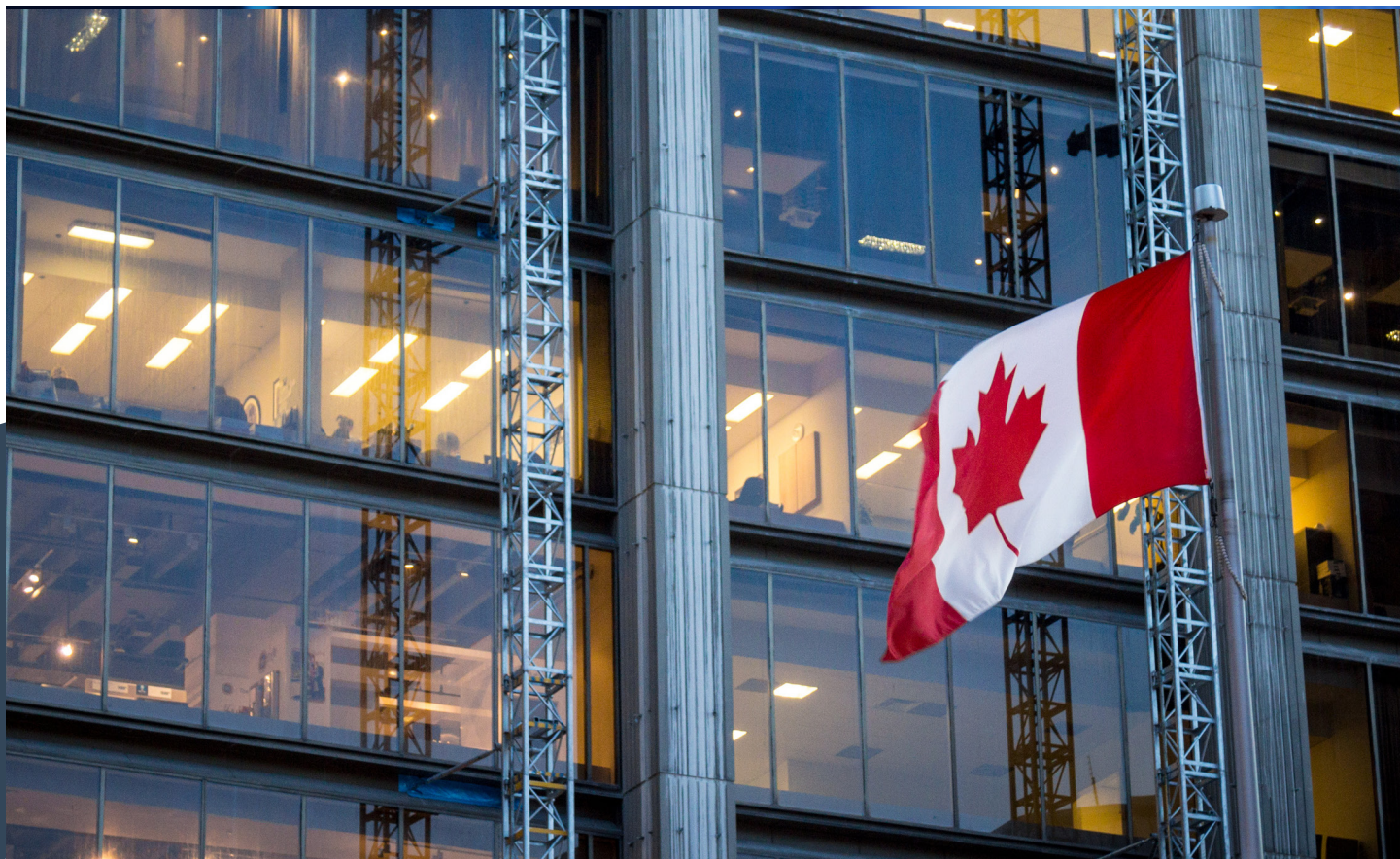


PANDEMIC MOBILITY AND RISK IMPACTS ON COMMERCIAL REAL ESTATE: EVIDENCE FROM CANADIAN REITS



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ABSTRACT:

Most countries implemented restrictions on mobility to prevent the spread of COVID-19. As a result, changes in human mobility have affected commercial real estate markets. This study reveals how local factors have been correlated with mobility reductions and evaluates the impact of changes in human mobility on commercial real estate cash flows in Canada. We first use a machine learning model, the least absolute shrinkage and selection operator (LASSO) to determine the best predictors of human mobility change. Then we analyze the impact of mobility reduction on the operational cash flows of Canadian Real Estate Investment Trusts (REITs). Our findings demonstrate that properties in locations with more significant mobility reductions were associated with lower real estate returns. We provide a tool that quantifies the exposure of REITs to such human mobility shocks.

KEYWORDS: Commercial real estate, REITs, mobility, pandemic risk

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1 Introduction

The stock price of REITs declined by 47% in March 2020. Statistics Canada states that there were more than three million jobs lost initially, while around one million jobs were added back to the labor force by the end of the second quarter of 2020. Following these immediate impacts, the financial markets are still interpreting how changes in our lifestyles brought about by the pandemic will have long-term impacts across various property types, and what risks will arise if new variants or pandemics occur in the future.

Real estate markets are central to our lifestyles, as we all live, work, and shop in buildings. COVID-19 has had a serious impact on our lifestyles and the real estate markets, accordingly. Uncertainty remains over the future of the market regarding office space, especially in downtown cores. We have yet to understand how working from home will affect the work environment and its impacts on commercial real estate needs. We have observed a surge in relocations to suburban areas. However, the long-term impacts on multi-family properties in downtown cores or single-family properties are still being studied. The retail market has begun adapting to new consumer behavior by largely expanding the concept of online shopping. The COVID-19 crisis has introduced new issues that will take time to figure out. For instance, Amazon reported a record profit of \$5 billion by the end of July 2020, indicating potential long-term impacts on brick-and-mortar retail stores and the need to adapt to changes in consumer behaviour.

In this project, our aim is to shed light on how COVID-19 has affected commercial real estate markets using Canadian REITs and to understand how commercial real estate may be affected by the changes COVID-19 has brought about as well as the potential impact of future pandemics. Instead of focusing on the number of cases or death counts, we first evaluated how the pandemic has affected human mobility. The spread of COVID-19 variants significantly decreased human mobility due to health issues, voluntary self-isolation, and government restrictions. In the end, decreased foot-traffic due to mobility reductions affected commercial real estate markets significantly.

For this purpose, we used mobility change data provided by Google (relative to the end of 2019) and evaluated how local characteristics such as demographics, income, or local points of interest (obtained from OpenStreetMap (OSM) and Canadian census data) correlated with mobility reductions during the pandemic. Our machine learning model-based analyses showed that locations with high population density, fewer residents with bachelor-degrees, lower median household incomes, a higher unemployment rate, a higher percentage of people working from home (based on 2006 census data) and a larger share of single-person households experienced larger mobility reductions due to the pandemic across Canada.

Overall, this type of analysis helps us characterize pandemic mobility reductions and create a location-based risk measure for pandemic mobility impacts. This is important in various ways. Our pandemic risk measure disconnects financial outcomes with the observed mobility reductions in the current pandemic. By characterizing the role of local factors in relation to pandemic mobility reductions, moving our risk measure forward can help measure the risk of a specific location without observing mobility reductions.

We then turn our attention to Canadian REIT data. In our dataset, we can observe the location, property type, acquisition and disposition date, and square footage of each property in a REIT portfolio. Using the location of each property, we merge REIT property portfolio data with mobility data and our local datasets containing local characteristics. This way, we obtain local characteristics and mobility reductions for each property in a REIT portfolio. We then calculate a quarterly weighted average mobility reduction measure for each REIT weighting by the square footage of each property in the total REIT portfolio. We follow the same procedure for local characteristics and our pandemic risk measure. These weighted measures capture the exposure of REITs to pandemic mobility reductions and risk measure.

To measure REIT performance and cash flows, we use REIT-level total rental revenue, operating expense, net operating income (NOI), general and administrative (G&A) expenses, interest expense, and funds from operations (FFO). We tested how weighted mobility reduction, the pandemic risk

measure, and local factors affected REIT performance following Devine and Yönder (2021). We also calculated weighted mobility changes for each property type to decompose pandemic impacts on different property types. We also calculated market-adjusted REIT returns and tested how they are affected by mobility reductions and our pandemic risk measure to understand how expectations are reshaped by the investors similar to Ling, Wang, and Zhou (2020).

Our findings on operational cash flows indicate that the variation in the exposure to pandemic mobility declines and risk can predict real estate returns. We find that an increase in the exposure to pandemic mobility reduction and risk lowers cash flows from real estate measured by NOI and FFO. The findings hold for both 2020 and 2021, separately and for all property types. While we find that investors price the impact of the exposure to mobility reductions and risk in 2020, they do not price in 2021 probably due to liquidity expansion.

While the pandemic research on commercial real estate lacks evidence on mobility effects, there are studies relating the pandemic effects to commercial real estate. Ling, Wang, and Zhou (2020) conducted a timely study on the market reaction of REIT investors in the US to COVID-19 exposure. The authors showed that REITs with larger exposure to COVID-19 reflect higher declines in the cumulative abnormal returns. According to the findings of the authors, retail and residential REITs are predominantly affected. There are also negative impacts on the office and hospitality REITs. On the other hand, industrial and specialty REITs did not experience negative returns due to COVID-19 exposure. In some specifications, the authors significantly find a positive impact on technology REITs.

In another study, Milcheva (2021) evaluated the impact of COVID-19 exposure on the stock returns of REITs internationally. Similarly, the author also finds that there is a larger negative impact if the exposure to COVID-19 increases. The negative impact exacerbates if a REIT has a larger debt-to-asset ratio. However, both studies were conducted during the initial shock but do not cover the recovery period in the stock markets following the initial impact. Additionally, these studies do not provide evidence on the property cash flow effects as these studies evaluate the first

outlook of the impact of COVID-19. Overall, our study is the first to (1) reveal how local factors correlate with mobility reductions and to (2) evaluate the impact of pandemic mobility reductions on commercial real estate cash flows. We also create a pandemic risk measure to analyze future pandemic impacts.

2 Pandemic Mobility Reductions and Local Exposure

To understand mobility impacts of the pandemic, we collected Google mobility data. Google uses the information collected from Google applications and creates human mobility data on a daily basis for Canadian census divisions and provinces. Specifically, Google tracks mobility in groceries, pharmacies, parks, transit stations, retail and recreation areas, residential properties, and workplaces. It reports changes in mobility relative to a baseline value obtained from the information collected before the start of the pandemic. In the end, the data represents a percentage change in mobility relative to a pre-pandemic baseline. Following Ilin et al. (2021), we focus on three categories: transit stations, retail and recreation areas, and workplaces. Mobility in parks is among the other categories we exclude, as it has complicated implications. Mobility in residential properties is highly correlated with mobility in retail and recreation and workplaces (Chernozhukov, Kasahara, and Schrimpf, 2021). Mobility in groceries is also complicated as it is an essential need.

In our final sample, we calculated the mean of these three categories by census divisions by quarters.¹ Figure 1 presents the map of Canada by census divisions for each quarter since the beginning of the pandemic. Overall, in all quarters, we observed mobility declines across Canada. In the second quarter of 2020, we observed the largest mobility declines. The second largest decline in mobility is in the second quarter of 2021.

¹If mobility by census division is not available, we use provincial values.

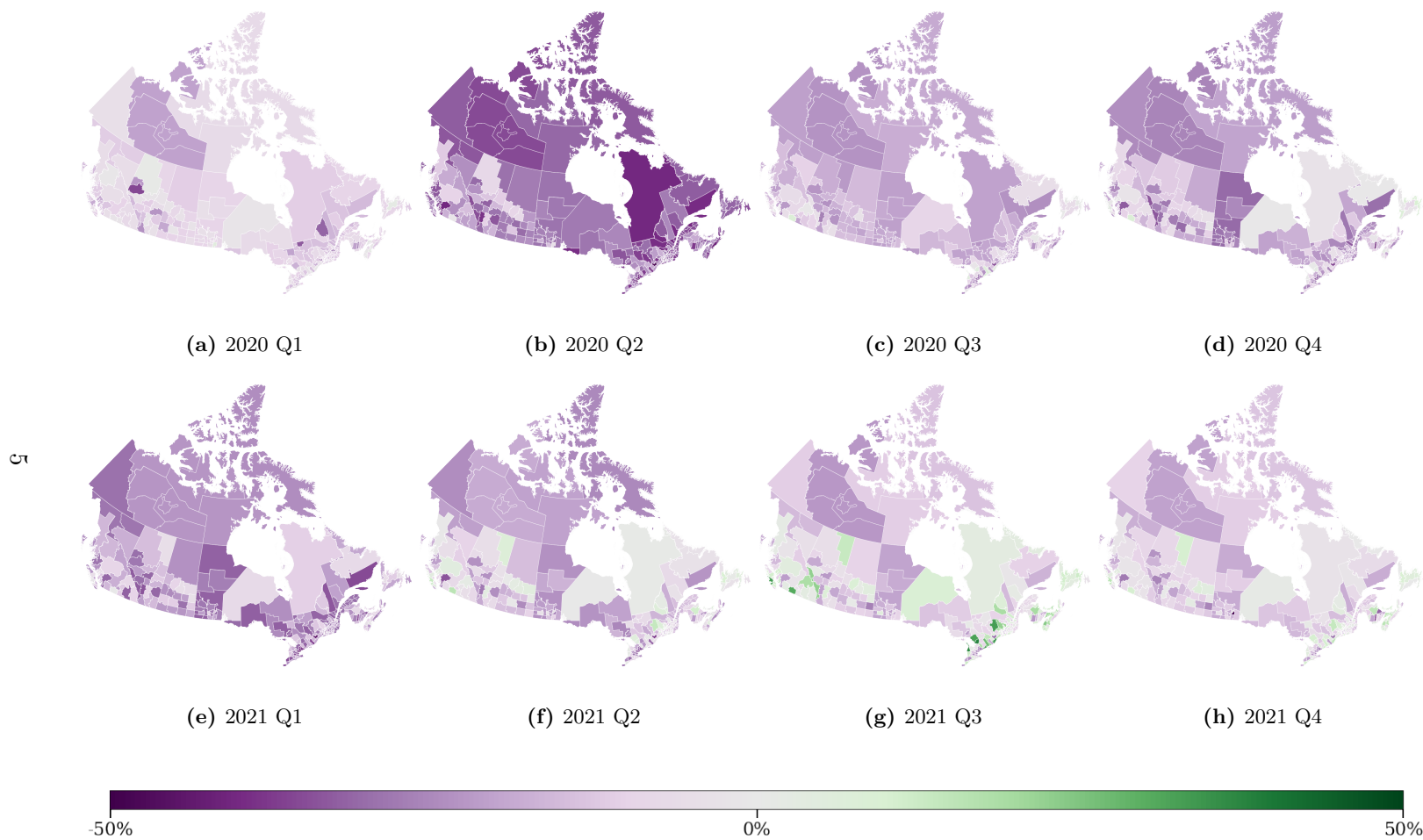


Figure 1. Mobility Reductions by the Quarters of 2020 and 2021

Importantly, we also observed cross-sectional variation in mobility changes in all quarters across Canada. This indicates that local characteristics across census divisions plays an important role in pandemic mobility reductions. Interestingly, we observed mobility increases relative to 2019 in some census divisions before the Omicron wave signalling the post-pandemic era.

We then turn our attention to evaluating local factors determining the cross-sectional variation across census divisions. For this purpose, we collected point of interest (POI) data from OSM and census data by census divisions from Statistics Canada. OSM is an open-source project where any individual can enter POI data, including restaurants, hospitals, office or retail buildings, parks, etc. The data are publicly available. We collect OSM data quarterly and count the number of various amenities for each census division for each quarter. We created variables based on the counts of amenities and buildings such as restaurants, shopping malls, childcare facilities, parking areas, office buildings, schools, etc. We also collected 2016 census data such as average income of households, percentage of residents by age, unemployment, education and working remotely from home, etc. for each census division.²

We merged our quarterly mobility data with 46 different local characteristics for each quarter and applied a machine learning approach to determine the best predictors of mobility. Specifically, we used the LASSO model to estimate the best predictors. The model forces coefficients to equate to zero if they are not strong predictors. This way, the model eliminates those predictors and determines the best predictors whose coefficients remain non-zero after multiple iterations. The results are presented in Table 1 (see page 8). The table reflects one-standard-deviation impact and ranks from negative to positive coefficients with magnitudes.

In the table, we present our results using all eight quarters in 2020 and 2021 and quarterly results during the waves of the pandemic in 2020 Q2, 2020 Q4, and 2021 Q1. Our findings on all variables presented in column (1) demonstrate that there are larger mobility reductions in the locations with more dense populations, lower household income, higher unemployment rate,

²The complete list of variables that we cover is presented in the Appendix.

less interprovincial migrants, less residents with a bachelor’s degree, more worked at home, and single-person households. We also find that higher median government transfers are associated with less mobility reductions.

We also find some points of interests are important drivers of mobility reductions like residential houses, commercial, school buildings, such locations experience larger mobility reductions. A larger number of pharmacies, farms, retail such as malls, department and clothing stores, in addition to apartment buildings, and industrial buildings are all associated with less mobility declines. More charging or fuel stations also lowers mobility declines.

In general, the best predictors are similar across different waves of the pandemic for (e.g., childcare, kindergarten and hotels during specific waves). The wave in 2020 Q2 seems to have some divergent predictors compared to other waves.

Based on the findings in Table 1, we developed a benchmark measure based on local predictors of mobility reductions. This benchmark measure does not use any realized mobility data but instead gives a score based on local characteristics that predict mobility. This enables us to obtain a dynamic risk measure for future waves and pandemics. Figure 2 compares average mobility changes in 2020 and 2021 Panel (a) to the benchmark scores during this period Panel (b). In general, the benchmark score captures mobility reductions especially in metropolitan areas and reflects a cross-sectional variation.

Table 1. Best Predictors of Mobility Change Selected by the LASSO Model

VARIABLES	Mobility Change				
	Std. Dev.	(1)	(2)	(3)	(4)
		All Quarters	2020 Q2 Wave	2020 Q4 Wave	2021 Q1 Wave
Normalized Coefficients (by Std. Dev.)					
Panel A - Point of Interest (thousand counts)					
School (Building)	0.113	-6.814	-9.631	-7.425	-5.782
Parking (Amenity)	1.318	-4.773	-6.570	-3.013	-4.206
Bank (Amenity)	0.060	-1.472	-1.465	-1.370	-0.268
House (Building)	7.258	-1.324	-1.800	-1.148	-0.655
Mall (Shop)	0.009	-0.792	-0.533	-0.607	
Commercial (Building)	0.381	-0.437	-0.146	0.227	-0.233
Residential (Building)	2.891	-0.304	-0.023	-0.154	-0.275
Clothes (Shop)	0.102	0.541	0.204	3.788	1.692
Apartments (Building)	0.622	0.609	0.381	0.405	0.548
Farm (Building)	0.022	0.637	0.640	0.605	0.350
Retail (Building)	0.413	0.714	2.317		1.336
Department (Shop)	0.082	1.062		1.065	
Charging (Amenity)	0.008	1.807	1.524	1.169	1.378
Pharmacy (Amenity)	0.048	2.872	3.832		
Industrial (Building)	0.417	3.626	3.810	2.519	2.941
Fuel (Amenity)	0.053	4.512	8.191	5.372	3.176
Childcare (Amenity)	0.009		-1.591		
Kindergarten (Building)	0.007			-0.417	
Hotel (Building)	0.009			-0.204	-0.179
University (Amenity)	0.004				0.150
Panel B - Census Variables					
Population density per km2 (1,000)	0.393	-1.502	0.316	-0.386	-1.007
1 person (%)	2.940	-1.014	-0.920	-2.266	-0.749
Walked (%)	2.348	-0.454	-1.775	-0.607	-0.438
Bachelor's degree (%)	2.600	-0.447	-0.787	-1.165	-1.701
Worked at home (%)	2.383	-0.146		-0.417	-0.503
Unemployment rate	5.287	-0.131	-0.824		-0.753
Median household income (\$1,000)	16.260	0.279	-0.645	1.180	1.356
Interprovincial migrants (%)	2.594	0.793	0.575	1.257	1.591
Median govt. transfers (\$1,000)	2.283	2.791	-1.462	4.747	2.278
Public transit (%)	2.298		-1.407	-0.732	-0.335
Renter (%)	3.654			0.644	
Couples without children (%)	2.854			0.107	

The table presents the results of the LASSO model to determine the best predictors of mobility changes during the period between 2020 Q1 and 2021 Q4. The table reports the best predictors and ranks them based on one-standard-deviation impact. Green cells represent statistically significant increase and purple cells represent statistically significant decline on mobility changes. The table excludes local characteristics that are eliminated by the LASSO model.

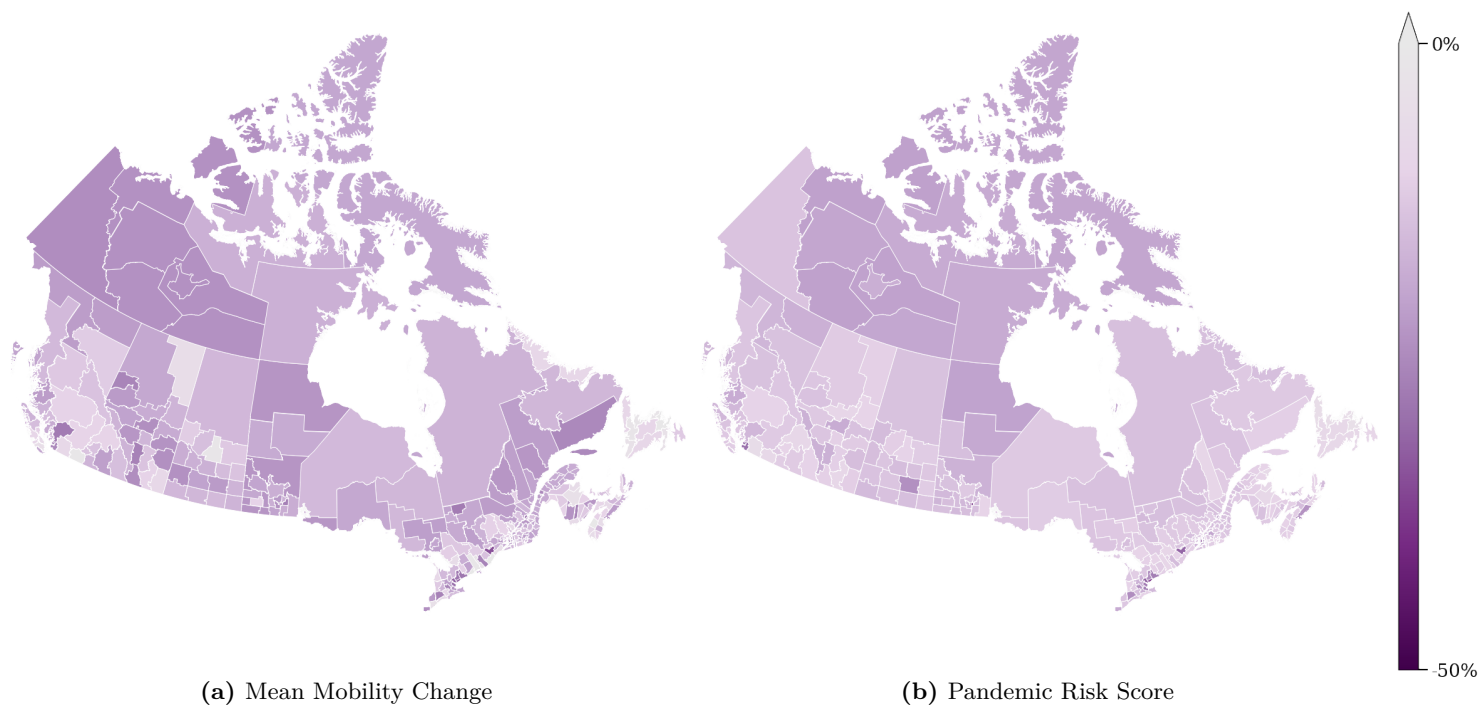


Figure 2. Mean Mobility and Pandemic Risk Scores

3 REIT Properties and Exposure of REITs to Mobility Reductions

After characterizing mobility reductions during the pandemic, we turn our attention to REIT data. We obtained REIT property data from S&P Global Market Intelligence. We have data on each REIT asset and possess information on property location, acquisition and disposition dates, property type, and asset size to determine property holdings of each REIT. We also cross-checked S&P Global Market Intelligence with company reports obtained from the System for Electronic Document Analysis (SEDAR). Using the information based on acquisition and disposition dates, we determined the quarterly property portfolios of REITs.

Figure 3 presents the dispersion of REIT properties across Canada. Panel (a) of the figure shows that REIT properties are dispersed across Canada, mainly with a larger concentration in metropolitan areas. In Panel (b), we zoom in on the Greater Vancouver, Montreal, and Toronto metropolitan areas. Within these locations, there is also some spread of properties across census subdivisions.

Using the information based on REIT property locations on a quarterly basis, we calculated total square footage of a REIT property portfolio for each census division and for all of Canada for each quarter. Then, following Ling, Wang, and Zhou (2020) and Devine and Yönder (2021), we calculated the following weighted average mobility and pandemic risk score measures by each REIT for each quarter in Equations (1) and (2):

$$Mobility\ Change_{i,t} = \frac{\sum_j LocalMobility_{i,j,t} * Sqft_{i,j,t}}{Sqft_{i,t}} \quad (1)$$

$$Pandemic\ Risk\ Score_{i,t} = \frac{\sum_j LocalPandemicRiskScore_{i,j,t} * Sqft_{i,j,t}}{Sqft_{i,t}} \quad (2)$$

where i denotes REIT i , j denotes census division j , and t denotes quarter t . Although the county-level mobility data is available at daily frequency, we obtain a quarterly measure for REITs.

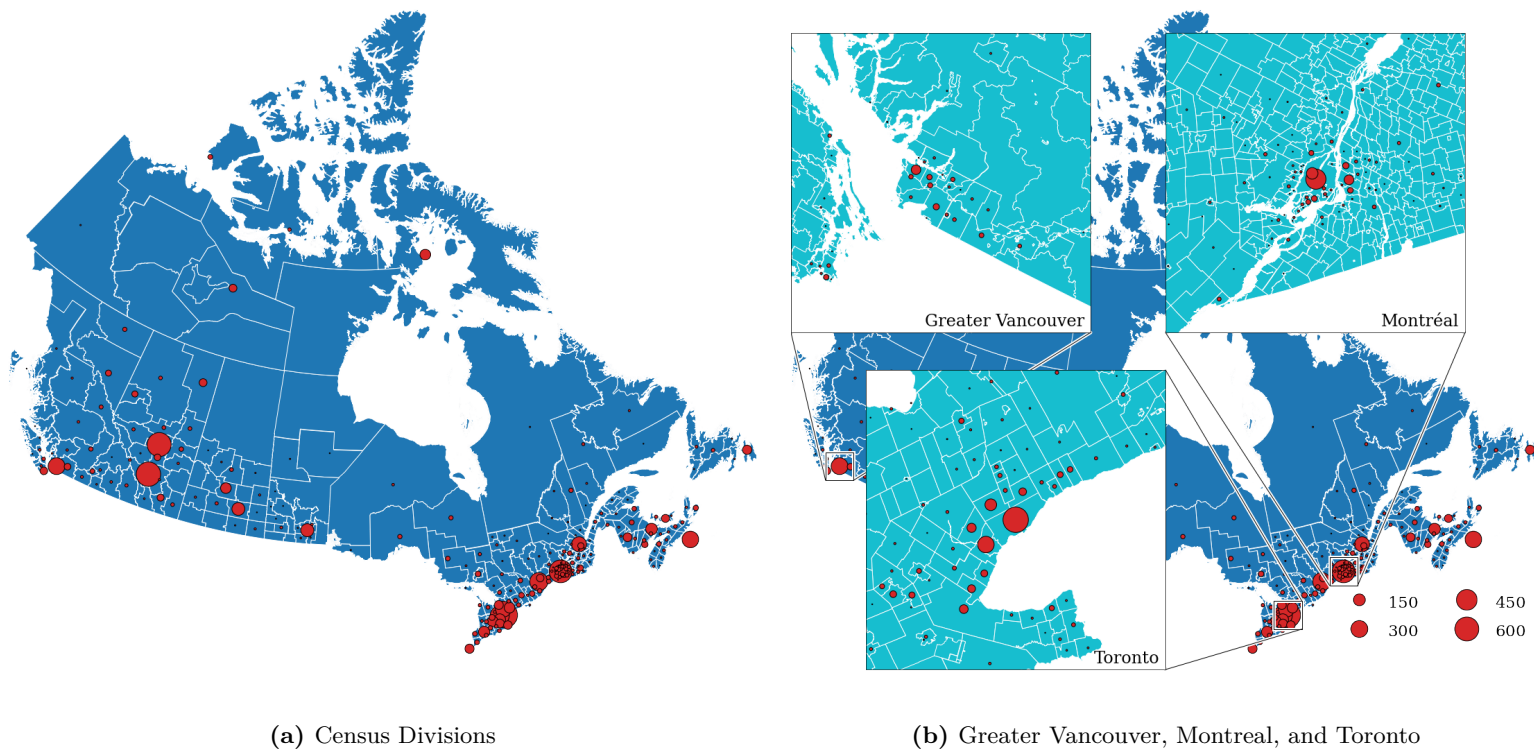


Figure 3. REIT Properties across Canada by 2021 Q3

4 Operational Effects of the Exposure to Pandemic Risk and Market Reaction

4.1 Financial Data and Methodology

REIT quarterly financials and stock prices were obtained from S&P Global Market Intelligence. Table 2 reports the descriptive statistics of REIT-level data. In our final sample, we have 620 REIT year-quarters.

Table 2. Descriptive Statistics

Variable	N	Mean	SD
Total assets (\$ billion)	620	4.53	4.35
Debt-to-Assets (%)	620	55.54	21.41
Cash-to-Assets (%)	620	1.45	2.63
Market-to-Book	620	1.02	0.22
Rental Revenue-to-Assets (%)	620	3.09	4.65
Rental Operating Expense-to-Assets (%)	620	1.71	4.30
NOI-to-Assets (%)	620	1.38	0.50
Interest Expense-to-Assets (%)	620	0.56	0.38
G&A Expense-to-Assets (%)	620	0.15	0.21
FFO-to-Assets (%)	620	0.77	0.55

The table presents the descriptive statistics by REIT-year-quarters for the period between 2018 Q1 and 2021 Q4.

The mean of total assets of REITs is \$4.53 million. Debt-to-asset ratio is on average 56%. Cash holdings as a percentage of total assets account for around 1.5%. REITs rental revenue is 3.1% while rental operating expense is 1.7% of total assets, on average. Accordingly, NOI to total assets is around 1.4%. The mean of FFO is 0.8% of total assets.

We relate quarterly exposure measures of mobility and pandemic risk score to REIT cash flows. Equation (3) presents our regression model for cash flow analysis

$$y_{i,t} = \beta_0 + \beta_1 Mobility_{i,t} + \beta_2 x_{i,t-1} + \gamma_t + \delta_i + u_{i,t} \quad (3)$$

where the dependent variable $y_{i,t}$ is rental revenue, rental operating expense, NOI, G&A expense, interest expense and FFO, all of which are normalized by total assets. We also calculated adjusted

market return for each quarter by subtracting quarterly market return from each quarterly individual REIT stock return and use it as a dependent variable. Our variables of interest are our mobility measures. We used both mobility exposure (weighted mobility measure) and pandemic risk exposure (weighted pandemic risk score) that we created in alternative regressions. Our control variables included the natural logarithm of total assets, debt-to-assets ratio, market-to-book ratio, and cash-to-assets ratio. All regressions include REIT property type and year-quarter fixed effects and heteroskedasticity robust standard errors are clustered by firm.

In our regression analysis, we also evaluated the REIT exposure to mobility and pandemic risk score, differentiating across property types. The analysis on the adjusted market return reflects how the expectations are set by investors considering future pandemic risks.

4.2 Operational Effects

We first evaluated the impact of mobility reduction and pandemic risk exposure on operational cash flows. Our analysis covers pandemic years, 2020 and 2021 as well as 2018 and 2019 to have a difference-in-difference like model to capture the relative impact of the pandemic as opposed to non-pandemic years. We presented our findings in Table 3 (see page 14). We show our findings on mobility exposure in Panel (a) and on pandemic risk exposure (based on our machine learning framework) in Panel (b). We also present the impacts of pandemic risk measures for 2020 and 2021, separately. All dependent variables in the table are normalized by total assets.

Our findings demonstrate that mobility change exposure of REITs negatively impacts NOI and FFO in both years. A one-percentage point decline in mobility change lowers NOI-to-Assets by 1.4-2.1% and FFO-to-Assets by 2.1-2.9% at 1%-5% significance level. These findings indicate that the geographic variation in mobility matters for commercial real estate returns. Firms with more exposure to locations with higher mobility reductions are impacted more negatively because of the pandemic.

Table 3. Operational Effects of the Pandemic Mobility Changes and Risk Score

Variables	(1) Rental Revenue	(2) Rental Operating Expense	(3) NOI	(4) G&A Expense	(5) Interest Expense	(6) FFO
Panel A - Mobility Change						
Mobility Change \times (Y=2020)	0.042 (0.042)	0.020 (0.044)	0.021** (0.009)	-0.001 (0.004)	0.003 (0.003)	0.021** (0.009)
Mobility Change \times (Y=2021)	0.024 (0.034)	0.009 (0.033)	0.014*** (0.005)	-0.002 (0.002)	-0.003 (0.008)	0.029** (0.014)
ln(Total Assets)	-0.289 (0.250)	-0.229 (0.229)	-0.055* (0.029)	-0.024 (0.015)	-0.011 (0.009)	-0.008 (0.039)
Debt-to-Assets	-0.037 (0.024)	-0.033 (0.023)	-0.004* (0.002)	-0.002** (0.001)	0.016*** (0.001)	-0.018*** (0.004)
Cash-to-Assets	0.865** (0.404)	0.805** (0.376)	0.061** (0.029)	0.040*** (0.014)	0.006 (0.004)	0.015 (0.017)
Market-to-Book	7.008* (3.680)	6.685* (3.587)	0.329 (0.219)	0.224* (0.122)	-0.073 (0.078)	-0.240 (0.322)
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Property Type FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	620	620	620	620	620	620
R-Squared	0.659	0.640	0.625	0.630	0.803	0.663
Panel B - Pandemic Risk Score						
Pandemic Risk Score \times (Y=2020)	0.008 (0.032)	-0.005 (0.031)	0.013*** (0.005)	-0.004 (0.004)	0.004 (0.005)	0.015* (0.008)
Pandemic Risk Score \times (Y=2021)	0.036 (0.046)	0.015 (0.044)	0.020*** (0.006)	-0.003 (0.003)	-0.001 (0.008)	0.039** (0.015)
ln(Total Assets)	-0.295 (0.252)	-0.234 (0.230)	-0.056* (0.030)	-0.025* (0.015)	-0.011 (0.009)	-0.009 (0.038)
Debt-to-Assets	-0.037 (0.024)	-0.032 (0.023)	-0.004* (0.002)	-0.002** (0.001)	0.016*** (0.001)	-0.018*** (0.004)
Cash-to-Assets	0.870** (0.404)	0.807** (0.375)	0.064** (0.030)	0.040*** (0.014)	0.006 (0.004)	0.018 (0.018)
Market-to-Book	7.071* (3.623)	6.711* (3.536)	0.364* (0.212)	0.224* (0.122)	-0.085 (0.079)	-0.172 (0.301)
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Property Type FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	620	620	620	620	620	620
R-Squared	0.659	0.640	0.622	0.633	0.803	0.662

The table presents the regression results for operational cash flows for the period between 2018 Q1 and 2021 Q4. All dependent variables are normalized by total assets. Firm clustered robust standard errors are shown in parentheses. Statistical significance is denoted by: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Since we also find significant impacts on FFO, that is available cash flow to shareholders, the decline in NOI is also reflected to shareholders. Another important note is that although there have been government support programs for workers and the provision of rental relief, commercial real estate rental income is still negatively affected by geographic mobility reduction.

We do not find any significant impact on rental operating expense, G&A expense, and interest expense. Highly leveraged firms, with less available cash, generate significantly lower cash flows (statistically) during the pandemic years.

In Panel (b) of Table 3, we present the impact of pandemic risk exposure based on our machine learning model (previous section). We find similar results when we use the pandemic risk score. If the pandemic risk score decreases by one percentage point, NOI-to-Assets declines by 1.3%-2% at 1% significance level and similarly, FFO-to-Assets decreases by 1.5%-3.9%. These findings indicate that a firm's exposure to pandemic risk measured by the characteristics of the locations that they operate in can predict how their cash flows are impacted. This is intuitive because such a pandemic risk benchmark can be used to measure the exposure of firms to future pandemic risks based on local characteristics. Since we use local characteristics to measure pandemic risk, the benchmark scores can be updated in the future to capture pandemic risk exposure at any point in time.

4.3 Operational Effects by Property Type

In this section, we evaluate whether there are any differences in the impact of pandemic mobility exposure and risk across property types. For each property type, we calculated the exposure of firms to local mobility changes and pandemic risk based on the assets of that property type. This limits the samples to a lower number of observations when a firm owns at least one asset of the specified property type. Results are presented in Tables 4 (see page 18) and 5 (see page 19).

In Table 4, we present the results for the mobility change impacts. We found that if a REIT is exposed to larger mobility declines, NOI declines significantly (statistically) for all property types in 2020 and 2021 except for industrial properties in 2020. This is a reasonable finding as

industrial properties performed well in the early quarters of the pandemic as online shopping increased significantly. We also found significant decline in rental revenue and operating expenses when there is more exposure to mobility declines for office, retail, and residential properties. The impact on FFO also generally holds for all property types. Interestingly, our findings demonstrate an increase in interest expenses as exposure to mobility is less (mainly) for industrial properties.

We turn our attention to the pandemic risk score in Table 5. The findings demonstrate similar impacts as in mobility change analysis. This, again, indicates that our pandemic benchmark score is a strong predictor of operational impacts of the pandemic. Overall, the variation in exposure of firms to local mobility changes and pandemic risk scores predicts operational effects.

4.4 Market Reaction to Pandemic Risk

Having documented that exposure of Canadian REITs to pandemic risk negatively affects cash flow in both years of the pandemic, we next analyzed how investors react to pandemic mobility reductions and risk. For this purpose, we calculated market adjusted return for the pandemic years and estimate Equation (3) for market adjusted return. Our aim was to understand whether pandemic mobility changes and risk can predict deviations in REIT returns from market return. Results are presented in Table 6 (see page 20).

As opposed to operational impacts, there are mixed results in the market reaction. An increase in exposure to mobility reduction reduces market adjusted return for office, retail, and industrial properties only in 2020. However, there is no statistically significant impact of mobility exposure in 2021. We anticipate that the lack of significant results in 2021 might be due to increased liquidity in the market. Combined with our findings on operational cash flows, although elevated exposure to mobility reduction lowers NOI and FFO, it is not priced by investors in 2021 indicating a mispricing of mobility impacts by investors. Overall, our findings are similar when we use our pandemic risk score measure. Our pandemic risk benchmark score also performs well in the market return analysis.

This indicates that our benchmark pandemic risk indicator could be applied to measure exposure to pandemic risk for future data.

5 Concluding Remarks and Practical Implications

The pandemic changed the way we interact with real estate as it changed our lifestyles. The number of cases, government interventions (such as lockdowns), and personal preferences all affect human mobility. In return, these affect how we utilize real estate. In this study, we aim to understand how local mobility changes, due to a pandemic, can impact cash flows from real estate. For this purpose, we first document how local factors influence mobility changes and then, how real estate owners' exposure to local factors and mobility changes affects their real estate returns in Canada.

Our findings demonstrate that mobility reductions are larger in the locations with more dense population, lower household incomes, higher unemployment rates, less interprovincial migrants, less residents with bachelor's degrees, more remote workers, and single-person households. Based on these local characteristics, we then create a benchmark pandemic risk score for each REIT.

At the REIT level, we find that exposure to larger mobility declines and pandemic risk (based on local factors) lowers cash flows from real estate measured by both NOI and FFO for both pandemic years, 2020 and 2021. The findings also hold for major property types including industrial properties. We also analyzed stock market reaction and find that investors price mobility declines in 2020. However, potentially due to larger liquidation in the market, they ignore the negative impacts of mobility changes and pandemic risk on REIT cash flows, and do not price them in 2021.

Our project has important implications as we explore how the variation in local factors and changes affecting mobility can predict real estate returns. Essentially, the benchmark pandemic risk scores that we created, based on local factors that can change over time, can help us track the exposure of REITs to pandemic risk for future unprecedented pandemics.

Table 4. Operational Effects of the Pandemic Mobility Changes by Property Type

Variables	(1) Rental Revenue	(2) Rental Operating Expense	(3) NOI	(4) G&A Expense	(5) Interest Expense	(6) FFO
Panel A - Office						
Mobility Change \times (Y=2020)	0.016* (0.009)	0.006 (0.005)	0.010* (0.006)	-0.001 (0.002)	0.001 (0.003)	0.007 (0.007)
Mobility Change \times (Y=2021)	0.019*** (0.007)	0.010** (0.004)	0.009** (0.003)	-0.000 (0.001)	0.007* (0.004)	0.010** (0.004)
Firm Financials	Yes	Yes	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Property Type FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	358	358	358	358	358	358
R-Squared	0.664	0.644	0.624	0.234	0.581	0.326
Panel B - Residential						
Mobility Change \times (Y=2020)	0.020** (0.009)	0.008 (0.007)	0.012** (0.005)	-0.002 (0.003)	0.007 (0.005)	0.010 (0.009)
Mobility Change \times (Y=2021)	0.032*** (0.008)	0.009* (0.005)	0.021*** (0.006)	-0.002 (0.003)	-0.010 (0.013)	0.044** (0.017)
Firm Financials	Yes	Yes	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Property Type FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	268	268	268	268	268	268
R-Squared	0.675	0.768	0.592	0.192	0.923	0.869
Panel C - Retail						
Mobility Change \times (Y=2020)	0.023*** (0.008)	0.010* (0.006)	0.013*** (0.003)	-0.000 (0.004)	-0.000 (0.002)	0.013** (0.006)
Mobility Change \times (Y=2021)	0.015** (0.007)	0.009** (0.004)	0.006** (0.003)	-0.001 (0.002)	0.002 (0.002)	0.007 (0.004)
Firm Financials	Yes	Yes	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Property Type FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	339	339	339	339	339	339
R-Squared	0.532	0.570	0.592	0.215	0.700	0.297
Panel D - Industrial						
Mobility Change \times (Y=2020)	0.001 (0.008)	-0.003 (0.006)	0.004 (0.005)	0.001 (0.002)	0.005* (0.003)	0.011* (0.006)
Mobility Change \times (Y=2021)	0.014** (0.007)	0.003 (0.004)	0.011*** (0.004)	0.001 (0.002)	0.011*** (0.004)	0.014*** (0.004)
Firm Financials	Yes	Yes	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Property Type FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	290	290	290	290	290	290
R-Squared	0.746	0.773	0.650	0.231	0.850	0.411

The table presents the regression results for operational cash flows for the period between 2018 Q1 and 2021 Q4 for the pandemic mobility change and risk measures created for each property type. All dependent variables are normalized by total assets. Firm clustered robust standard errors are shown in parentheses. Statistical significance is denoted by: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table 5. Operational Effects of the Pandemic Risk Score by Property Type

Variables	(1) Rental Revenue	(2) Rental Operating Expense	(3) NOI	(4) G&A Expense	(5) Interest Expense	(6) FFO
Panel A - Office						
Pandemic Risk Score \times (Y=2020)	0.017*** (0.006)	0.010** (0.004)	0.007** (0.003)	-0.002 (0.001)	-0.004 (0.005)	0.006 (0.005)
Pandemic Risk Score \times (Y=2021)	0.023*** (0.008)	0.012** (0.005)	0.011*** (0.004)	-0.001 (0.002)	0.007* (0.003)	0.014*** (0.004)
Firm Financials	Yes	Yes	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Property Type FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	358	358	358	358	358	358
R-Squared	0.675	0.653	0.628	0.240	0.583	0.342
Panel B - Residential						
Pandemic Risk Score \times (Y=2020)	0.014* (0.007)	0.005 (0.006)	0.009*** (0.003)	-0.001 (0.003)	0.008 (0.005)	0.002 (0.007)
Pandemic Risk Score \times (Y=2021)	0.025** (0.011)	0.006 (0.006)	0.018** (0.008)	-0.002 (0.003)	-0.006 (0.011)	0.035* (0.019)
Firm Financials	Yes	Yes	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Property Type FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	268	268	268	268	268	268
R-Squared	0.631	0.761	0.546	0.191	0.919	0.843
Panel C - Retail						
Pandemic Risk Score \times (Y=2020)	0.028*** (0.008)	0.011* (0.006)	0.017*** (0.004)	-0.003 (0.003)	-0.001 (0.003)	0.020** (0.008)
Pandemic Risk Score \times (Y=2021)	0.026** (0.011)	0.013** (0.007)	0.011** (0.006)	-0.003 (0.003)	0.002 (0.003)	0.013* (0.007)
Firm Financials	Yes	Yes	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Property Type FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	339	339	339	339	339	339
R-Squared	0.533	0.570	0.595	0.219	0.699	0.315
Panel D - Industrial						
Pandemic Risk Score \times (Y=2020)	0.003 (0.005)	0.001 (0.004)	0.003 (0.003)	0.000 (0.002)	0.004*** (0.001)	0.010** (0.005)
Pandemic Risk Score \times (Y=2021)	0.011* (0.006)	0.002 (0.004)	0.009** (0.003)	-0.001 (0.002)	0.010*** (0.003)	0.016*** (0.004)
Firm Financials	Yes	Yes	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Property Type FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	290	290	290	290	290	290
R-Squared	0.743	0.772	0.644	0.232	0.847	0.428

The table presents the regression results for operational cash flows for the period between 2018 Q1 and 2021 Q4 for the pandemic mobility change and risk measures created for each property type. All dependent variables are normalized by total assets. Firm clustered robust standard errors are shown in parentheses. Statistical significance is denoted by: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table 6. Market Reaction to the Pandemic Mobility Change and Risk Score

	All Sample (1)	Office (2)	Residential (3)	Retail (4)	Industrial (5)
Panel A - Mobility Change					
Mobility Change \times (Y=2020)	0.446* (0.263)	0.563** (0.257)	0.282 (0.396)	0.655*** (0.222)	0.619* (0.329)
Mobility Change \times (Y=2021)	0.145 (0.152)	0.044 (0.173)	0.245 (0.154)	0.054 (0.160)	-0.020 (0.220)
ln(Total Assets)	-0.297 (0.713)	-1.246 (1.224)	0.551 (1.506)	-1.086* (0.643)	-1.400 (0.880)
Debt-to-Assets	-0.113** (0.049)	0.120** (0.050)	-0.107 (0.103)	0.075 (0.069)	-0.076 (0.076)
Cash-to-Assets	-0.419** (0.176)	0.313 (0.431)	-0.241 (0.557)	-0.141 (0.516)	-0.645*** (0.231)
Market-to-Book	17.368*** (5.944)	14.968 (9.394)	17.217 (13.521)	12.552 (9.588)	20.102 (14.415)
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes
Property Type FE	Yes	Yes	Yes	Yes	Yes
Observations	254	143	114	135	112
R-Squared	0.196	0.447	0.155	0.437	0.387
Panel B - Pandemic Risk Score					
Pandemic Risk Score \times (Y=2020)	0.299 (0.319)	0.488*** (0.160)	0.144 (0.397)	1.022*** (0.267)	0.599*** (0.196)
Pandemic Risk Score \times (Y=2021)	0.263 (0.182)	-0.079 (0.138)	0.446** (0.171)	0.196 (0.196)	0.213 (0.128)
ln(Total Assets)	-0.392 (0.627)	-1.600 (1.202)	0.486 (1.284)	-0.793 (0.630)	-1.410* (0.828)
Debt-to-Assets	-0.120*** (0.046)	0.111* (0.060)	-0.118 (0.100)	0.066 (0.066)	-0.102* (0.056)
Cash-to-Assets	-0.346** (0.167)	0.200 (0.405)	-0.139 (0.573)	0.007 (0.434)	-0.657*** (0.197)
Market-to-Book	18.253*** (5.545)	16.268* (9.803)	18.777 (13.448)	12.282 (9.983)	14.971 (12.325)
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes
Property Type FE	Yes	Yes	Yes	Yes	Yes
Observations	254	143	114	135	112
R-Squared	0.193	0.456	0.161	0.448	0.394

The table presents the regression results for quarterly market adjusted return for the period between 2020 Q2 and 2021 Q4 for the pandemic mobility change and risk measures created for the whole sample and each property type. Firm clustered robust standard errors are shown in parentheses. Statistical significance is denoted by: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

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