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COVID-19, Growth of Virtual Meeting Technology, and Sector REITs Performance

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Abstract

We examine how sector-specific characteristics moderate the performance of commercial real estate investment trusts (REITs) in response to two major shocks: the COVID-19 pandemic and the growth of virtual meeting technologies. Using panel data covering multiple REIT sectors from 2007 to 2023, we document substantial cross-sectional heterogeneity in return dynamics. Office REITs have experienced the most persistent underperformance following the onset of the pandemic, with the adoption of virtual technology further exacerbating these losses. In contrast, industrial and specialized REITs demonstrate relative resilience, reflecting lower dependence on in-person interaction. While REITs are generally characterized by moderate leverage, differences in asset use, tenant demand, and space substitutability appear more important in explaining variations in REIT returns. Our results underscore the limitations of broad real estate classifications and emphasize the importance of sector-level fundamentals in shaping investment outcomes during periods of structural change.

Key Takeaways

1. This study analyzes the performance of sector REITs before and after the COVID-19 outbreak, with a focus on the role of virtual meeting technology in shaping post-pandemic return dynamics.
2. Sector-level differences are central to REIT performance. Office REITs exhibit sustained underperformance relative to Industrial and Retail REITs in the post-COVID period, reflecting structural shifts in space utilization.
3. The growth of virtual communication platforms is negatively associated with the performance of Office REITs, while its impact on Industrial and Residential REITs appears attenuated, likely due to lower reliance on in-person interaction.
4. Traditional commercial real estate classifications obscure meaningful cross-sector variation. Usage-specific attributes such as tenant composition are key to understanding return heterogeneity across REITs.

1. Introduction

Exogenous shocks often reveal latent friction in asset markets, prompting firms and investors to reassess capital allocation and operational strategies. The COVID-19 pandemic, as an acute and unanticipated disruption, introduced widespread uncertainty and forced rapid adaptation across industries. In commercial real estate, the pandemic serves as a quasi-natural experiment, exposing the sector's structural reliance on physical occupancy. Social distancing mandates and space-use restrictions accelerate the adoption of contact-minimizing technologies such as virtual conferencing tools, many of which become embedded in routine business practices. These shifts recalibrate the value of office and industrial space, creating persistent challenges to conventional real estate models and investor expectations.

Simultaneously, the U.S. Federal Reserve implements expansive monetary interventions to stabilize financial markets and support economic activity. Beginning in early 2020, interest rates declined to historically low levels, providing temporary relief through reduced borrowing costs. This period of accommodation is followed by a rapid and sustained reversal. Between February 2022 and August 2024, the Federal Reserve initiated one of the most aggressive interest rate hiking cycles in modern history. These abrupt changes in the interest rate, combined with long-term shifts in space utilization and technology adoption, create a complex and uneven operating environment for real estate investors. Given the sector's inherent reliance on long-duration assets and debt-financed capital structures, real estate is particularly exposed to the dual pressures of rising interest rates and structural demand shifts.

Real Estate Investment Trusts (REITs), which own, operate, or finance income-producing properties, provide a useful empirical setting to assess how financial markets respond to structural shocks. Because REITs span multiple real estate sectors, including office, industrial, healthcare, retail, residential, hotel, diversified, and specialized spaces, they offer an opportunity to evaluate heterogeneous effects tied to economic function, tenant composition, and space dependency. These dynamics are particularly relevant given the prominence of REITs in institutional portfolios and their role as publicly traded proxies for broader real asset exposures.

This study investigates whether the adoption of virtual meeting technologies and the onset of COVID-19 reshape performance patterns in the REIT sector. In particular, we evaluate how space-intensive sectors adjust to technology-driven substitutions and whether these adjustments generate persistent valuation asymmetries. We hypothesize that REIT sectors with less dependence on physical interaction, such as industrial, specialized, and, to a lesser extent, diversified sectors, are more resilient to COVID-19 disruptions and the continued expansion of digital infrastructure. Conversely, REITs operating in sectors where in-person interaction is critical, such as office, residential, and hotel, may exhibit persistent underperformance. We further hypothesize that the spread of virtual meeting technologies, proxied by the annual revenue growth of Zoom, Microsoft, and Cisco, reinforces these trends by reducing the value of in-person business and social functions. These hypotheses enable us to evaluate how changes in user behavior and communication infrastructure impact sector-specific returns over time.

The empirical results show that both COVID-19 and technological growth create meaningful, asymmetric effects across REIT sectors. Office REITs exhibit consistent underperformance relative to other sectors, even after accounting for firm characteristics and time fixed effects. Residential REITs exhibit moderate declines, while industrial, retail, and specialized REITs demonstrate resilience or recovery, depending on their alignment with post-pandemic space usage patterns. Virtual technology growth is negatively associated with REIT returns in most sectors, though industrial and residential REITs show mitigating or even positive interaction effects. These findings reinforce the view that both pandemic shocks and digital substitution reshape the underlying economic functions of real estate. The results also highlight the importance of disaggregating REIT performance by sector, especially when structural shocks interact with long-term behavioral and macroeconomic forces.

This study contributes to the literature in three key ways. First, it provides a longer-horizon, REIT-level investigation of the COVID-19 pandemic's impact that moves beyond event studies and short-term market responses. Second, it introduces a novel measure of technology exposure by linking REIT outcomes to changes in revenue of virtual meeting platforms, capturing a behavioral shift that is not easily observed in traditional asset pricing variables. Third, the analysis incorporates detailed Fama-French asset pricing controls and sectoral interaction terms, enabling a precise examination of how the sectors in which REITs invest and technology diffusion jointly influence REITs' performance.

The remainder of the paper is organized as follows. Section 2 reviews related literature. Section 3 describes the data and estimation design. Section 4 presents the main results. Section 5 concludes with a discussion of implications and directions for future research.

2. Literature Review

This study draws on three related strands of literature: (i) the impact of the COVID-19 pandemic on real estate markets, (ii) the diffusion of virtual communication technologies and their implications for physical space utilization, and (iii) the relationship between interest rate movements and real estate asset performance.

2.1 COVID-19 pandemic, REITs overall, and sector REITs

The outbreak of COVID-19 introduced a rare shock to global financial markets, significantly altering the way physical space is utilized. It presented a natural experiment for researchers studying real estate investment trusts (REITs). Early studies emerged to document the immediate impact, with a particular focus on how different commercial real estate sectors responded to the sudden and sustained disruption brought about by the COVID-19 pandemic. Despite growing interest, findings across this literature remain varied and, in many respects, incomplete, as they are constrained by data availability, time horizons, and methodologies. Several studies focus on the U.S. market and REIT's short-term performance. Cai and Xu (2022), for example, examined a broad sample of 220 U.S. publicly traded REITs spanning October 2007 through March 2020. They found no statistically significant pandemic-related impact on office or residential REIT returns. Their sample period includes only the earliest phase of the COVID-19 crisis in the United States, concluding shortly after state-level lockdowns were implemented. The limited exposure to pandemic-era conditions may explain the absence of statistically significant effects.

Differing from Cai and Xu (2022), sector-level index studies documented more pronounced disruptions. Ling et al. (2020) observed substantial variation across property types during the first months of the pandemic, with price declines of 16%, 28%, 30%, and 50% in the industrial, office, residential, and retail sectors, respectively. Among these, only the industrial REIT index rebounded above its pre-crisis level following the initial wave of infections. Similarly, Akinsomi (2020) reported that lodging/resort, retail, and

office REITs experienced some of the steepest losses by April 2020, while data center REITs, supported by increased reliance on remote work and digital infrastructure, posted positive returns of 17.66%.

Cross-country studies provide further insight into the REIT sector's response to COVID-related shocks. Bossman, Umar, and Teplova (2022) examined REIT regimes across the Americas, Asia, and Europe, found that COVID-19 case counts exhibited stronger predictive power for REIT returns under bearish conditions than in more stable or bullish environments. Micheva (2020) introduced a COVID-specific risk factor into a standard risk-return framework and showed that retail firms were most sensitive to pandemic-related shocks, whereas healthcare stocks exhibited the lowest exposure. In the Hong Kong market, Xie and Milcheva (2020) employed a difference-in-differences approach and found that proximity to confirmed COVID-19 cases corresponded with short-term price declines in real estate firms, particularly those holding non-residential assets.

Broader international comparisons also highlight the dynamics of resilience. Zhang et al. (2023) expanded the scope of analysis to a longer historical and geographic canvas. Analyzing mortgage, equity, and hybrid REITs across five major economies (Australia, the United Kingdom, the United States, Japan, and Canada), over a 22-year period, they found that REITs demonstrated resilience during the pandemic and recovered more quickly than broader equity markets. Their analysis, based on the Fama-French five-factor model with adjustments for skewness and kurtosis, suggests that under adequate monetary and fiscal policy support, pandemic-related disruptions may have limited long-term effects. Zhang et al. (2023) aggregate REITs at the market level, without disaggregating by sector, which leaves open questions regarding heterogeneity across underlying property types.

Hui and Chan (2022) offered a regional comparison of daily equity returns across eight economies, four in Asia and four in Europe, ranked by COVID-19 case severity. Their findings indicate sharper equity declines in European markets, which they attribute to comparatively slower implementation of public health measures. Although informative, their analysis focuses exclusively on broad equity indices and does not extend to U.S. REITs or commercial real estate specifically.

A growing body of work has explored how external risk channels influence REIT performance. Demiralay and Kilincarslan (2022) examined the role of political risk and economic policy uncertainty across U.S. REIT sectors. Their results show that risk sensitivity varies substantially across sectors, suggesting that aggregate-level analyses may mask important differences. These findings underscore the importance of sector-specific perspectives, particularly during periods of heightened uncertainty, such as the pandemic.

Other studies have shifted attention to asset-level outcomes and real estate fundamentals. Wen et al. (2022) employed a fixed-effects model using transaction data from the Florida metropolitan area between 2018 and 2021, encompassing office, industrial, and retail properties. They found that the pandemic temporarily suppressed rent growth in office properties. However, Florida's relatively lenient public health restrictions and the study's focus on localized transaction data limit the generalizability of these findings to broader REIT performance.

Milcheva (2022) compared the behavior of U.S. and Asian real estate companies during the early phase of the pandemic. Her findings suggest that Asian firms exhibited greater caution, as reflected in negative beta values, which may have positioned them as hedges against broader market downturns. Yet the study does not evaluate long-term return dynamics across REIT sectors or link observed effects to structural changes in tenant demand.

Some research directly addresses sector-level distinctions in post-pandemic expectations. Ciarcia and Khindanova (2021) examined which REIT sectors appeared most promising for investors following the initial market shock. Using data through October 2020, they identified data centers, cell towers/infrastructure, warehouses, and healthcare REITs as sectors with strong investment potential. Their findings underscore the importance of macroeconomic context and investor sentiment in shaping post-crisis performance trajectories.

Underlying changes in space utilization may shift the performance of many sector REITs. The office sector experienced a notable increase in vacancies, rising from 12% to 17% between early 2022 and 2023, a level not seen since the 2008 financial crisis (Dobbs, 2023). Office attendance remained below 60%, with important implications for investors and local governments reliant on commercial tax revenues (Tognini & Chang, 2023). In cities such as San Francisco, where highly leveraged office acquisitions occurred prior to the pandemic, vacancy rates doubled the national average, accompanied by shorter lease terms and declining valuations (Shifflett, 2023; Gupta et al., 2022).

Unlike the office sector, the industrial sector experienced record-low vacancy rates below 3% in 2022, driven by increased demand for e-commerce and last-mile logistics (Young, 2023). The retail sector, although initially affected, has since rebounded. Recent assessments suggest that retail REITs may now act as inflation hedges, benefiting from rising property values (Arroyo & Nguyen, 2022).

Although no formal declaration marked the end of the pandemic, the policy environment shifted significantly on May 11, 2023, when the Biden administration ended the national public health emergency. Nonetheless, the effects of the pandemic continue to influence labor markets, space utilization, and investor behavior. Many firms have institutionalized remote or hybrid work arrangements, suggesting that demand for physical space may have entered a new structural phase.

Despite the breadth of existing research, a clear empirical gap remains. Much of the literature is limited to index-level analysis or short-term effects observed during the early stages of the pandemic (Ling et al., 2020; Akinsomi, 2020; Cai and Xu, 2022; Milcheva, 2022; Wen et al., 2022). To date, no study has comprehensively examined REIT performance at the sector level over a time horizon that includes the post-pandemic policy transition. This omission limits understanding of possible reversals, persistence, or structural realignments in REIT sector performance. The present study addresses this gap by analyzing individual REITs across major sectors using a time frame that captures both the acute shock and the longer-run adjustment phase of the pandemic. By incorporating REIT-level characteristics and standard asset pricing controls, the analysis offers new evidence on the extent to which the pandemic's effects on real estate markets have been either transitory or structural in nature.

2.2 Virtual meeting technologies, REITs overall, and sector REITs

The COVID-19 pandemic accelerated the adoption of virtual meeting technologies and introduced the possibility of lasting changes in how firms utilize physical space. As public health measures restricted mobility and in-person interaction, organizations rapidly shifted toward remote work and online conferencing. These adjustments altered the demand for commercial real estate, particularly in sectors where occupancy and face-to-face engagement are central to value. The broader transition toward virtual communication, therefore, raises important questions regarding the long-term implications for real estate investment trusts (REITs), especially those operating in space-intensive property types.

Much of the existing literature on technology and real estate focuses on innovations that improve service delivery, brokerage efficiency, and building operations, including smart building systems, green technologies, and tools designed to enhance service quality or reduce transaction frictions (Giorgio 2000; Crowston and Wigand 1999; Saiz 2020; Oluwatofunmi et al. 2021). Relatively little research examines whether virtual communication technologies function as economic substitutes for physical space. Conceptually, commercial real estate can be viewed as a market for productive space. Virtual interaction platforms, such as Zoom and Microsoft Teams, as well as various virtual reality meeting environments, provide alternatives that may reduce the marginal benefit of physical space for certain business uses. As firms adopt these tools more broadly, the relative value of physical space may decline.

The onset of nationwide lockdowns in March 2020 accelerated the substitution. Early restrictions in major states prompted a rapid shift toward remote work, and federal guidance discouraged travel and group gatherings. These conditions led organizations to institutionalize hybrid work arrangements and to rely on virtual platforms to coordinate operations. Papageorgiou and Chalkia (2024), for example, document a persistent reorganization of conferences and events, suggesting that virtual and hybrid formats have become structural complements to, or substitutes for, traditional in-person business practices.

The implications for REITs were heterogeneous across sectors. Some property types experienced immediate and substantial declines in demand due to reduced physical interaction, while others benefited from structural adjustments such as expanded e-commerce activity or altered residential mobility patterns. Industrial REITs, for instance, experienced record-low vacancy rates driven by demand for warehousing and last-mile logistics (Young 2023). Retail REITs, although affected initially, rebounded as consumption patterns normalized. Residential REITs were influenced by migration trends and new preferences for geographic flexibility. In contrast, office and hotel REITs faced persistent challenges as remote work and virtual meetings replaced traditional in-person activities.

Recent empirical work highlights the importance of the tenant business model in shaping these outcomes. Wang and Zhou (2023) show that properties leased to tenants with operations that rely heavily on face-to-face engagement experienced greater performance declines during the pandemic.

Their results suggest that exposure to social interaction intensity plays a meaningful role in determining the extent of pandemic-related losses. Although their analysis covers only the early pandemic period, the economic mechanisms they identify, including reliance on co-location and the necessity of interpersonal interaction, are likely to persist well beyond the crisis.

Despite this evidence, the long-run implications of virtual communication technologies for REIT performance remain insufficiently understood. The degree of technological substitution may vary across sectors, lease structures, and tenant types. Few studies examine how these factors contribute to persistent variation in returns. The present study extends the literature by evaluating REITs over a period that captures both the acute pandemic shock and the subsequent policy transition marked by the end of the public health emergency in May 2023. This longer horizon enables us to assess whether early disruptions dissipate or instead evolve into a structural, persistent impact on sector performance. The analysis offers an opportunity to examine how technology adoption influences REIT valuations across various property types.

2.3 Hypotheses on the relationship between COVID, virtual Meeting technologies, and sector REITs

Building on the literature and the sectoral dynamics described above, we develop hypotheses that quantify the effects of the COVID-19 pandemic and the expansion of virtual communication technologies on the performance of the sector REIT. Because REITs invest in property types whose economic functions differ markedly in their reliance on physical proximity, we expect substantial heterogeneity in both the magnitude and persistence of pandemic-related disruptions.

We hypothesize that REIT sectors with limited dependence on in-person interaction, such as industrial, retail, and certain specialized or diversified categories, exhibit greater resilience to the pandemic shock and to subsequent technological adoption.

Industrial REITs, for example, facilitate warehousing, distribution, and fulfillment activities that do not require face-to-face interaction. The long-run expansion of e-commerce and supply chain modernization is expected to support performance in this sector. Virtual meeting technologies offer limited direct substitutes for industrial space, indicating muted exposure to technology-driven demand shifts.

Healthcare REITs may similarly benefit from stable demand driven by demographic trends and essential service needs. However, the consequences of telemedicine adoption introduce ambiguity. Virtual medical services may reduce the need for certain types of facilities while complementing others, implying the possibility of offsetting effects rather than a unidirectional impact on valuations.

Hotel REITs were among the most affected during the pandemic, experiencing sharp declines in occupancy as travel restrictions and public health measures reduced mobility. Although a partial recovery is expected with the conclusion of the federal public health emergency in May 2023, virtual communication technologies may suppress the rebound in business travel by providing an alternative to

in-person meetings. The performance of hotel REITs, therefore, reflects a combination of cyclical recovery forces and structural substitution pressures.

Office REITs are expected to experience the most persistent effects. The widespread adoption of remote and hybrid work models directly reduces the structural demand for commercial office space. Virtual meeting technologies substitute for the very interactions that office environments were designed to support. We therefore anticipate sustained underperformance in this sector, reinforced by ongoing adjustments in tenant space requirements and employer preferences.

For residential REITs, the pandemic introduced significant reallocation across regions as workers gained geographic flexibility. While remote work increased the desirability of suburban and lower-density locations, the net effect on REITs concentrated in traditional urban markets may be negative. Migration patterns, household formation decisions, and changing preferences regarding density all influence rental demand in ways that vary considerably by geography.

In addition to these sector-level mechanisms, we hypothesize that the spread of virtual meeting technologies, proxied by the combined revenue growth of Zoom, Microsoft, and Cisco, reinforces performance divergence across REIT sectors. Because these technologies reduce the necessity of physical co-location for business and social functions, we expect negative associations between technology adoption and REIT performance in sectors that rely heavily on face-to-face interaction. This effect is likely to be strongest for office and hotel properties. Conversely, sectors whose space usage is complementary to digital infrastructure, such as the industrial sector, may exhibit neutral or weakly positive relationships.

These hypotheses collectively form the purpose of our empirical analysis. We examine how the pandemic and technology diffusion jointly shape sector-specific REIT returns over a period that includes both the initial disruption and the longer-run adjustment phase. The analysis provides insight into whether observed sectoral differences represent temporary dislocations or instead reflect enduring changes in the economic function of real estate.

2.4 Interest rate, the use of leverage on REITs' performance

To examine the relationships of interest, we need to control for other variables such as leverage and interest rate, which have a significant impact on REITs' performance. Capital structure plays a central role in shaping REIT performance, particularly in periods of financial stress or interest rate volatility. The literature on leverage and REIT returns has highlighted both firm-level characteristics and external constraints that influence borrowing behavior and valuation outcomes.

Ghosh et al. (2011) find that leverage and debt maturity operate as substitutes, with more profitable firms and those with greater growth opportunities tending to use less leverage. Alcock (2018) demonstrates that leverage has an asymmetric effect on REIT return dependence, particularly during

periods of crisis, where its negative influence on firm performance is most pronounced. Doan and Nguyen (2018) revisit the commonly observed negative relationship between leverage and returns, highlighting the role of board governance in moderating this association.

Several studies have reviewed broader evidence on the effects of capital structure on the REIT sector. Letdin et al. (2019) provide a comprehensive summary of the literature on financial leverage and REIT returns. More recent work by Steven (2022) shows that REITs with lower leverage earned higher abnormal returns around regulatory announcements related to classification restrictions, suggesting that investors may view lower leverage as a signal of financial flexibility or risk mitigation. Breuer, Nguyen, and Steininger (2023) report that the average leverage ratio for U.S. REITs is approximately 50%, roughly twice the level observed among non–real estate firms. This heightened reliance on debt financing underscores the sector's vulnerability to fluctuations in interest rates and broader credit market conditions.

Given the empirical evidence linking leverage to valuation and risk exposure in the REIT sector, this study includes controls for capital structure in its analysis. In particular, we account for variation in debt ratios across firms to isolate the effects of pandemic-era shocks and technological shifts on performance outcomes[1].

3. Methodology

3.1 Data

Our sample consists of U.S. equity REITs. The firm-level financial data were from Capital IQ, while the return data were sourced from the Center for Research in Security Prices (CRSP). We include REITs (firms) listed on the New York Stock Exchange (NYSE), Nasdaq Global Market (Nasdaq), Nasdaq Capital Market (NasdaqCM), or Nasdaq Global Select Market (NasdaqGS) between 2007 and 2023. Observations are restricted to REITs whose primary sector classification corresponds to healthcare, hotel, industrial, office, residential, diversified, retail, or specialized real estate.

Annual returns are calculated by compounding monthly total returns over the calendar year. All results are robust to an alternative specification based on the sum of monthly returns. Appendix 2 provides variable definitions. Appendix 3 describes the sector classification procedure and lists the REITs included in the sample.

3.2 Descriptive statistics

Table 1 reports summary statistics for the variables used in the analysis. The main dependent variable, compounded annual return, averages 6% across the sample. For comparison, the annual market return averages 12%, and the excess return over the risk-free rate averages 11%. The risk-free rate averages 1%. Among the Fama-French factors, the size factor (SMB) and investment factor (CMA) each have average

excess returns of –1%, while the value factor (HML) and the profitability factor (RMW) average –6% and 4%, respectively. These values are consistent with those commonly used in asset pricing applications employing annual data.

----------Insert Table 1 Here----------

To capture the impact of the COVID-19 pandemic, we define a dummy variable COVID, which equals one for all observations from 2020 onward (post-COVID period) and zero otherwise. Variable COVID has a mean of 0.34, indicating that thirty-four percent of REIT-year observations fall in the post-COVID period. The technology revenue variable, based on the annual revenue growth of Zoom, Microsoft, and Cisco, averages 8%. Sector distributions are as follows: specialized (18%), retail (18%), office (14%), residential (13%), hotel (11%), healthcare (10%), diversified (9%), and industrial (7%).

Control variables include firm size, leverage, and profitability. Firm size, proxied by the natural logarithm of total assets, averages 8.02. Leverage, measured as total liabilities divided by total assets, averages 56%. Return on assets (ROA), calculated as earnings before interest and taxes divided by total assets, averages 2%.

As a preliminary diagnostic, we examine pairwise correlations among the key variables used in the analysis. **Table 2** reports correlation coefficients to assess the strength and direction of associations between return measures, firm-level controls, sector indicators, and macroeconomic variables. Leverage is negatively correlated with annual returns (–0.04, significant at the 1% level) and is also negatively associated with return on assets (ROA) (–0.18, significant at the 1% level), suggesting that firms with higher debt burdens tend to exhibit weaker operating performance. ROA is positively related to REITs' annual returns.

----------Insert Table 2 Here----------

The technology revenue variable is negatively associated with REIT returns (correlation coefficient of -0.02, not statistically significant) and positively correlated with the COVID-19 indicator (correlation coefficient of 0.37, significant at 1% level). This pattern is consistent with the timing and effects of pandemic-driven shifts toward virtual communication tools. The risk-free rate exhibits a negative correlation with REIT returns, while the market return is positively correlated, consistent with a positive beta across the REIT sample.

3.3 The impact of COVID-19 and growth in tech on REITs-univariate analysis and sector comparison

We begin the analysis by examining how sector-level REIT returns evolved both before and after the COVID-19 breakout. This univariate approach provides a preliminary assessment of heterogeneity in

return patterns across sectors and periods, offering initial insight into whether structural shocks, such as the pandemic and technological change, are reflected in observed return outcomes.

Table 3 reports the results. Panel A presents annual returns, calculated as compounded monthly returns, for each REIT sector by year, along with the annual market return, risk-free rate, and growth in technology firm revenues. The table facilitates visual inspection of performance trends across time, including the 2008 financial crisis and the COVID-19 period. In 2008, the market return was –37%, and several REIT sectors experienced larger declines. Hotel REITs declined by 62%, diversified REITs by 39%, and both office and retail REITs by approximately 33%. By contrast, in 2020, when the pandemic reached the United States, hotel, office, and retail REITs again posted losses of 30%, 20%, and 22%, respectively, while industrial and specialized REITs gained 19%, and the overall market returned 24%. These patterns suggest substantial cross-sector differences in exposure to pandemic-related disruptions.

----------Insert Table 3 Here----------

Panel B formally compares average returns before and after 2019. T-tests indicate that diversified, hotel, office, and residential REITs experienced statistically significant declines in annual returns following the onset of the pandemic. In contrast, the overall market and risk-free rate show modest increases over the same period. The average return across all REIT sectors declines from 10% before 2019 to 3% after 2019, representing a 7 percentage point decline, which is statistically significant at the 1% level. Over the same window, technology revenue growth increases from 6% to 12%, highlighting the contemporaneous expansion of virtual technologies. The observed performance divergence suggests that certain REIT sectors have been more adversely affected by structural changes in space demand and capital market conditions. Industrial, retail, and specialized REITs exhibit comparatively stronger performance, consistent with greater adaptability or lower sensitivity to pandemic-era behavioral shifts.

3.4 The impact of COVID-19 and growth in tech on sector REITs: multivariate analysis, cross-sector comparison

To evaluate the role of COVID-19 and virtual communication technologies in shaping REIT sector performance, we estimate a series of ordinary least squares regressions using compounded annual return as the dependent variable. Table 4 presents the full specification. Columns (1) and (2) introduce baseline models incorporating COVID and Tech Revenue as key explanatory variables, both with and without REIT and year fixed effects. Columns (3) and (4) include interaction terms for the office sector to capture potential amplification effects in space-intensive property types. Columns (5) and (6) extend this framework to the full set of REIT sectors, allowing both pandemic-related shocks and technological shifts to vary by property type. All specifications include standard control variables, Fama-French asset pricing factors, and fixed effects where indicated.

Table 4 reports the results of estimating the effects of the COVID-19 pandemic and virtual meeting technologies on REIT sector performance. The dependent variable in all regressions is the compounded

annual return. Columns (1) through (6) include the full set of Fama-French factor sizes (SMB), value (HML), profitability (RMW), and investment (CMA), along with the risk-free rate and market excess return, to control for time-varying macroeconomic risk exposures consistent with standard asset pricing models.

----------Insert Table 4 Here----------

Column (1) presents the baseline regression with COVID and technology variables. Both coefficients are negative and statistically significant at the 1% level. The variable COVID's coefficient of −0.15 reflects the general performance decline for REITs in the post-2019 period. The coefficient on Tech Revenue (−0.49) suggests that broader adoption of virtual meeting platforms correlates with reduced REIT returns, supporting our expectation that digital substitution negatively affects real estate assets tied to physical space. Column (2) introduces REIT and year fixed effects. The magnitude of the COVID coefficient increases to −0.41, while the Tech Revenue coefficient becomes more negative (−2.11), reinforcing the association after controlling for unobserved heterogeneity. These results are consistent with our core hypothesis that COVID and technology shocks reduce REIT returns overall.

Columns (3) and (4) incorporate sectoral heterogeneity by interacting COVID and Tech Revenue with an indicator for office REITs. The COVID and Office interaction term is negative and significant (−0.09), indicating that office REITs underperformed other sectors during the post-pandemic period, consistent with our hypothesis that office properties are disproportionately affected by long-term shifts toward remote work and virtual collaboration. The interaction between Tech Revenue and Office is statistically insignificant, implying that while technology adoption is broadly detrimental to REIT performance, the marginal effect is not uniquely amplified in the office sector beyond what is already captured by the general COVID effect. Notably, the inclusion of fixed effects in Column (4) leaves these core inferences unchanged, suggesting robust sector-specific underperformance in office assets.

Columns (5) and (6) expand the interaction terms to all sector REITs, using office as the baseline. The results provide a detailed view of how each sector was affected. We use model (6) to illustrate the results, as it controls for both fund and year effects. Consistent with our hypotheses, the interaction between COVID and specialized REITs is positive and significant (0.21), supporting the idea that these REITs, many of which include data centers and infrastructure, benefit from digital trends. The positive and significant COVID × Industrial (0.10) and COVID × Retail (0.10) interactions further support our projections that sectors with lower dependence on in-person business activity are more resilient. By contrast, interactions for hotel, residential, and diversified REITs are small and insignificant, aligning with our hypothesis that these sectors either experience mixed effects or are more vulnerable to physical-space substitution.

Sector-level interactions with Tech Revenue reveal additional heterogeneity. While the main effect of Tech Revenue remains negative (−2.16) in model (6), positive interactions for industrial (0.98) and residential (0.80), respectively, indicate that the negative association is partially or fully offset in these sectors. For example, the net effect of technology on industrial REITs is less severe (−2.16 + 0.98),

consistent with increased demand for logistics infrastructure. The interaction between Tech Revenue and Hotel (Tech Rev × Hotel) has a negative coefficient (-0.74, significant at 10% level), suggesting that increased digitalization may substitute for in-person services like lodging.

Overall, the regression evidence aligns closely with the hypotheses developed earlier in the paper. REITs operating in sectors that rely on in-person occupancies, such as office and residential, have experienced persistent underperformance in the wake of COVID-19 and the widespread adoption of virtual meeting technologies. In contrast, industrial and specialized sectors show resilience, consistent with shifts in demand toward digital infrastructure and distributed logistics. These findings underscore the asymmetric impact of structural shocks across the REIT universe and reinforce our interpretation that both the pandemic and tech adoption have triggered a long-run reallocation of value in the commercial real estate landscape.

3.5 Robustness analysis comparison within the same sector

For robustness, we estimate sector-specific regressions using subsamples restricted to each REIT sector. This approach allows us to examine the within-sector variation in annual returns and assess how the COVID-19 pandemic and growth in virtual technology revenues are associated with return performance across different real estate categories. Each model includes sector-specific regressions with controls for firm-level variables (firm size, leverage, and profitability), macroeconomic factors (risk-free rate and market excess return), and the full set of Fama-French factors. Fund and year fixed effects are included in all specifications, and heteroskedasticity-robust standard errors are reported in parentheses.

Table 5 presents the results. The coefficient on the COVID dummy is negative for six of the eight REIT sectors: Office (−0.42), Residential (−0.70), Retail (−0.41), Specialized (−0.42), Diversified (−0.28), and Industrial (−0.59), with all six coefficients significant at conventional levels. This suggests that the pandemic period is associated with a decline in return performance for most sectors. Only Hotel and Healthcare REITs exhibit statistically insignificant COVID coefficients, suggesting either recovery from initial losses or that the losses incurred during the pandemic were not sustained in the longer analysis window.

The coefficient on Tech Revenue is significantly negative for Office (−2.37), Residential (−2.92), Retail (−3.33), and Specialized (−2.58) REITs, consistent with the hypothesis that virtual meeting technologies captured via revenue growth of Zoom, Microsoft, and Cisco have negative implications for space-dependent sectors. For Hotel, Diversified, Healthcare, and Industrial REITs, the coefficient on Tech Revenue is not statistically significant, suggesting a weaker or less direct linkage between technological growth and return performance in those segments.

These results are consistent with our main results and confirm that the effects of COVID-19 and digital substitution are not evenly distributed across REIT categories. Table 5 provides additional support for our main hypothesis that the pandemic and the development of virtual technology have differentially affected the real estate sector, depending on the reliance on physical space and the nature of tenant demand.

4. Conclusion

The COVID-19 pandemic introduced structural disruptions that permanently altered space utilization and continue to reshape performance across real estate sectors. As remote work, digital commerce, and virtual communication technologies become embedded in business and lifestyle practices, the demand profile for physical space shifts in lasting ways. Our study examines the impact of these changes on Real Estate Investment Trusts (REITs), utilizing an extended post-pandemic panel of REIT-level data across eight property sectors.

The results reveal substantial sector-level heterogeneity in post-COVID performance. Office REITs experience the most pronounced and persistent underperformance, consistent with declining demand for traditional workspace. Residential, retail, specialized, and industrial REITs also exhibit adverse effects, though the magnitude and duration vary. Hotel REITs show evidence of short-term disruption followed by recovery, while healthcare and industrial REITs prove relatively resilient.

Growth in virtual meeting technologies is negatively associated with performance in space-intensive sectors, particularly office and retail REITs. These findings highlight the substitutive relationship between digital infrastructure and physical occupancy. Importantly, the degree of technological exposure interacts with each sector's functional dependence on in-person interaction, emphasizing the need for disaggregated analysis.

Our findings highlight the importance of sector-specific fundamentals in determining asset resilience to structural shocks. The long-term viability of traditional office and retail formats appears increasingly uncertain, highlighting the importance of adaptive reuse strategies and reallocating capital to flexible, tech-compatible real estate models. The results provide valuable insights for investors, developers, and policymakers navigating the evolving relationship between real estate markets, macroeconomic forces, and technological transformation in the aftermath of the COVID-19 pandemic.

Declarations

Ethical Approval:

Not applicable

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Not applicable

Author Contribution

Authors contribute equally to the paper. Weishen initiated the idea, conducted empirical analyses, and developed the early draft. John restructured and rewrote the manuscript text.

Data Availability

Our sample consists of U.S. equity REITs. The firm-level financial data were from Capital IQ, while the return data were sourced from the Center for Research in Security Prices (CRSP).

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Footnotes

1. A summary of key studies reviewed in this section is provided in Appendix 1.

Tables

Tables 1 to 5 are available in the Supplementary Files section.

Supplementary Files

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