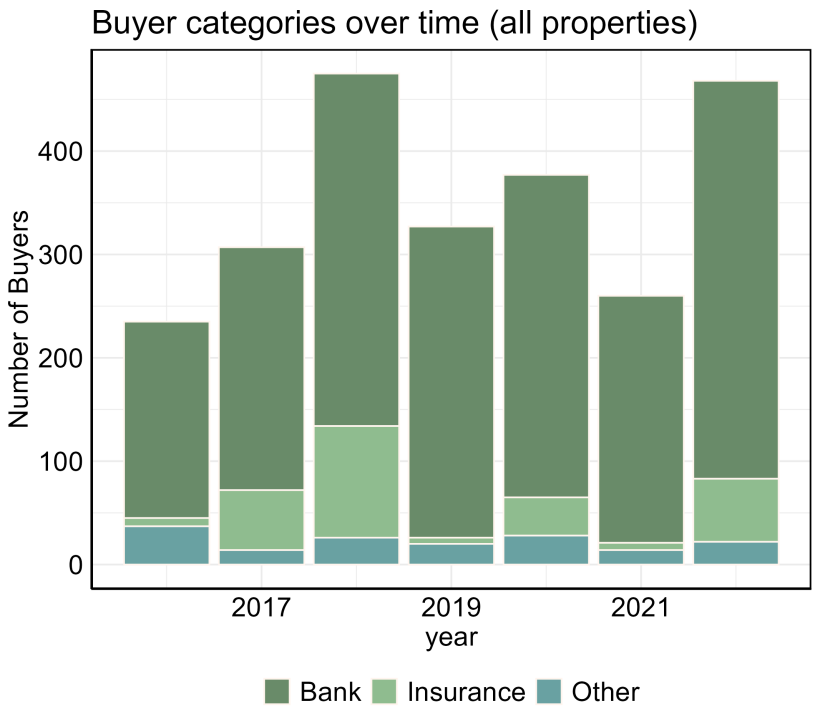
Notes: Each plot shows the dynamic effect of exposure to underlying office lease expiration on the likelihood of sales of private-label CMBS by insurers, as in specification (5). The level of observation is bond j held by insurer i at the end of year t. The dependent variable I_{ijt}^{sold} is a dummy which equals 1 if bond j was sold by insurer i in year t. The sample period is 2017 to 2022. $Treat_{jt}^{Exp\ Office}$ is defined as in (4), and $D_{j\iota}^{Exp\ Office}$ are dummies equal to 1 if bond j is exposed to mortgages whose main lease expires up until six years ahead in year ι. We include the same set of controls as in column 3 of Table 3. Shaded area corresponds to the 95 percent confidence interval around point estimates. Source: Trepp, NAIC, and authors' calculations.

Figure A.4: Share Insurers' CMBS Portfolio Exposed to Treatment (Office Lease Expiration



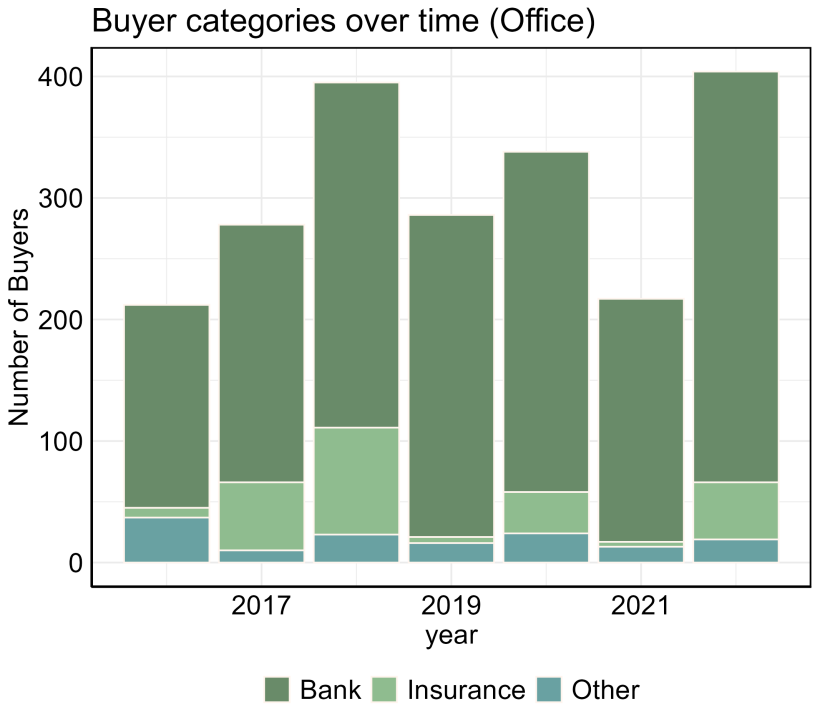
Notes: The plot shows the share of the private-label CMBS portfolio of insurance companies at the end of each year, for bonds which have $Treat_{jt}^{Exp\ Office}$ equal 1, that is, bond j has any underlying office-linked mortgages whose leases expire within six years in year t. Source: Trepp, NAIC,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

Figure A.5: 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.6: 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 Trading Difference-in-Differences—Exposure to Lease Expiration (Extension)

	I_{ijt}^{sold}							
	Threshold = 25%					Threshold = 33%		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Treat_{jt}^{Exp\ Office}$	0.0021	0.0039	0.0040	0.0031	0.0028	0.0045	0.0054	0.0036
	(0.0031)	(0.0032)	(0.0037)	(0.0033)	(0.0036)	(0.0036)	(0.0045)	(0.0040)
$Post\ Covid_t \times Treat_{jt}^{Exp\ Office}$	0.0176***	0.0135***	0.0068	0.0099**	0.0210***	0.0168***	0.0128**	0.0101*
	(0.0040)	(0.0044)	(0.0053)	(0.0047)	(0.0043)	(0.0049)	(0.0061)	(0.0054)
I_{jt}^{Office}		-0.0151	-0.0115	-0.0088		-0.0146	-0.0130	-0.0086
		(0.0207)	(0.0209)	(0.0212)		(0.0207)	(0.0209)	(0.0211)
$Post\ Covid_t \times I_{jt}^{Office}$		0.0151**	0.0094	0.0121		0.0120*	0.0107	0.0104
		(0.0071)	(0.0075)	(0.0074)		(0.0073)	(0.0075)	(0.0075)
I_{jt}^{Exp}			0.0033				-0.0008	
			(0.0052)				(0.0059)	
$Post\ Covid_t \times I_{jt}^{Exp}$			0.0166**				0.0071	
			(0.0070)				(0.0075)	
$I_{jt}^{Exp\ Retail}$				0.0042				0.0043
				(0.0043)				(0.0053)
$I_{jt}^{Exp\ Other}$				0.0104***				0.0076**
				(0.0032)				(0.0036)
I_{jt}^{Retail}				-0.0247				-0.0242
				(0.0314)				(0.0313)
$Post\ Covid_t \times I_{jt}^{Exp\ Retail}$				0.0072				0.0072
				(0.0068)				(0.0076)
$Post\ Covid_t \times I_{jt}^{Exp\ Other}$				-0.0078**				-0.0031
				(0.0038)				(0.0043)
$Post\ Covid_t \times I_{jt}^{Retail}$				0.0193**				0.0171**
				(0.0077)				(0.0080)
Observations	219,731	219,731	219,731	219,731	219,731	219,731	219,731	219,731
R^2	0.60753	0.60756	0.60762	0.60771	0.60755	0.60756	0.60757	0.60767
Within R^2	0.00047	0.00054	0.00069	0.00092	0.00051	0.00055	0.00057	0.00083
Year x Insurer ID fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
CUSIP x Insurer ID fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
Year x Coupon Type fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
Year x 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. 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. $Treat_{jt}^{Exp\ Office}$ is a dummy which equals 1 if bond j is exposed to office mortgages whose main lease expires within three years (threshold = 25%) or within four years (threshold = 33%), excluding year t. I_{jt}^{Exp}, $I_{jt}^{Exp\ Retail}$, and $I_{jt}^{Exp\ Other}$ are dummy variables which equal 1 if bond j is exposed to mortgages whose main lease expires within three years (threshold = 25%) or four years (threshold = 33%), excluding year t, for all properties, retail only, and properties that are neither retail nor offices. I_{jt}^{Office} and I_{jt}^{Retail} are dummy variables which equal 1 for any exposure to offices/retail. 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. ***, **, and * indicate significance at the 1%, 5%, and 10% levels. Sources: Trepp, NAIC, and authors' calculations.

Table A.3: CMBS Insurance Buyer Difference-in-Differences—Exposure to Lease Expiration

	$I_{ijt}^{sold\ to\ insurer}$			
	(1)	(2)	(3)	(4)
$Treat_{jt}^{Exp\ Office}$	0.0011**	0.0009*	0.0005	-5.71×10^{-5}
	(0.0005)	(0.0005)	(0.0006)	(0.0006)
$Post\ Covid_t \times Treat_{jt}^{Exp\ Office}$	0.0003	0.0008	0.0018*	0.0017*
	(0.0006)	(0.0007)	(0.0009)	(0.0009)
I_{jt}^{Office}		-0.0017	-0.0019	-0.0014
		(0.0013)	(0.0013)	(0.0013)
$Post\ Covid_t \times I_{jt}^{Office}$		-0.0011	-0.0011	-0.0010
		(0.0009)	(0.0009)	(0.0009)
I_{jt}^{Exp}			0.0004	
			(0.0007)	
$Post\ Covid_t \times I_{jt}^{Exp}$			-0.0013	
			(0.0009)	
$I_{jt}^{Exp\ Retail}$				0.0008
				(0.0008)
$I_{jt}^{Exp\ Other}$				0.0012**
				(0.0006)
I_{jt}^{Retail}				-0.0020
				(0.0014)
$Post\ Covid_t \times I_{jt}^{Exp\ Retail}$				-0.0012
				(0.0008)
$Post\ Covid_t \times I_{jt}^{Exp\ Other}$				-0.0010*
				(0.0005)
$Post\ Covid_t \times I_{jt}^{Retail}$				0.0016*
				(0.0009)
Observations	203,987	203,987	203,987	203,987
R^2	0.41866	0.41867	0.41868	0.41871
Within R^2	5.36×10^{-5}	7.15×10^{-5}	8.45×10^{-5}	0.00014
Year x Insurer ID fixed effects	✓	✓	✓	✓
CUSIP x Insurer ID fixed effects	✓	✓	✓	✓
Year x Coupon Type fixed effects	✓	✓	✓	✓
Year x 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 *insurers*. 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 $I_{ijt}^{sold\ to\ insurer}$ is a dummy which equals 1 if bond j was sold by insurer i in year t to another insurer. We excluded CMBS holdings with the following buyers: FA REINSURANCE, Resolution Life Insurance, Coinsurance Talcott-Allianz. $Post\ Covid_t$ equals 1 after 2019. $Treat_{jt}^{Exp\ Office}$ is a dummy which equals 1 if bond j is exposed to offices whose main lease expires within six years (excluding year t). I_{jt}^{Exp}, $I_{jt}^{Exp\ Retail}$ and $I_{jt}^{Exp\ Other}$ are also variables which equal 1 if bond j is exposed to mortgages whose main lease expires within six years (excluding year t), for all properties, retail only, and properties that are neither retail nor offices. I_{jt}^{Office} and I_{jt}^{Retail} are dummies which equal 1 for any exposure to offices and retail. 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. ***, **, and * indicate significance at the 1%, 5%, and 10% levels. Sources: Trepp, NAIC, and authors' calculations.

Table A.4: 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.[14]

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.

[14]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 τ years.

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.