Lease Expirations and CRE Property Performance*

David Glancy and J. Christina Wang

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Abstract

We study how lease expirations affect the performance of commercial real estate (CRE) properties and how these patterns changed during the COVID-19 pandemic. Even before the pandemic, lease expirations produced notable downside risk to property income, mostly reflecting the potential for increased vacancy. On average, 8 percent of space on expiring leases went vacant, causing a proportional decline in income. These risks became more pronounced since the onset of COVID-19, driven by office properties; lease expirations reduced office occupancy and income about 45 and 70 percent more during the pandemic, respectively, with even larger effects in Central Business Districts. Our results shed light on how lease terms, search frictions in leasing markets, and systematic demand shocks shape the distribution of financial outcomes for CRE properties.

Keywords: Commercial real estate, lease expirations, COVID-19, office loans, bank loan exposure
JEL codes: R30, R33, G21, G23.

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Contact: David.P.Glancy@frb.gov, Christina.Wang@bos.frb.org.

1 Introduction

Risks faced by commercial real estate (CRE) investors depend meaningfully on the extent of frictions in leasing markets. Absent leasing frictions, the primary risk investors face is repricing risk (i.e., fluctuations in market rents due to supply and demand conditions passing through to income). However, search and matching frictions can also subject investors to turnover risk; tenants may be difficult to replace when they exit, creating the risk of large, protracted declines in occupancy and income. Understanding these risks is critical for a wide range of decisions that CRE market participants make, including tenant selection, the design of lease contracts, and CRE loan underwriting.[1] These considerations have become particularly acute since the pandemic outbreak as many businesses intend to downsize their office space in response to increased remote work, and some have done so already.

This paper uses micro-data on CRE property performance to quantify the risks associated with lease expirations and how they vary across different markets and over time. Lease expirations are informative for understanding repricing and turnover risks for two reasons. First, since expiration timing is determined far in advance by earlier contracting decisions, lease expirations provide an exogenous and discrete increase in a tenant's ability to exit that is useful for empirically evaluating frictions associated with tenant turnover. Second, the effects of lease expirations on property performance differ depending on the source of risk. Repricing risk is in principle symmetric as income could rise or fall depending on how the prevailing market-clearing rent compares to that of the existing lease. In contrast, turnover risk is skewed to the downside. Moreover, it affects occupancy as well as income.

Empirically, the risks posed by lease expirations are sizable and negatively skewed, as demonstrated by Figure 1, which presents histograms of income growth for CRE properties by the share of space with expiring leases. Lease expirations are associated with a pronounced downside skew in the income growth distribution before the pandemic, consistent with a dominant role for tenant turnover risk (left panel). For offices during the pandemic, lease expirations are associated with both a downward skew and a leftward shift in the distribution, consistent with both a higher turnover risk and a broader decline in rents when leases are renewed amid weak demand (right panel). The primary goal of this paper is to quantify these effects more formally, especially as they pertain to the pass-through of COVID-induced strains to CRE investors.

First, we analyze the effects of lease expirations before the pandemic, and demonstrate that they are consistent with significant frictions to tenant turnover. We estimate that a property with expiring leases accounting for 10 percent of its square footage would be expected to experience a roughly 80 basis point decline in its occupancy rate and net operating income (NOI) growth following the expiration. Estimates from quantile regressions reveal that these declines predominantly

[1] For example, greater risk from tenant turnover would incentivize property owners to diversify their tenant base so as to diversify the idiosyncratic risk associated with tenant exits, and prioritize longer lease terms to safer tenants to reduce the incidence of tenant exits. CRE lenders should be particularly attentive to these considerations when underwriting since turnover risks are skewed to the downside.

reflect downside risk; lease expirations had little effect on median or better outcomes of property performance, but were associated with notable declines in occupancy and income at lower quantiles.

These effects of lease expirations are highly dependent on the strength of the local property market. In markets with minimal vacancy, expirations brought about only a modest decline in occupancy and little change in income. However, expirations were associated with notable declines in income and occupancy in markets with relatively higher vacancy rates. That is, when net demand for space in a market is weak, expiring leases are less likely to be renewed or replaced, and when they are, costlier concessions are needed to do so, resulting in weaker cash flows after the expiration.

Second, we quantify how these risks changed during the pandemic for different types of CRE properties. We find that, over all property types, expirations during the pandemic had only modestly larger effects on occupancy and income compared with the period before the COVID-19 outbreak. However, some segments show clear signs of stress. For offices on the whole, lease expirations reduced occupancy and income growth by roughly 45 percent and 70 percent more, respectively, during the pandemic. These effects vary substantially across localities: in Central Business Districts (CBDs), lease expirations reduced occupancy and income growth by about 150 percent and 250 percent more, respectively, than before pandemic. CBD offices suffered both an increase in tenant exit (exacerbating downside risk) and a general reduction in rents amid weak demand (shifting the entire income-growth distribution down). Likewise, COVID-era lease expirations caused a greater deterioration in property performance in counties with a greater declines in time spent at workplaces. We also find evidence for a flight-to-quality effect: expiring leases worsened performance more for properties that have not been renovated recently.

Taken together, these findings demonstrate that lease expiration outcomes can help reveal the strength of local property markets. Weak demand—whether manifested in high market vacancy or exposure to remote work during COVID—is associated with worse deterioration in property performance following lease expirations. Soon after the COVID-19 outbreak, even before office loan delinquencies or aggregate vacancy rates rose noticeably, the elevated share of space becoming vacant as leases expired signaled more widespread impairment to come. Motivated by this result, we conduct two supplemental analyses that investigate the longer-term implications of these findings for office property performance and different lenders' credit risk exposure.

First, we project future changes in vacancy under different scenarios, using a reduced-form model of occupancy dynamics calibrated with our empirical estimates. Under the most adverse scenario, if rates at which tenants renew expiring leases and landlords fill vacant space remain permanently depressed, steady-state vacancy rates would rise by about 7 and 27 percentage points for suburban and CBD offices, respectively, relative to pre-COVID levels. More realistically, leasing dynamics should improve over time as asking rents fall, the supply of office space adjusts downward, and remote-work-heavy firms exit the tenant pool. If parameters pertaining to tenant exit and space filling revert to their pre-COVID values at a rate of 10 percent per year (roughly the rate at which leases and CRE loans turn over), we project that vacancy rates would peak at about 4 and 10 percentage points above pre-COVID levels for suburban and CBD offices, respectively.

Second, we quantify the extent to which different types of lenders are exposed to vulnerable CRE loan segments. Since downside risk is disproportionately borne by debt holders, the risk of large income declines documented above is of particular concern for CRE lenders. Although small and regional banks are vulnerable to CRE market strains due to their concentrated portfolio-holdings of CRE loans, we show that this vulnerability is partially offset by their lower exposure to the most at-risk areas (that is, CBDs and high-remote-work counties). Thus, while office loans at small and regional banks still face headwinds from higher interest rates and difficulties in refinancing, this geographic distribution should mitigate the risk of further deterioration in office loan performance straining their capital positions.

1.1 Related Literature

Broadly speaking, this paper contributes to three strands of research. First, we contribute to work analyzing frictions in leasing markets. Mooradian and Yang (2000); Yoshida et al. (2016) provide evidence of lessees paying premiums for short-term leases or cancellation options, consistent with landlords requiring compensation for transaction costs associated with tenant turnover.[2] Moszkowski and Stackman (2022) show that search frictions in leasing markets contribute to long vacancy spells since the option value of vacant space causes landlords to hold out for a high rent offer. We add to this work by directly testing how lease expirations affect property performance. Consistent with search frictions producing significant rollover risk, we show that lease expirations result in sizable downside risks to occupancy and income.

Second, we characterize how leasing dynamics have changed during the COVID-19 pandemic. The pandemic caused a significant movement of people and businesses to lower density areas (Ramani and Bloom, 2021; Monte et al., 2023), resulting in adverse effects on property prices (Ghosh et al., 2022) and commercial rent (Rosenthal et al., 2022) in urban areas. Gupta et al. (2022) estimate that declines in leasing revenue due to the rise of remote work lowered the value of office buildings in the U.S. substantially. We document two important mechanisms underlying the decline in leasing activity. We estimate that, during the pandemic, there was both a sizable increase in the rate at which tenants exited office space when leases expired, and a decline in the rate at which vacant space was filled, which prolongs the adverse effects of lease expirations. Both effects were more pronounced in CBDs and areas with a greater increase in remote work.

Third, we contribute to work examining the exposure of the banking sector to CRE-market strains. Jiang et al. (2023) use information on commercial mortgage-backed securities (CMBS) loans with negative equity to demonstrate that CRE credit risk compounds bank solvency concerns, particularly for smaller banks. Similar concerns are also noted by Acharya et al. (2023) and Gupta et al. (2022). In contrast, Glancy and Kurtzman (2024) show that smaller banks' CRE loans have several characteristics that are associated with lower delinquency rates. Along a similar vein, we

[2]While we study income risk from the contractually-allowed downsizing or exiting of space, property owners also contend with the risk that tenants fail to make contractually-obligated payments. Ambrose and Yildirim (2008) and Agarwal et al. (2011) study how default risk affects the term structure of leases.

show that small banks are less exposed than other CRE lenders to markets where leasing activity has weakened the most (i.e., CBDs and localities with a larger shift to remote work). Our findings underscore that the extent of CRE market distress differs markedly across property types and locations, so it is critical to account for banks' specific holdings when assessing their exposure to credit losses.

2 Data and Methodology

2.1 Data

We use panel data from Morningstar on properties securing CMBS loans to investigate the effects of lease expirations on property performance. CMBS are the second-largest funding source for office properties in the United States (behind banks) and tend to specialize in larger loans.[3] This market segment is useful for our purpose because borrowers need to provide regular updates regarding their properties' financial performance and lease expiration schedule. Our sample contains office, retail, and industrial properties, the three property types for which lease expirations are important. The sample starts in 2009, when reporting of leasing variables began, and runs through 2024:Q1.[4]

While the data are reported monthly, the main variables of interest typically are updated at a lower frequency. At each lease-rollover review date, scheduled lease expirations are reported in one-year increments up to four years out. We measure pending lease expirations as of the last lease-rollover review date that is at least one year before the date financial data were updated. Measuring pending lease expirations using scheduled expirations from more than a year away addresses the sample selection concern that very-near-term expirations are observed only for tenants that do not extend their leases by that point.[5] Namely, we measure lease expirations from year t to $t+1$ using the year-ahead pending expirations as reported in the lease review of year $t-1$.

Regarding property performance, we consider changes in occupancy and net operating income between the last financial update before the lease expiration window starts to the first update after that window ends (which we denote as t_- and $t+1_+$, respectively).[6] As financials are typically updated annually, the outcome variable is generally the change in occupancy or income over the two-year period containing the lease-expiration window. Details on how we measure lease expirations and changes in financials are provided in Appendix A.

Finally, we supplement the CMBS data with several geography-specific measures that help

[3] See Glancy et al. (2022) for a discussion of how CMBS loan portfolios differ from those of other major CRE lenders.

[4] Properties securing pari passu loans (loans split across multiple deals) appear multiple times in the data. We only keep one observation per property-month in such cases.

[5] Appendix Figure A.2 plots the distribution of scheduled lease expirations as of 2019. The density drops off considerably when the expiration is less than a year away, suggesting that some leases that would have had imminent expirations were renewed instead. By comparison, the density is fairly flat for expirations that are more than a year away. Consequently, scheduled lease expirations that are more than a year away should reflect the timing of previous contract arrangements rather than endogenous renewal decisions.

[6] We drop observations where the financial update is more than 1.5 years after the end of the lease expiration window in order to guarantee that we are consistently examining the near-term effects of expirations.

gauge the strength of local property markets. First, we use CBRE data on vacancy rates in major property markets as of the start of each financial reporting window (denoted Market Vacancy$_{i,t_-}$), to examine possible heterogeneity in the effects of lease expirations depending on how tight the local property market is. This measure of vacancy is defined broadly as the share of space in the market currently available for leasing.[7]

Second, we include variables that capture likely heterogeneity in the COVID-induced contraction in demand for office space. Central Business District$_{z(i)}$ is an indicator equal to 1 if i's ZIP code belongs to a submarket identified by CBRE as being in a CBD, and 0 otherwise. To capture cross-county differences in remote work patterns, Work From Home$_{c(i)}$ measures the decline in time spent at workplaces in a county relative to before the pandemic based on Google's Community Mobility Reports.[8] We also consider property-specific quality measures to capture potential flight-to-quality effects, as Gupta et al. (2022) document an increased preference for newer and higher-amenity office properties during the pandemic. Specifically, Unrenovated$_{i,t_-}$ is an indicator for whether the most recent construction or renovation was over 20 years ago, and ln(Price Per Sq Ft)$_{i,t_-}$ measures the (log) valuation of the space as of the most recent appraisal before the financial-reporting window starts.

2.2 Methodology

To analyze the effects of lease expirations and how they changed during the pandemic, we estimate equations along the lines of:

$$\begin{aligned} Y_{i,t_-,t+1_+} = \alpha_{p,t} &+ \text{Expirations}_{i,t,t+1} \times \left(\gamma_0 + \sum_{j\in J} \gamma_j Z_{j,i,t}\right) \\ &+ \text{COVID Expirations}_{i,t,t+1} \times \left(\beta_0 + \sum_{j\in J} \beta_j Z_{j,i,t_-}\right) \\ &+ \eta' X_{i,t_-} + \varepsilon_{i,t}, \end{aligned} \tag{1}$$

where $Y_{i,t_-,t+1_+}$ is the change in the occupancy rate or NOI growth for property i over the roughly two-year period containing the lease expiration window. Expirations$_{i,t,t+1}$ is the share of leases (in terms of square footage) set to expire, and COVID Expirations$_{i,t,t+1}$ is the interaction of

[7] In addition to strictly vacant space, this availability measure also includes space available for sublease and marketed space currently under construction. We use availability for two reasons. First, unlike vacancy, it is reported for all property types. Second, it reflects tightness in the leasing market more accurately by accounting for the full range of space available to prospective tenants. There is an almost 1-to-1 correspondence between vacancy and availability when both measures are provided (see Figure B.1), so we just refer to the availability rate as the market vacancy rate, since the latter terminology is generally more familiar.

[8] Work From Home$_{c(i)}$ is the decline (relative to the pre-pandemic period) in the average daily time spent at workplaces in property i's county as of September 2022, the last full month for which data are available in Google's Community Mobility Reports (see Chetty et al., 2020). We use the last available data point to best capture the persistent change in remote-work patterns.

$\text{Expirations}_{i,t,t+1}$ with the pandemic indicator (equal to 1 if t is 2020 or later). $\{Z_{j,i,t_-}\}_{j\in J}$ is a set of variables potentially affecting the sensitivity of property performance to lease expirations, and X_{i,t_-} is a vector of controls that include the property vacancy rate at the start of the financial-reporting window as well as the non-interacted Z_{j,i,t_-} variables. $\alpha_{p,t}$ is a property type-year fixed effect.

The key objects of interest are $\hat{\gamma}_0$, which estimates how lease expirations affect property performance in normal times, and $\hat{\beta}_0$, which estimates the degree to which expirations became more impactful during the pandemic. Additionally, coefficients on the interaction terms ($\hat{\gamma}_k$ and $\hat{\beta}_k$) quantify how much certain factors, such as local vacancy or remote-work patterns, amplify the effects of lease expirations. In some specifications, we estimate equation (1) by quantile regression, in which case coefficient estimates pertain to how lease expirations affect various quantiles (rather than the expected value) of $Y_{i,t_-,t+1_+}$.

2.3 Summary Statistics

Summary statistics for the main variables of interest are reported in Table 1. It shows that leases associated with CMBS-funded properties are typically long term, and expirations tend to be lumpy. On average, about 10 percent of leases expire each year, but with a median of only 2 percent. This means that little space is typically covered by expiring leases, however, when leases do expire, they can be associated with a nontrivial fraction of space and thus can have large implications for the performance of the property.

Regarding property performance, occupancy for CMBS-funded properties tends to trend down slightly over time, while NOI growth averages about 2 percent.[9] The average property vacancy rate is about 8.3 percent, which is moderately below the average market-level vacancy rate of 13.7 percent. This difference partly stems from our measure of the market vacancy rate, which includes some new construction and space available for sublease. In addition, it could also partly reflect CMBS' comparative advantage in funding properties with higher-than-average quality, which generally have higher occupancy rates (Black et al., 2017).

3 Effects of Lease Expirations During Normal Times

This section establishes the baseline estimates of how lease expirations affect income and occupancy in normal times, before we turn to the impact of the COVID-19 pandemic next. Section 3.1 uses quantile regressions to demonstrate that lease expirations generate downside risk to property performance. Section 3.2 shows that the effects of expirations are amplified in markets with higher vacancy rates.

[9] NOI growth exhibits some extreme values, so we winsorize at the 1% and 99% levels.

3.1 Quantile Regression Estimates

Broadly speaking, the expiration of a lease generates two types of cash flow risk. The first is repricing risk. Since leases typically feature long terms, the rent under an existing lease might differ meaningfully from the market rent on comparable space at the time that lease expires. Thus, the renewal rent might rise or fall depending on supply and demand conditions in the local market. The second type of risk to cash flow stems from frictions in tenant turnover. If a tenant leaves, search frictions can cause long vacancy spells before the space is refilled. Even when a new tenant is found, leasing commissions, free rent periods and tenant improvement allowances can make that replacement costly. These frictions pose potentially nontrivial downside risks to occupancy and income when leases expire.

To capture this asymmetry, we start with quantile regressions, following the specification in equation (1), to estimate the relationship between property performance and lease expirations, controlling for the initial vacancy rate of the property.[10] The sample covers 2009 through 2018 in order to examine the effects of leases that expired before the pandemic.

Figure 2 plots estimates of how lease expirations affect various quantiles of occupancy changes (the left panel) and NOI growth (the right panel). The dashed line marks the OLS estimate from the same specification. This figure reveals that lease expirations typically do not affect occupancy or NOI notably. At the median and higher quantiles, more expirations are associated with no change in occupancy and only modest declines in NOI growth. This suggests that leases are typically renewed (or replacement tenants found quickly), and at rents comparable to those under existing leases. However, expirations present substantial downside risk. At the fifth percentile, the estimated elasticities are about -0.4 and -0.25 for occupancy and NOI growth, respectively, indicating that almost half of the space occupied by an expiring lease ends up vacant after it expires.

The smaller decline in NOI growth relative to occupancy at the lower percentiles is counterintuitive since a drop in occupancy would typically cause a roughly proportional decline in income but, due to the fixed costs of operating a property, a less-than-proportional decline in operating costs. In other words, operating leverage can cause NOI to decline somewhat more than one-for-one with occupancy. However, this effect may be obscured at short time horizons by the fact that NOI is a trailing flow measure and thus can include some rental payments received prior to a tenant's exit (that is, income collected before a lease expires can appear on the financial statement that is reported after the lease expires). In contrast, occupancy is a snapshot measure at the time of the financial report. When we increase the time horizon over which we assess changes in occupancy and NOI by a year, we indeed see post-expiration NOI growth decline slightly more than occupancy (see Figure A.3).[11] In sum, these results are consistent with the interpretation that the risk of

[10] We exclude property type-year fixed effects in this specification because a greater impact of lease expirations in times of stress is one factor that could cause effects to be asymmetric, but results are broadly similar when these fixed effects are included.

[11] Despite this limitation, we mostly focus on changes in income growth over the shorter horizon to facilitate the COVID-era analysis. Requiring a longer time horizon for the outcome variables would limit our pandemic-era analysis to only the effects of lease expirations that occurred early in the pandemic.

tenant exit (rather than the risk of rent repricing) drives the downside risk to property income.

A couple of factors likely contribute to lease expirations affecting performance predominantly at the lower quantiles. First, as already discussed, difficulty replacing tenants cause the effects of expirations to be asymmetric; if tenants depart, occupancy and income may fall sharply, whereas if they stay, the property's financials may change little. Thus, even if lease expiration outcomes were completely determined by idiosyncratic factors related to the tenants, they would mostly affect the lower quantiles of the performance metrics. Second, lease expirations are likely more detrimental in weaker markets, as tenants are harder to replace and, irrespective of the tenants' renewal decision, equilibrium rents would have declined relative to other markets. In this case, lease expirations will further pull down the bottom part of the distribution because their effects are most pronounced for properties whose financial performance is impaired by other factors. We next investigate this second mechanism, showing that property performance indeed deteriorates more following lease expirations in markets with higher vacancy rates.

3.2 Effects Depend on Local Conditions

The effects of lease expirations likely depend on local conditions. In a tighter market, it is harder to find alternative space, so tenants would be less likely to leave their current space and have less bargaining power in renewal negotiations. To study such effects, we now estimate equation (1) including interaction terms with the market-level vacancy, which is measured using the availability rate reported by CBRE for the given city, property type, and quarter as of the start of the financial-reporting window.[12]

Table 2 presents the coefficient estimates from this analysis. For comparison, the first column reports the baseline OLS estimates without the market-vacancy-related terms. It shows that a 10 percentage point increase in lease expirations results in a roughly 80 basis point decline in occupancy, on average. Column 2 interacts lease expirations with the market vacancy rate, allowing the effects of lease expirations to depend on market conditions. As expected, the adverse effects of expirations increase with market vacancy; the estimates imply an elasticity of occupancy with respect to expirations of about -0.07 in markets with a 10 percent vacancy rate, compared with an elasticity of $-.04$ in a market with no vacancy. Column 3 presents quantile regression estimates of the effect of lease expirations on the 25th percentile of occupancy changes. The estimates indicate that the detrimental effects of lease expirations in weaker property markets are felt predominantly on the lower end of the performance distribution, similar to the pattern shown in Figure 2.

Columns 4 through 6 repeat this analysis for NOI growth. Overall, the effects of lease expirations on income growth are roughly similar to the effects on occupancy, but the importance of local market tightness is even more pronounced. In fact, when market vacancy is negligible, lease expirations are associated with modest increases in income. However, when the market vacancy rate is high, lease expirations are associated with greater declines, on average, in NOI than in occupancy. This

[12]For properties in markets not covered by CBRE, We use the national index for the property type and quarter. Our estimates change little when we restrict the sample to properties in CBRE markets.

result is consistent with a higher market vacancy increasing both repricing risk and tenant turnover risk (i.e., even when tenants renew, rents decline, causing NOI to fall more than occupancy). The estimates imply that lease expirations exert no effect on income when market vacancy is about 2.5 percent, but the elasticity between NOI and the expiring-lease share deteriorates to about -0.06 in a market with a 10 percent vacancy rate. Again, effects are stronger for lower quantiles, indicating that weaker market conditions amplify the downside risks stemming from lease expirations.

Overall, these findings indicate that the possibility for tenant turnover creates meaningful idiosyncratic risk for CRE investors. Even in a tight market with little available space, tenants may exit when leases expire, creating downside risk to property cash flow. This risk is magnified in markets with an excess supply of space (as manifested in high market vacancy), because these is not only a greater risk of tenant departure but also a decline in market-wide rents that reduces income more systematically when leases are renegotiated.

One complication with using market vacancy to measure the strength of a local property market is that it is an equilibrium outcome. Leasing dynamics in a market with high vacancy due to weak demand may differ notably from one with vacancy due to, for example, a high option value of vacant space (Moszkowski and Stackman, 2022). In the next section we study the effects of lease expirations in a setting where the demand is known to have fallen: office space following the pandemic. This allows us to both characterize the risks posed by the pandemic and further our understanding of how demand shocks propagate to CRE property performance.

4 Effects of Lease Expirations During the Pandemic

This section analyzes how the effects of lease expirations changed during the pandemic and which market segments were most affected. Section 4.1 reveals that the adverse effects of lease expirations on property performance increased during the pandemic, driven by office properties. Section 4.2 shows that these adverse effects have been concentrated in CBDs and areas where remote work rose more.

4.1 Heterogeneous Effects across Property Types

The risks associated with lease expirations discussed in Section 3 presumably became more pronounced during the pandemic, at least for more adversely affected segments of the CRE market. First, lower demand for office space overall means that even when a tenant chooses to renew, they should be able to negotiate for lower rents or greater concessions. Second, dramatic changes in firms' space needs may increase tenant churn and result in more firms exiting upon expiration.[13] In other words, the risks associated with both repricing and tenant turnover are likely to have risen.

To investigate how the effects of lease expirations on property performance have changed since the COVID-19 outbreak, we extend the sample to include the pandemic era and add an explanatory

[13] In the first two years of the pandemic, the expiration of a lease was likely the primary event that allowed a firm to shed space given the low business bankruptcy rate.

variable, COVID Expirations$_{i,t,t+1}$, which is the share of expiring leases interacted with a pandemic indicator (equal to 1 if t is 2020 or later).[14]

Table 3 presents the estimates from these regressions. Columns 1 through 4 report the effects on occupancy rate changes, while columns 5 through 8 report results for NOI growth. The OLS estimates presented in column 1 consider occupancy changes for the full sample of all property types for which leasing data are available. Overall, while lease expirations are associated with increased vacancy, the effects of expirations became only slightly stronger during the pandemic, rising from 0.07 before to 0.08 during the pandemic.

One reason that the adverse effects of lease expirations may not appear to be greatly magnified during the pandemic is that the sample includes many properties with limited susceptibility to the disruptions associated with the crisis. For example, while the office sector has been significantly affected by the shift to remote work, as noted by Gupta et al. (2022), the acceleration in e-commerce sales during the pandemic boosted demand for industrial real estate (such as warehouses). We thus next analyze the effects of pandemic lease expirations separately by property type. Columns 2 through 4 report these estimates, with the sample restricted to office, retail, and industrial properties, respectively.

As would be expected, the pandemic amplified the effects of lease expirations more for offices than for retail or industrial properties. The estimated elasticity between office occupancy growth and lease expirations rose in magnitude from -0.09 before to -0.13 during the pandemic (column 2). Likewise, the elasticity for NOI growth deteriorated from about -0.14 to -0.24 (column 6). That the effects are larger for NOI than for occupancy indicates that, in addition to turnover risk rising, the pandemic has also reduced rents for newly-leased office space. These changes in occupancy and NOI following pandemic-era office lease expirations mirror the effects found in high-vacancy markets before the pandemic: the estimates in Table 2 indicate that a market with a 30 percent vacancy rate would have occupancy and NOI elasticities of -0.13 and -0.22, respectively, which are nearly identical to the elasticities of -0.13 and -0.24 found here. This similarity suggests that the effects quantified in this study are informative about how CRE market strains pass through to property income and occupancy more generally.

The other two commercial property types fared better by comparison. For retail, the elasticities of occupancy and income vis-à-vis lease expirations were unchanged during the pandemic relative to the period before the outbreak (columns 3 and 6). Lease expirations actually became less problematic for industrial properties during COVID-19, consistent with increased demand for these properties due to pandemic-induced shift in spending patterns (columns 4 and 8).

In addition to tenants becoming more likely to vacate their offices upon lease expiration, the estimates in Table 3 also indicate that vacant space has become more difficult to fill. The coefficient of 0.64 on Property Vacancy$_{i,t}$ indicates that landlords were able to fill about two-thirds of their

[14] In our baseline specifications, we exclude observations for which the lease-expiration window starts in 2019 but ends in 2020, because some tenants could have renewed before becoming aware of the pandemic whereas others may have been affected by the pandemic. Nevertheless, our results are robust to including these observations as either pre-COVID expirations or COVID expirations.

vacant space during the financial-reporting window in the pre-pandemic period. However, this rate at which vacant space is filled fell by about half for office and retail properties during the pandemic. This means that, when tenants did leave, space was likely to remain vacant longer. We investigate the implications of this result for future vacancy rates in Section 5.1.

4.2 Effects of Office Lease Expirations by Geography

Since the effects of the COVID-19 pandemic are most pronounced for offices, the rest of our analysis focuses on the subsample of office properties. In particular, we explore whether offices in markets with a greater shift toward remote work exhibited greater vulnerability to lease expirations during the pandemic. We identify such vulnerable places using two metrics: being a central business district (CBD) or suffering a more persistent decline in time spent at workplaces (or equivalently, more remote work). We estimate equation (1) for office properties only, allowing the effects of lease expirations to depend on these geographic variables. The coefficients on the relevant interaction terms measure cross-location heterogeneity in the effects of lease expirations and how they changed during the pandemic.

Table 4 presents these estimates. For comparison, columns 1 and 4 repeat columns 2 and 5 of Table 3, respectively, estimating the effects of lease expirations on office performance without the geographic variables.[15] Columns 2 and 5 add interactions between the expiration variables and an indicator for whether the property's ZIP code belongs to a CBD (according to CBRE submarket definitions). Columns 3 and 6 present similar estimates with an alternative measure of each local market's exposure to remote work: the decline in time spent at workplaces relative to before the pandemic.

Columns 2 and 5 show that the adverse effects of lease expirations became much more pronounced for CBD properties after the onset of COVID-19. The marginal effect of lease expirations on occupancy during the pandemic was -0.24 for CBD properties, compared with about -0.12 for other office properties, and only -0.09 before the pandemic for all offices. That is, the detrimental effect of expirations on occupancy nearly tripled during the pandemic for CBD properties.

Patterns are broadly similar for income growth; the elasticity between NOI growth and lease expirations deteriorated from about -0.14 to -0.22 for non-CBD properties during the pandemic, and from about -0.14 to -0.54—more than tripling—for CBD properties. These geographic differences are consistent with the findings from Ghosh et al. (2022) that, during the pandemic, property values for suburban offices remained more resilient than valuations for urban offices.

Finally, columns 3 and 6 report estimates where a direct measure of remote work replaces the CBD indicator. Raising Work From Home$_{c(i)}$ by 0.15 (roughly the difference between New York City and the average property in the sample) increases the adverse effect of pandemic-era lease expirations on occupancy by about 0.08 and the effect on NOI growth by about 0.25.[16]

[15] The sample size declines slightly because those regressions require the geographic variables to be available, nonetheless estimates are virtually identical.

[16] Table 5 reports estimates from a horse-race specification where the CBD and Work-From-Home measures are included simultaneously, along with other controls to account for flight-to-quality effects. The estimates remain

Offices in CBDs and high-remote-work localities also experienced declines in occupancy and income during the pandemic even when leases were not expiring. These changes could reflect factors such tenants buying out leases to exit early or declines in supplemental income (e.g., parking income) caused by the reduction in physical occupancy. Overall, these results demonstrate that demand for office space fell in those markets, and that lease expirations prompted this change to get reflected in financial performance over time, by giving tenants the opportunity to exit or renegotiate leases. The aggregate implications of these dynamics are shown in Appendix Figure B.2. Market-level occupancy declined disproportionately in high-remote-work areas, and these declines showed no signs of moderating as of the end of 2023. This chart suggests that conditions are likely to continue to deteriorate as more leases turn over, a topic we discuss further in the next section.

We next examine how pandemic-era lease expirations affected the full distribution of performance. The OLS estimates, reflecting the average effects, suggest that the most adversely affected markets experienced a broad-based repricing of space when leases expired, as evidenced by the worse contraction in NOI than in occupancy. More direct support for this interpretation can be found in Figure 3, which presents quantile regression estimates of the effects of COVID-era lease expirations on the performance of CBD and non-CBD office properties.[17] Quantile regression estimates of the effects of pandemic-era lease expirations for properties located outside of CBDs (the green lines) qualitatively resemble those from before the pandemic, with declines in NOI and occupancy principally driven by the bottom quantiles of the distribution. In contrast, in CBDs (red), lease expirations are associated with notably weaker NOI growth throughout almost the entire distribution. Even at the 80th percentile, NOI for CBD offices declined by about one-third of a percentage point for every one percentage point increase in the expiration share. This occurs despite lease expirations not affecting the top quartile of occupancy change. These estimates confirm that weaker demand for CBD offices went beyond prompting more tenants to exit; even when new leases were signed, rents appear to have contracted notably.

Table 5 extends the analysis to consider additional factors that could influence the impact of lease expirations during COVID-19. Gupta et al. (2022) show that leasing activity and rents fell more for lower-quality offices, consistent with an increased preference for higher-amenity space. To proxy for such effects, we add interaction terms with $\text{Unrenovated}_{i,t\_}$ (an indicator equal to one if the property was last renovated more than 20 years ago), and with the (log) property price per square foot as of the last appraisal. Columns (1) and (4) present results along the lines of the specification from Table 4, but with the CBD and Work From Home variables included together. The point estimates shrink somewhat and standard errors rise when these variables are included jointly, but the estimated interaction effects remain economically meaningful for both variables. Columns (2) and (5) additionally include the quality measures in the specification. The estimates

qualitatively similar. Appendix Table B.2 further shows that the baseline findings are generally robust to alternative measures of work-from-home intensity.

[17] We separately estimate the effect of lease expirations for CBD and non-CBD offices, restricting the sample period to the pandemic. Additionally, Table B.1 presents quantile regression estimates from the same specifications underlying the OLS estimates reported in Table 4. Echoing earlier results, effects of pandemic lease expirations were generally more pronounced for the lower-end of the distribution.

show that higher quality properties (as measured by valuation or recency of renovation) experienced smaller declines in occupancy and income when leases expired during the pandemic. Furthermore, these effects are robust to the inclusion of CBSA-year fixed effects in columns (3) and (6). Table B.2 further shows that these findings are generally robust to alternative measures of work-from-home intensity based on the American Community Survey (ACS) data, and measures of remote-work potential in a locality (based on job types and job listings) as estimated by Dingel and Neiman (2020) and Hansen et al. (2023).

Overall, our estimates of the cross-sectional determinants of the sensitivity to lease expirations align well with popular perceptions of which office properties are most vulnerable to the disruptions wrought by the pandemic. Namely, tenants were more likely to exit upon lease expiration in areas exhibiting greater shifts toward remote work (as represented by CBDs and counties with a larger decline in time at work places) and in lower-quality properties (as proxied by renovation timing and property valuation). Furthermore, income declines upon expiration were more broad-based across properties in CBDs, indicating that the income losses were not just temporary declines due to tenant turnover, but reflect a significant contraction in equilibrium rents.

5 Further Implications for the CRE and Banking Sectors

This section investigates the implications of the above findings for the longer-run performance of office properties and CRE lenders. First, Section 5.1 presents a simple model of office occupancy dynamics, and uses the corresponding empirical estimates to project future vacancy rates for urban and suburban markets under different scenarios for the normalization of office market conditions. Second, motivated by a significant projected rise in future vacancy rates for CBD office markets, Section 5.2 analyzes the exposure of different CRE lenders to these at-risk markets. We demonstrate that small and regional banks are generally less exposed to CBD office loans than larger banks and nonbank lenders. Although this benefit is partially offset by smaller banks financing relatively lower-quality offices, we nonetheless find that small and regional banks are less exposed than other lenders to the most-adversely affected office properties.

5.1 Vacancy Rate Projections

Table 4 showed that, during the pandemic, lease expirations were associated with larger declines in occupancy, and vacant space became slower to fill. These findings indicate that vacancy rates are likely to continue to rise as more leases roll over. The important question is: how much will vacancy rise and how long will it remain elevated? To address this question, we use the empirical estimates to calibrate a simple reduced-form model of occupancy dynamics. Previously estimated regression coefficients map directly into model parameters and help gauge how vacancy rates may evolve going forward.

There are three channels through which a building's occupancy can change: occupied space being vacated because the lease is expiring, occupied space being vacated for other reasons (e.g.,

from bankruptcies, good guy clauses, or buyouts), and vacant space getting filled. Suppose that the owner of a building i is able to fill vacant space at rate $f_{i,t}$, experiences tenant exits following lease expirations at rate $\lambda_{i,t}$, and exits outside of expirations at rate $\delta_{i,t}$. Then the change in occupancy can be described by the following law of motion:

$$\Delta Occ_{i,t} = f_{i,t}Vac_{i,t} - \lambda_{i,t}Exp_{i,t} - \delta_{i,t}(1 - Vac_{i,t} - Exp_{i,t}), \tag{2}$$

where $Occ_{i,t}$ and $Vac_{i,t}$ $(= 1 - Occ_{i,t})$ are the occupancy and vacancy rate, respectively, and $Exp_{i,t}$ is the share of space with expiring leases.

Next, we can use coefficient estimates from the following regression

$$\Delta Occ_{i,t} = \alpha + \beta^{vac}Vac_{i,t} + \beta^{exp}Exp_{i,t} + \varepsilon_{i,t}$$

to back out the average filling rate and the two exit rates:

$$\begin{aligned}\hat{\delta} &= -\hat{\alpha} \\ \hat{f} &= \hat{\beta}^{vac} + \hat{\alpha} \\ \hat{\lambda} &= -(\hat{\beta}^{exp} + \hat{\alpha})\end{aligned}$$

Likewise, by parameterizing the expiration-related exit rate as

$$\lambda_{i,t} = \lambda_0 + \lambda_1 CBD_i + COVID_t(\lambda_2 + \lambda_3 CBD_i) + \varepsilon^{\lambda}_{i,t},$$

we can use coefficient estimates from fully-interacted regressions along the lines of equation (1) to back out how these parameters changed during COVID-19 for CBD versus non-CBD properties. $f_{i,t}$ and $\delta_{i,t}$ can be parameterized analogously.[18]

The primary value of this simple model is to provide a framework for assessing how the change in leasing dynamics during COVID-19 will affect future vacancy rates for office properties under alternative trajectories for the recovery of leasing dynamics. The results of this exercise are presented in Table 6. The estimates indicate that lease breaks (that is, exits outside of expirations) declined during COVID, perhaps owing to low levels of bankruptcies in 2021 and 2022. However, this effect was more than offset by a decline in the rate at which vacant space was filled (f) from 0.48 before the pandemic to 0.19 during the pandemic, and an increase in the rate at which tenants exit upon lease expiration (λ) from 0.16 to 0.17. These last two effects are more pronounced for urban offices (columns 5 and 6) than for suburban ones (columns 3 and 4). The estimates imply that the rate at which tenants cut space upon lease expiration rose from 0.17 to 0.30 in CBDs, and was almost unchanged outside of CBDs.

[18] To focus on the effects of lease expirations, the specifications in Table 4 did not interact the vacancy rate with the geographic risk factors, so they differ slightly from the specifications in this section. $\varepsilon^{\lambda}_{i,t}$ reflects idiosyncratic determinants of whether a tenant exits upon expiration. If these idiosyncratic terms are uncorrelated with the CBD and COVID indicators, this specification should identify the average rates at which tenants leave and vacant space is filled.

Roughly 10% of leases expire per year in the data, namely $\mathbb{E}(Exp_{i,t}) = 0.10$. Treating this rate as exogenous and assuming it will remain roughly the same going forward, we can use equation (2) to solve for the vacancy rate in steady state (that is, the vacancy rate such that $\mathbb{E}(\Delta Occ_{i,t}) = 0$) as:

$$Vac_{i,t}^{SS} = \frac{\hat{\delta}_{i,t} + (\hat{\lambda}_{i,t} - \hat{\delta}_{i,t}) \times 0.10}{\hat{f}_{i,t} + \hat{\delta}_{i,t}}$$

These implied steady-state vacancy rates are reported in the last row of Table 6. Before the pandemic, leasing dynamics—embodied in the exit rates and filling rate—were consistent with a steady-state vacancy rate of 13.7%. The COVID-period estimates provide the vacancy rate at which a market would stabilize under the extreme (and likely unrealistic) assumption that the leasing dynamics observed during the first couple of years of the pandemic were to become permanent. These estimates indicate that office vacancy would rise to about 18% in suburban office markets and 34% in CBD office markets.

More realistically, the longer-run rise in vacancy should be smaller, as a few factors push f up and λ down over time. First, those tenants with the greatest propensity to switch to a remote-work-heavy model will constitute a diminishing share of the tenant pool over time as leases expire, leaving the composition of tenants tilted more toward those who are willing to maintain their office space. In other words, those tenants who have chosen to sign new leases during the pandemic are likely to exit at a slower rate than the overall pool of tenants who entered into leases before the pandemic. This should push λ back toward pre-pandemic levels over time. Second, in the longer run, supply should be able to adjust to the lower demand through lower rates of construction and the conversion of offices to other property types. This would reduce the excess supply of office space and make vacant space easier to fill (i.e., f rising toward the pre-pandemic level). Third, over time, landlords are likely to further reduce asking rents in an effort to clear the market. This process may be aided by the turnover of owners for distressed properties, as the lower prices paid by the new owners would enable them to profitably lease space at lower rents.

To investigate how vacancy would evolve under different scenarios for the speed at which leasing dynamics improve, Figure 4 projects changes (from 2019:Q4 levels) in vacancy rates for CBD and suburban office markets under three different scenarios. First, the top of the shaded region marks the projected change in vacancy rates if the COVID-era dynamics were to remain permanent. Second, the bottom of the shaded region corresponds to the most optimistic scenario where leasing dynamics revert fully to the pre-pandemic parameters (those from columns 3 and 5 of Table 6) starting in 2024. Finally, the dashed line depicts the intermediate projection if f, λ and δ revert back to pre-pandemic values starting in 2024 at a geometric rate of 2.5 percent per quarter (roughly the rate at which leases expire and loans mature). Each projection assumes that vacancy rates start at the pre-pandemic steady state, and projects changes in vacancy into the future using the specific sequence of $\{f_t, \lambda_t, \delta_t\}$ determined by the parameter values in Table 6 in combination with the assumed rate at which conditions normalize after the sample period ends.

The projections show that the predicted rise in vacancy is particularly stark for CBD offices (in

red), and the rate at which leasing conditions normalize are especially important for the predicted trajectories. The projections predict a roughly 8-percentage-point increase in CBD office vacancy rates over the first four years of the pandemic. Under the intermediate case with geometric reversion of leasing parameters going forward, CBD vacancy peaks in 2027 at around 10 percentage points above pre-pandemic levels, and then slowly returns to normal over the 2030s. However, because CBD leasing activity deteriorated so much during the pandemic, there is a rather wide range of possible future outcomes depending on how quickly conditions normalize. For suburban markets (in blue), the deterioration to date in leasing activity is less stark, so the range of predicted outcomes is much narrower. Under the intermediate scenario, projected vacancy rates were already approaching their new peak values as of the start of 2024, although they are expected to remain elevated for a while relative to before the pandemic.

How well do these projections line up with observed changes in vacancy rates? The solid lines plot the actual change in vacancy rates for CBD and suburban offices based on CBRE vacancy data through the end of 2023.[19] The projections over the sample period, which serve as an informal back-test of the model, match the observed change in vacancy rates for CBD markets, with both rising about 7.5 percentage points through the fourth quarter of 2023. However, the model under-predicts the actual rise in vacancy for suburban markets; vacancy rose by about 4 percentage points through 2023:Q4 in suburban markets, but was projected to rise by only 2 percentage points. This indicates that the deterioration in suburban office markets may be somewhat worse than indicated by the CMBS data, perhaps because CMBS loans tend to fund higher quality (and thus higher price) properties for suburban markets. This discrepancy notwithstanding, our estimates confirm that CBD office properties have experienced more deterioration to date, and project a worse (as well as murkier) outlook for them in the future.

5.2 Exposures of Lenders to At-risk Office Markets

The results so far demonstrate that the effects of the COVID-19 pandemic on the office CRE sector are far from uniform. In areas outside of CBDs and where the amount of time spent at workplaces has not declined notably, leasing dynamics do not differ substantially from before the pandemic. That is, when leases expire, the spaces continue to be filled at rates and rents similar to those observed over the decade before the COVID-19 outbreak. However, in CBDs and markets where remote work has risen notably, lease expirations have proven more damaging to occupancy and income. Namely, demand for office space in those markets appears to have fundamentally weakened, causing property performance to deteriorate as leases roll over. Because the various types of CRE lenders differ in their geographic footprint, these cross-market differences have potentially important implications for which lenders are most exposed to losses from office loans in the coming years.

[19] Estimates are formed by aggregating quarterly CBRE submarket vacancy rates separately for CBD and non-CBD markets, weighting submarkets by net rentable area. To align with the vacancy concept in the CMBS data, vacancy is measured as "direct vacancy," which excludes space available for sublease.

To examine the implications of these differences, we combine data from MSCI Real Capital Analytics (RCA) and CoreLogic to identify key characteristics of the loan portfolios of different types of lenders. We then examine the compositions of CRE portfolios across lenders to assess their exposures to potentially stressed properties. More information on the data construction is provided in Appendix C.

The left panel of Figure 5 plots the shares of outstanding office loans made by large and foreign banks, nonbank CRE lenders (for example, CMBS pools and life insurers), and smaller domestic banks (banks with under $100 billion in assets) that are secured by properties with the following risk factors: central business district locations (red bars), counties with an over-one-third decline in time at workplaces (blue bars), year of last renovation before 2000 (purple bars), and a price per square foot under $300.

This figure reveals that small and regional domestic banks tend to finance properties located in markets less exposed to the COVID-19-related disruptions. Nearly 40 percent of office CRE lending by large/foreign banks and nonbanks are in CBDs, and similar shares of lending are in counties with a high work-from-home share. In contrast, less than 15 percent of the office loan portfolios of smaller domestic banks are subject to these risk factors.

While smaller banks tend to originate office loans in less adversely-affected markets, their loans have other risk factors. Nearly two-thirds of office loans from smaller banks are secured by properties that have not been renovated since before 2000 (almost double the fraction from other lenders), and bank-funded offices tend to also have lower valuations. Consequently, loans from smaller domestic banks might be hurt more by the flight-to-quality effects documented in Table 5.

To gauge how these potentially offsetting effects net out, we use the coefficient estimates from columns (2) and (5) of Table 5 to estimate the average elasticity of occupancy and NOI with respect to lease expirations for the loans of different types of CRE lenders. These estimates measure the rate at which tenants leave or income falls as leases expire and thus are indicators of the degree of stress for a lender's office loan portfolio given its characteristics. The left panel of Figure 5 plots kernel density estimates of the distribution of occupancy elasticities for the three lender categories. The distribution for smaller domestic banks (the blue line) is clearly located to the right of those for the other lender groups, indicating a smaller tendency for tenants to vacate when their leases expire. Much of the difference is attributed to less mass in the lower tail, meaning fewer loans against properties with high turnover risk during the pandemic. On average, smaller domestic banks face an elasticity of -0.18, while non-banks and larger banks have elasticities around -0.20. The right panel plots the distribution of the estimated NOI elasticities, reflecting both repricing and turnover risks. The distribution for small banks is again to the right of the other lenders, with less mass in the left tail. They have an average elasticity of -0.28, while the other lenders have elasticities around -0.34.

The comparatively lower exposure of smaller banks to the most at-risk loans is in large part driven by these banks making smaller loans, which tend to finance properties located in the parts of cities facing less of a decline in office demand. Specifically, Appendix Table C.1 investigates

the determinants of smaller banks' market shares for office loans. The results confirm that (1) smaller banks made fewer office loans in CBDs and counties with more working from home, (2) these differences predominantly reflect where small banks originate loans *within a given city*, and (3) these differences are partially attributable to small banks making smaller sized loans.

In sum, while there remains some concern about small and regional banks as a group facing headwinds from high CRE loan concentrations and funding pressures, these banks appear to be at least partially protected from loan losses by having office loans in markets less damaged by the pandemic. With this more favorable geographic distribution of lending, small and regional banks overall may be better positioned than other lenders to weather the strains in the office sector.

6 Discussion and Concluding Remarks

This paper documents three key facts about the relationship between lease expirations and CRE property performance. First, lease expirations create notable downside risk for the performance of commercial properties. While the intensity of lease expirations has little effect on median or higher percentiles of financial performance, it significantly impacts the lower end of the distribution. Specifically, lease expirations increase the likelihood that a property experiences a large decline in occupancy and income.

Second, this risk of performance deterioration following lease expirations is highly sensitive to the strength of the local property market. In markets with low vacancy rates, lease expirations are associated with only a modest decline in occupancy and no decline in income. This indicates that leases in tight markets are typically renewed or replaced and the ability to increase rent upon renewal offsets the modest expected income losses from tenant turnover. However, in markets with high vacancy rates, occupancy and income both fall considerably when leases expire, reflecting increased turnover and weaker rent growth upon renewal.

Third, while the CRE market as a whole has remained relatively resilient since the COVID-19 outbreak, lease expiration outcomes indicate serious stresses for office properties. The adverse effects of lease expirations on the financial performance of office buildings increased substantially during the pandemic, especially for properties in central business districts or counties with a large and persistent increase in remote work. Within a city, older and lower-quality office properties also fared worse.

These findings have important implications for the evaluation of cash flow risks for CRE properties. For one, the potential for a sharp contraction in occupancy and income when a lease expires, along with the fact that occupancy is slow to recover, indicates that frictions to replacing tenants subject property owners to substantial idiosyncratic downside risks when leases expire. These risks could be mitigated by measures such as prioritizing longer-term leases (to reduce the incidence of turnover and the associated costs) and a more diversified tenant base (to diversify risks from individual renewal decisions). These considerations should be particularly relevant for debt-holders, who disproportionately bear downside risks.

Our findings also have implications for assessing CRE risks at a more macro level. Due to the long-term nature of commercial leases, shifts in market fundamentals take time to become reflected in property performance. Thus, changes in occupancy and income upon lease expirations can provide a timely signal about changing market conditions. Indeed, the effects of the pandemic documented in this study was already apparent in 2020 and 2021 lease expirations, before much of the deterioration in office markets by other metrics became visible. Our analysis showcases how the information embedded in lease expiration outcomes can be used to quantify the extent of stress in different CRE markets (e.g., by property type and location). These estimates in turn can be used to assess the portfolio risk of different CRE lenders based on their exposures to stressed market segments.

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Table 1: Summary Statistics

Variable	Mean	sd	Percentile			N
			25	50	75	
$\text{Expirations}_{i,t,t+1}$	0.101	0.172	0.000	0.020	0.135	112,539
$\Delta\text{Occupancy}_{i,t_-}$	-0.004	0.176	-0.010	0.000	0.008	113,045
$\text{NOI Growth}_{i,t_-}$	0.020	0.264	-0.074	0.011	0.100	113,210
$\text{Property Vacancy}_{i,t_-}$	0.082	0.155	0.000	0.010	0.110	113,045
$\text{Market Vacancy}_{m(i),t_-}$	0.137	0.054	0.095	0.126	0.172	113,210
$\text{Central Business District}_{z(i)}$	0.056	0.231	0.000	0.000	0.000	113,210
$\text{Work From Home}_{c(i)}$	0.244	0.071	0.212	0.254	0.293	113,210
$\text{Unrenovated}_{i,t_-}$	0.300	0.458	0.000	0.000	1.000	112,287
$\ln(\text{Price Per Sq Ft})_{i,t_-}$	5.199	0.718	4.755	5.198	5.660	105,265
COVID_t	0.168	0.374	0.000	0.000	0.000	113,210
Office_i	0.278	0.448	0.000	0.000	1.000	113,210
Retail_i	0.614	0.487	0.000	1.000	1.000	113,210
Industrial_i	0.108	0.311	0.000	0.000	0.000	113,210

Notes: Summary statistics for the regression sample. i indexes properties, and t denotes the start of the one-year lease expiration window under consideration. Market vacancy rates and CBD definitions come from CBRE, and the county-level decline in time at workplaces (Work From Home) are from Google mobility data (via Opportunity Insights). Remaining variables come from Morningstar CMBS data. Unrenovated is an indicator for whether the most recent renovation was over 20 years ago, and Price Per Sq Ft is the ratio of the value of the most recent appraisal to the property square footage. NOI Growth and Price Per Sq Ft are winsorized at the 1 percent level.

Table 2: Effects of Lease Expirations before the Pandemic, by Market Vacancy

	ΔOccupancy$_{i,t_-}$		$Q_{25}(\Delta Occ_{i,t_-})$	NOI Growth$_{i,t_-}$		Q_{25}(NOI Gr$_{i,t_-}$)
	(1)	(2)	(3)	(4)	(5)	(6)
Expirations$_{i,t,t+1}$	-0.08**	-0.04**	0.02*	-0.09**	0.02	-0.01
	(0.00)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
Property Vacancy$_{i,t_-}$	0.65**	0.65**	0.02**	0.08**	0.08**	-0.21**
	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)
Market Vacancy$_{m(i),t_-}$		-0.25**	-0.00		-0.31**	-0.26**
		(0.02)	(0.00)		(0.04)	(0.03)
$\times$ Expirations$_{i,t,t+1}$		-0.30**	-1.33**		-0.80**	-1.13**
		(0.08)	(0.08)		(0.11)	(0.12)
R^2_a	0.330	0.332		0.013	0.015	
R^2_a(within)	0.327	0.329		0.006	0.009	
Observations	94,494	94,494	94,494	94,041	94,041	94,041
Property Type-Year FEs	✓	✓	✓	✓	✓	✓

Notes: The dependent variable is the change in occupancy (columns 1 through 3) or NOI growth (columns 4 through 6). Columns 3 and 6 present estimates from quantile regressions (25th quantile), while the other columns present OLS estimates. Market Vacancy$_{m(i),t_-}$ denotes the vacancy rate in property i's market as defined by CBRE. "$\times$Expirations$_{i,t,t+1}$" denotes its interaction with Expirations$_{i,t,t+1}$. Standard errors, in parentheses, are clustered by loan. $^{+}$,*,** indicate significance at 10%, 5%, and 1%, respectively.
Sources: Morningstar, CBRE, and authors' calculations.

Table 3: Effects of Lease Expirations during the Pandemic

	ΔOccupancy$_{i,t_-}$				NOI Growth$_{i,t_-}$			
	Full Sample	Offices	Retail	Industrial	Full Sample	Offices	Retail	Industrial
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Expirations$_{i,t,t+1}$	-0.07**	-0.09**	-0.07**	-0.06**	-0.09**	-0.14**	-0.06**	-0.10**
	(0.00)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
COVID Expirations$_{i,t,t+1}$	-0.01^{+}	-0.04*	0.00	0.03*	-0.04*	-0.10**	-0.01	0.03
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.03)	(0.02)	(0.03)
Property Vacancy$_{i,t_-}$	0.64**	0.54**	0.68**	0.68**	0.08**	0.05**	0.06**	0.18**
	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.04)
$\times$ COVID$_t$	-0.30**	-0.32**	-0.28**	-0.07	-0.08^{+}	-0.24**	-0.00	0.48**
	(0.02)	(0.03)	(0.02)	(0.05)	(0.04)	(0.06)	(0.05)	(0.17)
R^2_a	0.310	0.229	0.350	0.336	0.018	0.016	0.015	0.038
R^2_a(within)	0.306	0.227	0.348	0.331	0.006	0.011	0.003	0.017
Observations	121,117	33,610	74,133	13,374	120,575	33,362	73,973	13,240
Property Type-Year FEs	✓				✓			
Year FEs		✓	✓	✓		✓	✓	✓

Notes: This table presents estimates of the effects of lease expirations on occupancy (columns 1 through 4) and NOI growth (columns 5 through 8). Expirations$_{i,t,t+1}$ is the share of leases (in terms of square footage) set to expire, and COVID Expirations$_{t,t+1}$ denotes its interaction with an indicator for whether t is 2020 or later. For each outcome variable, the first column presents estimates for the full sample of properties, and the next three restrict the sample to office, retail, and industrial properties, respectively. All specifications control for the property's initial vacancy rate and its interaction with the COVID indicator, and include either property type-year (the first column in each block) or year fixed effects (the other columns). Standard errors, in parentheses, are clustered by loan. $^{+}$,*,** indicate significance at 10%, 5%, and 1%, respectively.
Sources: Morningstar and authors' calculations.

Table 4: Effects of Office Lease Expirations during the Pandemic, Geographic Differences

	ΔOccupancy$_{i,t_-}$			NOI Growth$_{t,t_-}$		
	(1)	(2)	(3)	(4)	(5)	(6)
Expirations$_{i,t,t+1}$	-0.09**	-0.09**	-0.08**	-0.14**	-0.14**	-0.03
	(0.01)	(0.01)	(0.03)	(0.01)	(0.01)	(0.04)
$\times$ Central Business District$_{z(i)}$		-0.00			-0.00	
		(0.03)			(0.03)	
$\times$ Work From Home$_{c(i)}$			-0.05			-0.44**
			(0.11)			(0.16)
COVID Expirations$_{i,t,t+1}$	-0.04*	-0.03^{+}	0.08	-0.10**	-0.08*	0.21*
	(0.02)	(0.02)	(0.05)	(0.03)	(0.03)	(0.10)
$\times$ Central Business District$_{z(i)}$		-0.12*			-0.32**	
		(0.05)			(0.10)	
$\times$ Work From Home$_{c(i)}$			-0.48*			-1.24**
			(0.22)			(0.37)
COVID$_t$						
$\times$ Property Vacancy$_{i,t_-}$	-0.32**	-0.31**	-0.32**	-0.24**	-0.23**	-0.24**
	(0.03)	(0.03)	(0.03)	(0.06)	(0.06)	(0.06)
$\times$ Central Business District$_{z(i)}$		-0.02*			-0.01	
		(0.01)			(0.02)	
$\times$ Work From Home$_{c(i)}$			-0.19**			-0.30**
			(0.04)			(0.08)
Property Vacancy$_{i,t_-}$	0.54**	0.54**	0.54**	0.05**	0.05**	0.05**
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
Central Business District$_{z(i)}$		-0.00			0.01	
		(0.00)			(0.01)	
Work From Home$_{c(i)}$			0.03			0.21**
			(0.03)			(0.04)
R^2_a	0.229	0.230	0.231	0.016	0.017	0.018
R^2_a(within)	0.227	0.228	0.228	0.011	0.011	0.013
Observations	33,540	33,540	33,540	33,292	33,292	33,292
Year FEs	✓	✓	✓	✓	✓	✓

Notes: This table presents estimates of the effects of lease expirations on occupancy and income growth for office properties. Expirations$_{i,t,t+1}$ is the share of leases (in terms of square footage) set to expire in the financial financial reporting window, and COVID Expirations$_{i,t,t+1}$ interacts this expiration share with an indicator for whether t is 2020 or later. The dependent variable is the change in occupancy in columns 1 through 3 and the growth in NOI in columns 4 through 6. Columns 1 and 4 repeat results from Table 3, columns 2 and 5 add interactions for whether the property is in a central business district, and columns 3 and 6 instead add interactions for the percentage decline in time spent at workplaces relative to pre-pandemic levels. All specifications control for the initial vacancy rate, its interaction with the COVID-19 indicator, and year fixed effects. Standard errors, in parentheses, are clustered by loan. $^{+}$,*,** indicate significance at 10%, 5%, and 1%, respectively.
Sources: Morningstar, CBRE, Opportunity Insights, and authors' calculations.

Table 5: Effects of Office Lease Expirations during the Pandemic, Flight to Quality

	ΔOccupancy$_{i,t_}$			NOI Growth$_{i,t_}$		
	(1)	(2)	(3)	(4)	(5)	(6)
Expirations$_{i,t,t+1}$	-0.08*	0.06	0.05	-0.02	0.14	0.09
	(0.03)	(0.09)	(0.09)	(0.04)	(0.13)	(0.14)
$\times$ Central Business District$_{z(i)}$	0.00	0.00	0.00	0.03	0.03	0.02
	(0.03)	(0.03)	(0.03)	(0.04)	(0.04)	(0.04)
$\times$ Work From Home$_{c(i)}$	-0.06	-0.02	0.06	-0.49**	-0.40*	-0.37
	(0.12)	(0.13)	(0.16)	(0.17)	(0.19)	(0.23)
$\times$ Unrenovated$_{i,t_}$		0.03^{+}	0.04*		-0.00	-0.01
		(0.02)	(0.02)		(0.03)	(0.03)
$\times$ ln(Price Per Sq Ft)$_{i,t\_}$		-0.03	-0.03		-0.03	-0.03
		(0.02)	(0.02)		(0.03)	(0.03)
COVID Expirations$_{i,t,t+1}$	0.05	-0.28^{+}	-0.24	0.14	-0.70*	-0.59*
	(0.06)	(0.17)	(0.18)	(0.10)	(0.27)	(0.29)
$\times$ Central Business District$_{z(i)}$	-0.10	-0.10^{+}	-0.12^{+}	-0.25*	-0.28**	-0.31**
	(0.06)	(0.06)	(0.06)	(0.11)	(0.11)	(0.10)
$\times$ Work From Home$_{c(i)}$	-0.33	-0.48*	-0.45	-0.85*	-1.34**	-1.08*
	(0.25)	(0.24)	(0.30)	(0.41)	(0.40)	(0.47)
$\times$ Unrenovated$_{i,t_}$		-0.09*	-0.11*		-0.08	-0.11
		(0.04)	(0.05)		(0.06)	(0.07)
$\times$ ln(Price Per Sq Ft)$_{i,t\_}$		0.07*	0.07*		0.18**	0.15**
		(0.03)	(0.03)		(0.05)	(0.05)
R^2_a	0.231	0.229	0.235	0.018	0.022	0.030
R^2_a(within)	0.229	0.226	0.234	0.013	0.016	0.016
Observations	33,540	30,913	29,952	33,292	30,684	29,722
Non-expiration-interacted controls	✓	✓	✓	✓	✓	✓
Year FEs	✓	✓		✓	✓	
CBSA-Year FEs			✓			✓

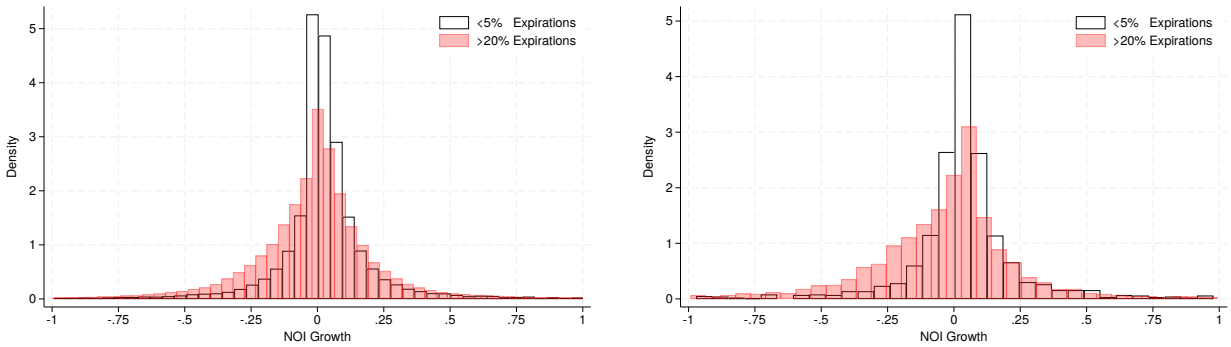
Notes: This table presents estimates along the lines of Columns (3) and (6) of Table 4, but adding interaction effects pertaining to building quality: Unrenovated$_{i,t_}$ is an indicator for whether the years of construction and last renovation were over 20 years ago, and ln(Price Per Sq Ft)$_{i,t\_}$ is the logarithm of the price per square foot of the property as of the most recent appraisal. Columns (1) and (4) repeat analysis from Table 4, Columns (2) and (5) add the new interaction terms to the specification, and columns (3) and (6) add CBSA-Year fixed effects. The four risk factors and their interaction with COVID$_t$ are included in the specification, but estimates are not displayed. Standard errors, in parentheses, are clustered by loan. $^{+}$,*,** indicate significance at 10%, 5%, and 1%, respectively. *Sources*: Morningstar, CBRE, Opportunity Insights, and authors' calculations.

Table 6: Estimates of Structural Parameters

Market	Overall		Suburban		CBD	
Period	Pre-COVID	COVID	Pre-COVID	COVID	Pre-COVID	COVID
	(1)	(2)	(3)	(4)	(5)	(6)
δ	0.065	0.032	0.063	0.030	0.076	0.048
	(0.001)	(0.003)	(0.001)	(0.003)	(0.004)	(0.008)
f	0.477	0.187	0.469	0.201	0.534	0.164
	(0.005)	(0.017)	(0.006)	(0.018)	(0.014)	(0.043)
λ	0.159	0.171	0.158	0.159	0.170	0.297
	(0.005)	(0.011)	(0.005)	(0.012)	(0.016)	(0.036)
Steady State Vacancy (%)	13.7	21.0	13.6	18.4	14.0	34.2

Notes: This table presents estimates of the structural parameters affecting occupancy based on regressions of changes in occupancy on the property-level vacancy rate, the lease expiration share, and the interaction of these two variables with a COVID indicator (columns 1–2), or fully interacted with the COVID indicator, the CBD share, and their interaction (Columns 3–6). Columns (1) and (2) present estimates for dynamics before and during COVID, respectively, pooling across markets. Columns (3) and (4) present equivalent estimates for suburban office properties, and columns (5) and (6) for CBD office properties. The steady-state vacancy rate implied by the estimates is reported in the last row.

Figure 1: Distribution of Net Operating Income Growth

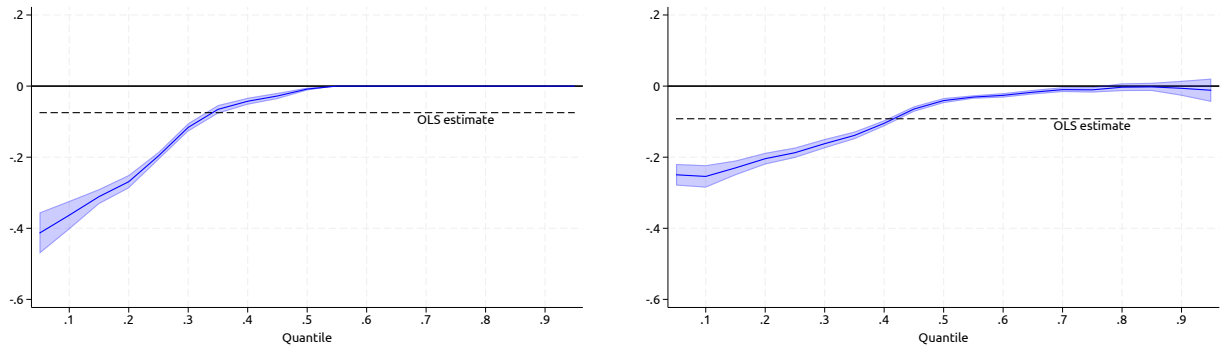


(a) Pre-COVID Distribution

(b) COVID Distribution, Offices

Notes: This figure plots histograms of NOI growth for properties with a high (red bars) or low (hollow black bars) exposure to lease expirations. Properties have a high (low) exposure if more than 20% (less than 5%) of space is accounted for by leases that expired in the last two years. The left panel includes office, retail and industrial properties in the pre-COVID period, while the right panel only includes office properties during the COVID period.
Sources: Morningstar, and authors' calculations.

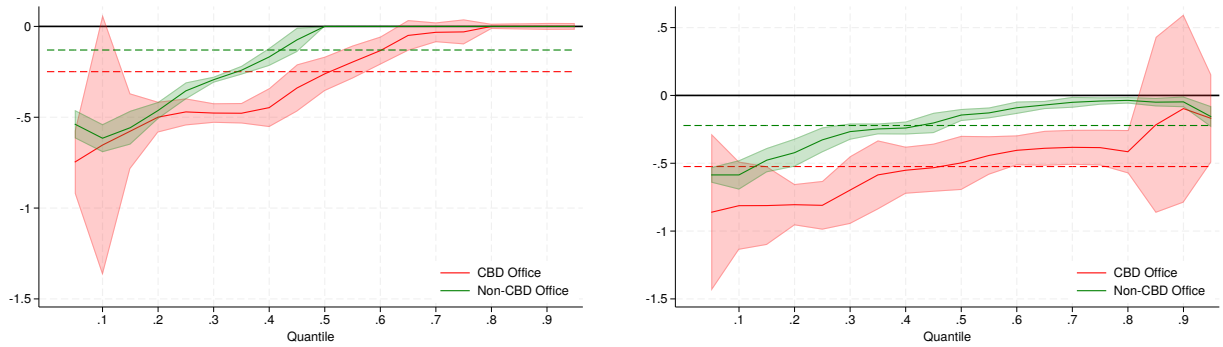
Figure 2: Effects of Lease Expirations from Quantile Regressions



(a) $\Delta\text{Occupancy}_{i,t\_}$ (b) $\text{NOI Growth}_{i,t\_}$

Notes: This figure plots quantile regression estimates of the effects of lease expirations on occupancy rate changes (left panel) and NOI growth (right panel) according to equation (1). The x-axis indexes the quantiles of each outcome variable, and the y-axis displays the coefficient estimate for a given quantile. The blue area represents the 95 percent confidence interval. Standard errors are clustered by loan.
Sources: Morningstar, and authors' calculations.

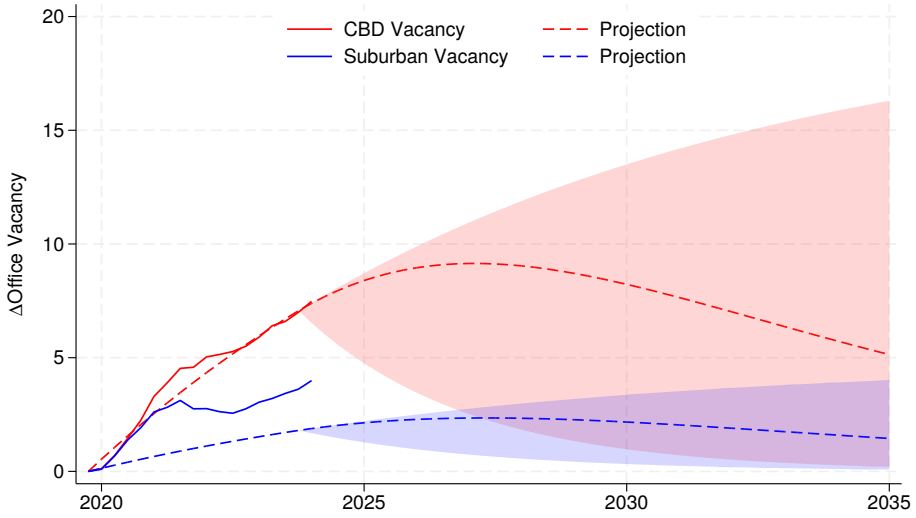
Figure 3: Effects of Office Lease Expirations during the Pandemic



(a) $\Delta\text{Occupancy}_{i,t-}$ (b) $\text{NOI Growth}_{i,t-}$

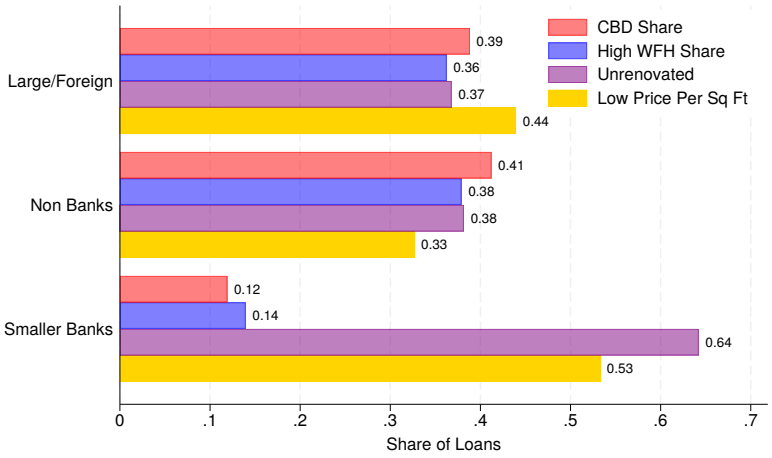
Notes: This figure plots quantile regression estimates of the effects of lease expirations on occupancy rate changes (left panel) and NOI growth (right panel), controlling for initial property vacancy. The x-axis indexes the quantiles of each outcome variable, and the y-axis displays the coefficient estimate for a given quantile. The red lines and regions present the point estimates and 95% confidence intervals, respectively, for the sample of CBD offices during COVID-19, whereas the green lines and regions present estimates for non-CBD offices during COVID-19. Dashed lines correspond with respective OLS estimates from the same specification. Standard errors are clustered by loan.
Sources: Morningstar, and authors' calculations.

Figure 4: Changes in U.S. Office Vacancy

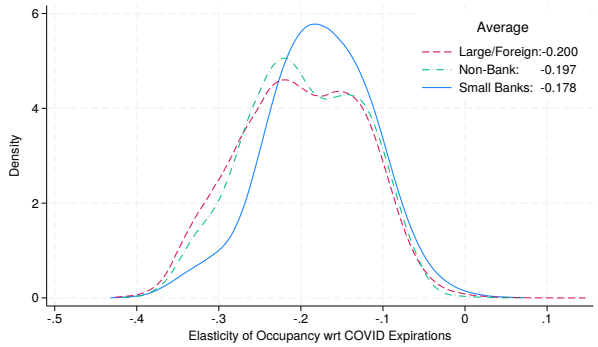


Notes: This figure plots projected changes in office vacancy rates for suburban (blue) and CBD (red) markets. Solid lines show observed changes in vacancy between 2019:Q4 and 2024:Q4 based on CBRE data. The dashed line shows the projected changes in vacancy assuming markets start at their pre-COVID steady state, evolve according to the COVID-era parameter estimates from Table 6 for four years, and then have leasing parameters revert back to pre-COVID levels at a rate of 2.5 percent per quarter. The shaded areas give the range of projected vacancy rates from the scenario where COVID-era parameters become permanent (the top of the range) to the one where they revert immediately to pre-COVID values after four years (the bottom of the range). Projections assume that 10% of leased space expires per year.
Sources: CBRE, and authors' calculations.

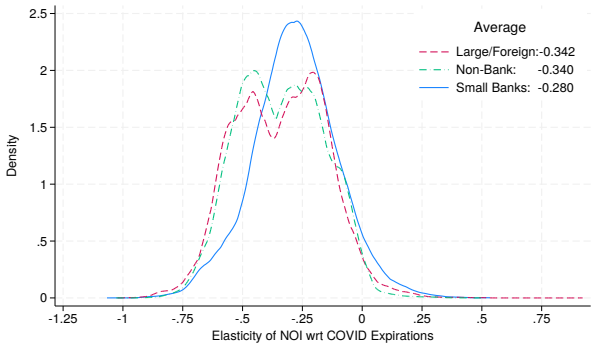
Figure 5: Exposures to At-risk Office Loans by Lender



(a) Specific Risk Factors



(b) Estimated Sensitivity to Expirations



(c) Estimated Sensitivity to Expirations

Notes: The top figure (Panel (a)) depicts the shares of lending in the RCA/CoreLogic data that are secured by properties in central business districts (red bars), in counties where the time at workplaces declined by at least one-third relative to before the pandemic (blue bars), built and last renovated before 2000 (purple bars) and with a Price Per Square Foot under $300 (yellow bars). These shares are plotted for three lender groups: Large/foreign banks, nonbanks, and smaller banks. The two bottom figures present kernel density plots of the estimated elasticity of occupancy (Panel (b)) and NOI growth (Panel (c)) with respect to lease expirations during COVID-19 for the portfolios of the three lender groups. The elasticities are estimated based on the coefficients reported in Columns (2) and (5) of Table 5.
Sources: RCA, CoreLogic, CBRE, Opportunity Insights, and authors' calculations.

APPENDIX

A Variable Construction

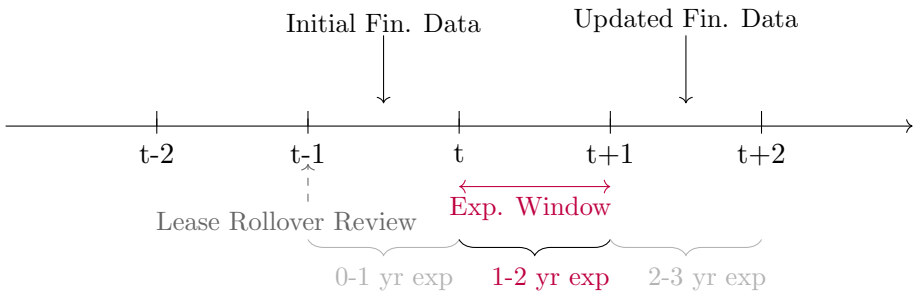
While data on the loans underlying commercial mortgage-backed securities (CMBS) deals are reported monthly, the variables concerning property performance and lease expiration schedules are updated less frequently. This appendix outlines how we address these timing issues. Figure A.1 displays a timeline for key variables pertaining to financial updates and lease expirations.

The primary explanatory variable is the share of leases (weighted by a tenant's square footage) expiring in a given year. CMBS data report lease expirations over separate one year intervals: For each lease rollover review, the shares of space with leases expiring within one year, one to two years, two to three years, three to four years, or more than four years are reported (the brackets in Figure A.1). We use scheduled lease expirations as measured one year before to avoid selection bias from early renewals, so our measure of lease expirations between t and $t+1$ pertains to the lease rollover review as of $t-1$.[20]

For the performance variables (occupancy rate and net operating income), we consider changes over the shortest available time horizon that contains the lease expiration window. If a property reports financials annually, and financial reporting occurs halfway between rollover reviews (the circumstance depicted in the figure), then the outcome variables would be the change in the two years starting 6 months before the start of the lease expiration window and ending 6 months after the end of the window. These two dates are shown as "Initial Fin. Data" and "Updated Fin. Data" in Figure A.1. The actual lead and lag may differ depending on the timing of data reporting. We drop observations where the financial update is more than 1.5 years after the end of the lease expiration window in order to guarantee that we are consistently examining the near-term effects of expirations. One limitation of studying financial performance over this short horizon is that the trailing NOI reported after a lease expires may include some rental payments received before the expiration. Indeed, Figure A.3 demonstrates that the effects of expirations on income growth are stronger when income growth is measured over a longer horizon (by one year), consistent with a lagged response of measured income growth to expirations.

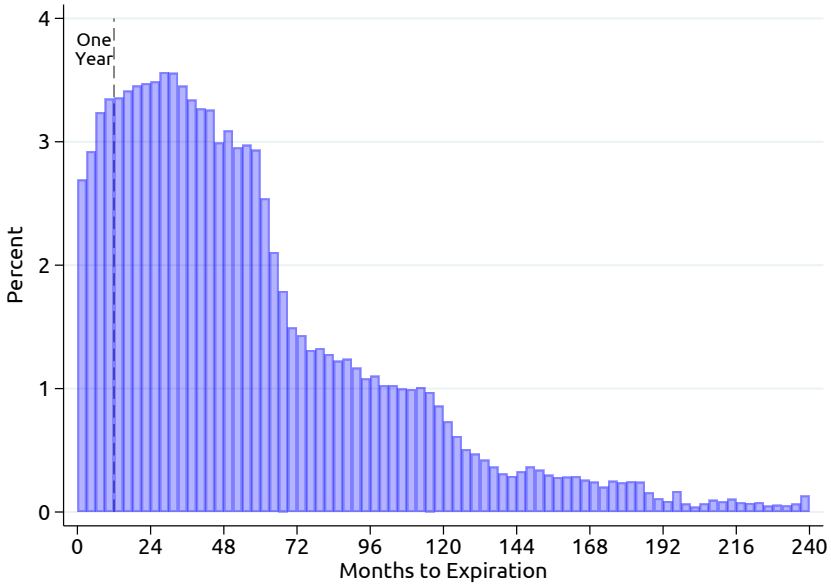
[20] Figure A.2, which plots the distribution of scheduled lease expirations as of 2019, shows that the density of scheduled lease expirations decreases in the three quarters before expiration (consistent with extensions being executed) but levels off at about a year out.

Figure A.1: Timeline of Lease Review and Lease Performance Reporting



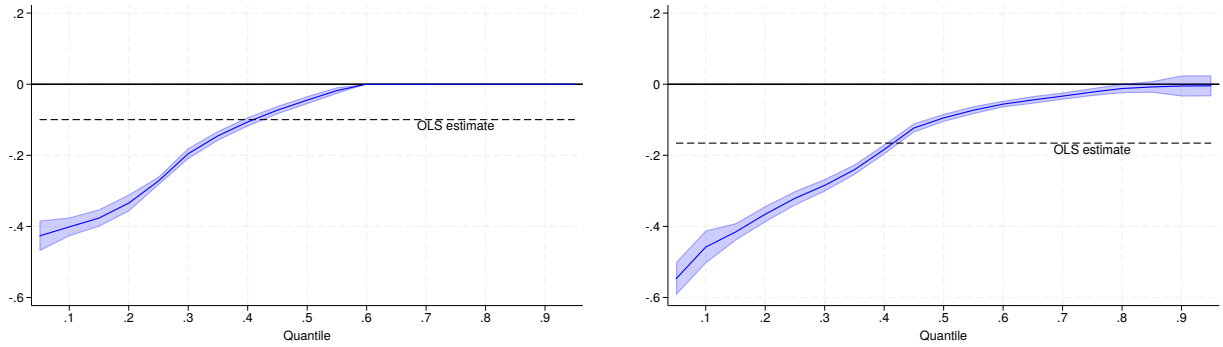
Notes: This diagram illustrates the timing with which lease expirations and financial data are reported. "Lease Rollover Review" is the time lease data is reported, "Exp. Window" is the period over which lease expirations are measured, and "Initial Fin. Data" and "Updated Fin. Data" give the time points over which changes in occupancy or NOI growth are calculated. See Appendix A for detailed explanations.

Figure A.2: Distribution of Scheduled Lease Expirations as of 2019



Notes: This figure shows the distribution of the number of months to expiration for leases observed in 2019. It shows the distribution for properties' top five tenants by square footage of occupancy. (The exact expiration dates for these tenants are reported rather than just the aggregate expirations within a given window.)
Sources: Morningstar and authors' calculations.

Figure A.3: Effects of Lease Expirations from Quantile Regressions



(a) $\Delta\text{Occupancy}_{i,t_-,t+2_+}$ (b) $\text{NOI Growth}_{i,t_-,t+2_+}$

Notes: This figure plots quantile regression estimates of the effects of lease expirations on occupancy rate changes (left panel) and NOI growth (right panel). Changes in financial performance are measured over a horizon that is one year longer than in Figure 2 to make sure that the measure of NOI after the end of the expiration window does not include rent earned before the lease expired. The x-axis indexes the quantiles of each outcome variable, and the y-axis displays the coefficient estimate for a given quantile. The blue area represents the 95 percent confidence interval. Standard errors are clustered by loan.
Sources: Morningstar, and authors' calculations.

B Pandemic Risk Factors by Geography: Additional Results

This subsection presents three additional sets of results pertaining to geographic determinants of leasing dynamics, paying special attention to the change since the onset of COVID-19. First, we present quantile regression estimates demonstrating that the adverse effects of lease expirations in at-risk office markets (CBDs and counties with a larger shift to remote work) are particularly pronounced at lower quantiles. Second, we present results using alternative measures to quantify the shift to remote work. Third, we provide additional analysis on the effect the shift to remote work has had on market-level office occupancy.

Table B.1 presents quantile regression estimates of the form presented in Table 4. The results confirm that lease expirations during the pandemic had more severe effects on occupancy and net operating income (NOI) for offices in CBDs or counties with more remote work. Declines in occupancy and income following leases expirations in these more at-risk markets are stronger at the 25th percentile than in the OLS estimates, further demonstrating that lease expirations substantially increase the downside risk to property performance.

Table B.2 repeats the analysis in Table 5 for alternative measures of remote work intensity. Columns (1) and (5) repeat findings based on Google Mobility data, columns (2) and (6) measure the Work From Home share based on 2022 ACS data, columns (3) and (7) use the share of jobs in a city that can be done remotely as measured by Dingel and Neiman (2020), and columns (4) and (8) use the share of 2022 and 2023 job postings in a city that allow for remote work from Hansen et al. (2023). Each measure of work from home is associated with greater adverse effects of lease expirations during COVID, as well as greater general declines in occupancy and NOI. Estimated effects of expirations on occupancy are generally a bit stronger using the Google-mobility-based proxy of remote work, perhaps because it has less sampling error than the ACS measure and is based on actual time spent at workplaces rather than the potential to work from home, which underlies the indicators compiled in Dingel and Neiman (2020) and Hansen et al. (2023). The estimated effects on NOI are fairly similar across the work-from-home measures.

Figure B.1 presents a scatter plot of availability rates against direct vacancy rates for CBRE markets. Blue dots represent values for 2019:Q4 and red for 2023:Q4. This figure confirms that there is a tight linear relationship between the two measures. It also reveals that there was a clear shift towards higher vacancy and availability rates during the pandemic, while the relationship between the two measures remains nearly identical to before COVID-19.

Figure B.2 shows that the magnitude of the increase in office vacancy is stronger in markets with a greater shift to remote work. The left panel of Figures B.2 shows that markets with a greater rise in remote work experienced a greater decline in occupancy as of the end of 2023; raising Work From Home$_{c(i)}$ by 0.15 (roughly the difference between New York City and the average property in the sample) reduces the occupancy rate by about .05 on average. The time series in the right panel shows the timing when these effects occurred. This chart also reveals that the decline in occupancy in markets with a high degree of remote work has shown little sign of abating in the last couple quarters of 2023.

Table B.1: Effects of Office Lease Expirations during the Pandemic, Quantile Regressions

	$Q_{25}(\Delta\text{Occupancy})$			$Q_{25}(\text{NOI Growth})$		
	(1)	(2)	(3)	(4)	(5)	(6)
$\text{Expirations}_{i,t,t+1}$	-0.26**	-0.27**	-0.21**	-0.22**	-0.23**	-0.23**
	(0.01)	(0.01)	(0.04)	(0.01)	(0.01)	(0.07)
$\times$ $\text{Central Business District}_{z(i)}$		0.03			0.05	
		(0.05)			(0.05)	
$\times$ $\text{Work From Home}_{c(i)}$			-0.19			0.04
			(0.16)			(0.25)
$\text{COVID Expirations}_{i,t,t+1}$	-0.11*	-0.09*	0.36**	-0.17**	-0.09	0.58**
	(0.05)	(0.03)	(0.05)	(0.05)	(0.06)	(0.08)
$\times$ $\text{Central Business District}_{z(i)}$		-0.15*			-0.51**	
		(0.06)			(0.08)	
$\times$ $\text{Work From Home}_{c(i)}$			-1.86**			-2.75**
			(0.22)			(0.36)
COVID_t						
$\times$ $\text{Property Vacancy}_{i,t_-}$	-0.10**	-0.08**	-0.10**	-0.42**	-0.38**	-0.40**
	(0.02)	(0.02)	(0.02)	(0.06)	(0.05)	(0.05)
$\times$ $\text{Central Business District}_{z(i)}$		-0.02*			-0.02	
		(0.01)			(0.01)	
$\times$ $\text{Work From Home}_{c(i)}$			0.01			-0.23**
			(0.01)			(0.05)
$\text{Property Vacancy}_{i,t_-}$	0.02**	0.01**	0.02**	-0.39**	-0.39**	-0.39**
	(0.00)	(0.00)	(0.00)	(0.03)	(0.03)	(0.03)
$\text{Central Business District}_{z(i)}$		-0.02**			0.00	
		(0.00)			(0.01)	
$\text{Work From Home}_{c(i)}$			-0.01**			0.06
			(0.00)			(0.04)
Observations	33,540	33,540	33,540	33,292	33,292	33,292
Year FEs	✓	✓	✓	✓	✓	✓

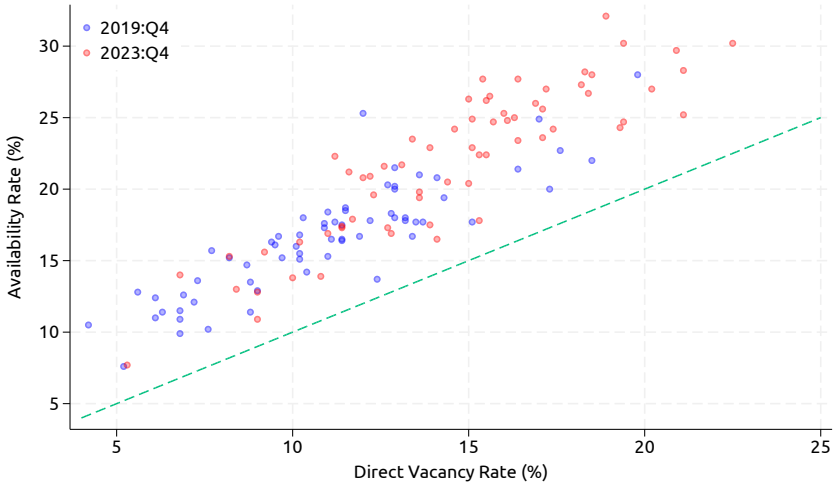
Notes: This table presents quantile regression estimates of the relationship between lease expirations and the 25th percentile of occupancy changes (columns 1 through 4) and NOI growth (columns 5 through 8) for office properties. $\text{Expirations}_{i,t,t+1}$ is the share of leases (in terms of square footage) set to expire over the following year, and COVID $\text{Expirations}_{t,t+1}$ interacts this expiration share with an indicator for whether t is 2020 or later. Each specification follows that of the same column in Table 4, but with a quantile regression rather than OLS. $^{+}$,*,** indicate significance at 10%, 5%, and 1%, respectively.
Sources: Morningstar, Real Capital Analytics, Opportunity Insights, and authors' calculations.

Table B.2: Effects of Pandemic Office Lease Expirations, Alternative WFH Measures

	ΔOccupancy				NOI Growth			
Work From Home Measure	Google	ACS	DN20	HLBDST23	Google	ACS	DN20	HLBDST23
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\text{Expirations}_{i,t,t+1}$	0.06	0.03	0.01	0.06	0.14	0.08	0.16	0.12
	(0.09)	(0.09)	(0.10)	(0.09)	(0.13)	(0.13)	(0.14)	(0.13)
$\times$ $\text{Work From Home}_{c(i)}$	-0.02	0.05	0.17	0.12	-0.40*	-0.39*	-0.26	-0.06
	(0.13)	(0.14)	(0.16)	(0.16)	(0.19)	(0.19)	(0.22)	(0.24)
$\times$ $\text{Central Business District}_{z(i)}$	0.00	-0.00	-0.00	-0.01	0.03	0.02	0.01	0.02
	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)
$\times$ $\text{Unrenovated}_{i,t-}$	0.03^{+}	0.04*	0.03^{+}	0.03^{+}	-0.00	-0.00	0.00	-0.00
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)
$\times$ $\ln(\text{Price Per Sq Ft})_{i,t-}$	-0.03	-0.02	-0.03^{+}	-0.03^{+}	-0.03	-0.03	-0.04	-0.05^{+}
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)
$\text{COVID Expirations}_{i,t,t+1}$	-0.28^{+}	-0.30^{+}	-0.23	-0.33*	-0.70*	-0.78**	-0.40	-0.90**
	(0.17)	(0.17)	(0.19)	(0.17)	(0.27)	(0.28)	(0.30)	(0.28)
$\times$ $\text{Work From Home}_{c(i)}$	-0.48*	-0.24	-0.10	-0.23	-1.34**	-0.65	-1.42*	-1.80**
	(0.24)	(0.28)	(0.33)	(0.40)	(0.40)	(0.43)	(0.59)	(0.61)
$\times$ $\text{Central Business District}_{z(i)}$	-0.10^{+}	-0.13*	-0.15*	-0.13*	-0.28**	-0.35**	-0.40**	-0.27**
	(0.06)	(0.06)	(0.06)	(0.06)	(0.11)	(0.10)	(0.11)	(0.10)
$\times$ $\text{Unrenovated}_{i,t-}$	-0.09*	-0.10*	-0.09*	-0.10*	-0.08	-0.10^{+}	-0.07	-0.07
	(0.04)	(0.04)	(0.04)	(0.04)	(0.06)	(0.06)	(0.07)	(0.06)
$\times$ $\ln(\text{Price Per Sq Ft})_{i,t-}$	0.07*	0.06^{+}	0.05	0.06*	0.18**	0.15**	0.16**	0.19**
	(0.03)	(0.03)	(0.03)	(0.03)	(0.05)	(0.05)	(0.06)	(0.05)
COVID_t								
$\times$ $\text{Property Vacancy}_{i,t-}$	-0.28**	-0.29**	-0.28**	-0.28**	-0.21**	-0.23**	-0.22**	-0.21**
	(0.03)	(0.03)	(0.03)	(0.03)	(0.07)	(0.07)	(0.07)	(0.07)
$\times$ $\text{Work From Home}_{c(i)}$	-0.12**	-0.11*	-0.15*	-0.22**	-0.29**	-0.23*	-0.35**	-0.38**
	(0.04)	(0.05)	(0.06)	(0.07)	(0.08)	(0.10)	(0.12)	(0.14)
$\times$ $\text{Central Business District}_{z(i)}$	-0.00	-0.01	-0.01	0.00	0.01	0.00	-0.00	0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)
$\times$ $\text{Unrenovated}_{i,t-}$	0.02**	0.02**	0.02**	0.02**	0.01	0.01	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
$\times$ $\ln(\text{Price Per Sq Ft})_{i,t-}$	-0.02**	-0.02**	-0.02**	-0.02**	-0.01	-0.02	-0.02	-0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
R^2_a	0.229	0.229	0.227	0.229	0.022	0.021	0.022	0.021
R^2_a(within)	0.226	0.226	0.225	0.227	0.016	0.015	0.016	0.016
Observations	30,913	30,370	29,191	30,290	30,684	30,142	28,974	30,062
Year FEs	✓	✓	✓	✓	✓	✓	✓	✓

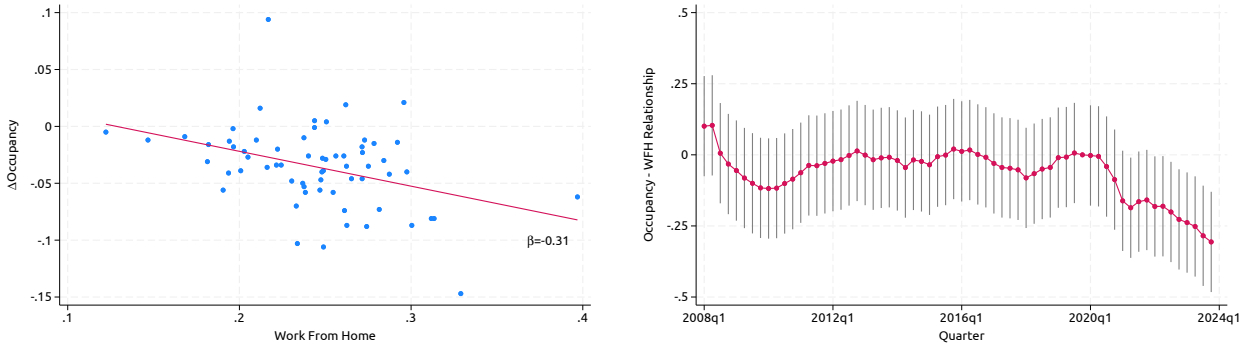
Notes: This table presents estimates along the lines of Columns (2) and (5) of Table 5, but using alternative measures of remote work intensity. Columns (1) and (5) repeat estimates based on Google Mobility Reports, columns (2) and (6) use ACS measures of remote work shares, columns (3) and (7) use the share of jobs in a city that can be done remotely as measured by Dingel and Neiman (2020), and columns (4) and (8) use the share of job postings in a city that allow for remote work from Hansen et al. (2023). Standard errors, in parentheses, are clustered by loan. $^{+}$,*,** indicate significance at 10%, 5%, and 1%, respectively.
Sources: Morningstar, CBRE, Opportunity Insights, data shared by above papers, and authors' calculations.

Figure B.1: Office Vacancy versus Availability Rates



Notes: This figure presents a scatter plot of availability rates by vacancy rate for CBRE office markets as of 2019:Q4 (blue) and 2023:Q4 (red).
Sources: CBRE.

Figure B.2: Relationship between Work from Home and Office Occupancy Rate



(a) Change in Office Occupancy during COVID

(b) Occupancy over Time

Notes: The left figure presents a scatter plot between the change in office occupancy (from 2019:Q4 to 2023:Q4) and the decline in time spent at workplaces during the pandemic for markets covered in the CBRE database. Work From Home$_m$ is the population weighted average across the counties in market m. The right chart presents estimates of $\{\beta_t\}$ and 95% confidence intervals from the specification:

$$\text{Occupancy}_{m,\tau} = \alpha_m + \alpha_t + \sum_{t \in T} \beta_t \text{Work From Home}_m \times \mathbb{1}(\tau = t),$$

representing how occupancy changes in markets with a high 2022 work-from-home share over time.
Sources: CBRE, Opportunity Insights, and authors' calculations.

C Bank Exposures to At-risk Office Markets: Additional Results

This section provides more detail on our analysis of lenders' exposure to at-risk office markets. First we discuss how we compile the data, then we present evidence that smaller banks' lower exposure reflects their tendency to make smaller loans, which tend to fund properties located in more suburban markets.

First, regarding the data, we use a combination of data from RCA and CoreLogic to obtain information on different lenders' portfolio characteristics. The primary data source is RCA, which uses a combination of public records and intelligence from industry contacts to compile information on transactions of CRE properties with a value of over $2.5 million dollars. Outstanding loans are not directly reported, but are imputed based on the absence of subsequent transactions and on origination and maturity dates. We impute a loan to be outstanding if (1) there are no later transactions associated with the property, or any such transactions involve the assumption of existing debt, and (2) its maturity date is after April 2023. If a maturity date is not reported, it is imputed by assuming the loan has a ten-year term, the most prevalent maturity in the sample.

In order to include mortgages below RCA's reporting threshold, we supplement the RCA data with information from CoreLogic on active voluntary liens against commercial properties. Unlike the other data sources we use, CoreLogic only provide prices for property purchases (i.e., appraised values for refinance deals are unavailable). Since we cannot compute price per square foot for refinances in CoreLogic, we only include mortgages for property purchases in the data, and then rescale aggregation weights for the other office loans under $2.5 million to make up for these omissions.[21]

We then match the lender names to institution names in National Information Center data (available from https://www.ffiec.gov/). We identify lenders as Large/Foreign banks (domestic banks with over $100 billion in assets and foreign banks, or their subsidiaries), small domestic banks (banks with under $100 billion in assets) or nonbanks.

Second, Table C.1 provides analysis examining why small banks differ in the risk factors identified as affecting leasing dynamics. The first three columns present estimates from a linear probability model predicting whether the lender is a small bank (assets under $100 billion) and the last three predict whether the lender is a community bank (with assets under $10 billion). Consistent with Figure 5, the results in columns 1 and 4 indicate that small and community banks disproportionately finance properties in less adversely affected areas (i.e., fewer loans in CBDs or high work from home counties) and lower tier properties (i.e., less recently renovated and lower valuation). Columns 2 and 5 add CBSA fixed effects to assess whether these differences reflect variation within or across cities. The most prominent change is that the relationship between PPSF and bank size falls to near zero, which suggests that small banks tend to operate more in markets with lower property values overall rather than lending against lower value properties within a city. Estimated

[21] While there is some amount of subjectivity in how the CoreLogic data is processed, the decisions have little bearing on our results because the vast majority of office lending, even for small banks, is accounted for by properties with values above the RCA reporting threshold.

effects of WFH weaken somewhat with the inclusion of core-based statistical area (CBSA) fixed effects, but the effects of being in a CBD strengthen. Namely, smaller banks do more lending in suburban markets, where demand appears to have fallen less than it has around city centers. Finally, columns 3 and 6 control for the size of the loan. The estimated differences in exposure to high-risk markets fall when we control for loan size, and the effects of property valuation switch signs, indicating that differences in exposure to these risk factors in large part reflect smaller banks making smaller loans.

Table C.1: Determinants of Bank Exposure to At-risk Office Loans

	Small Bank Indicator			Community Bank Indicator		
	(1)	(2)	(3)	(4)	(5)	(6)
Work From Home$_{c(i)}$	-1.04**	-0.71**	-0.50**	-0.86**	-0.44**	-0.27**
	(0.12)	(0.11)	(0.13)	(0.11)	(0.08)	(0.07)
Central Business District$_i$	-0.08**	-0.10**	-0.06**	-0.03*	-0.06**	-0.03**
	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)
ln(Price Per Sq Ft)$_{i,t}$	-0.02**	-0.00	0.03**	-0.03**	-0.00	0.02**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)
Unrenovated$_{i,t}$	0.08**	0.09**	0.06**	0.06**	0.06**	0.05**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
ln(Loan Amount)			-0.05**			-0.04**
			(0.00)			(0.00)
R^2_a	0.038	0.084	0.103	0.035	0.101	0.118
Observations	47890	47786	47786	47890	47786	47786
CBSA FEs		✓	✓		✓	✓

Notes: This table presents estimates of a linear probability model predicting whether a lender is a small bank (columns 1 through 3) or a community bank (columns 4 through 6) based on whether the property securing a loan is in a central business district, the decline in the time spent at workplaces, an indicator for whether the property has not been renovated since 2000 and the log price-per-square-foot of the property. Small (community) banks are defined by whether assets are under $100 billion ($10 billion). The second and third columns in each set add in CBSA fixed effects and a control for the size of the loan, respectively. The sample is of office loans reported in RCA that we impute to be outstanding outstanding as of 2023q1 and CoreLogic office purchase mortgages with a sale price under $2.5 million. $^{+}$,*,** indicate significance at 10%, 5%, and 1%, respectively.
Sources: RCA, CoreLogic, Opportunity Insights, and authors' calculations.