The Impact of a Disastrous Hurricane on Commercial Real Estate

Preliminary Draft

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Abstract: Using Hurricane Sandy ('Sandy') as a natural experiment, this study investigates whether the occurrence of a major hurricane affects the way flood risk is capitalized in commercial real estate prices. We draw from a detailed property-level commercial real estate transaction data set covering the four major commercial property types – office, retail, industrial, and multifamily. In order to explore various price channels, we investigate both hurricane affected areas and unaffected areas. Rresults vary significantly across property types. In the office submarket, we find a significant price discount for properties located in high flood risk areas directly affected by the hurricane. However, this impact lasted for only two years, and was not found in the hurricane unaffected areas. In the apartment submarket, we document a significant price discount associated with flood risk prior to the hurricane. However, following the hurricane we observe a significant apartment price appreciation across the NYC metropolitan area. Such an impact was not found in hurricane unaffected areas. One possible explanation for this finding is the substitution effect whereby the hurricane leads some households to move from single-family homes to apartments. For retail and industrial properties, we do not find any evidence that Sandy significantly affected prices in hurricane-affected or unaffected areas.

Keywords: Hurricanes, Climate Change, Flood Risk, Commercial Properties

1. Introduction

Over the past two decades as more extreme weather events (e.g., hurricanes, wildfires, heatwaves, droughts), became more frequent popular interest in climate risk has increased dramatically. Given that scientific forecasts predict an increasingly dire climate future (e.g., Bender et al., 2010) this trend is likely to continue. Indeed, the existing literature predicts this trend will continue and warns that a potential increase in the frequency, duration, and intensity of destructive tropical storms and hurricanes in the near future will pose significant economic challenges to many coastal urban areas and exacerbate economic threats to many regions around the world. (e.g., Rahmstorf and Coumou, 2011; Bender et al., 2010).

There is a growing literature that explores how residential real estate prices reflect emerging climate risk (e.g., Bernstein et al., 2019; Baldauf et al., 2020; Fang et al., 2022) and whether a residential property's flood risk exposure is capitalized in property values (e.g., Turnbull et. al 2013; Atreya and Czajkowski, 2019). However, little is known about how commercial real estate markets respond (Addoum et al., 2021) to climate change or increasing flood risk. This is important as results reported for residential properties do not necessarily apply to commercial real estate for a number of reasons. First, commercial real estate investors are more sophisticated than those in the housing market. Ling and Archer (2018) show that among the $8.8 trillion value of commercial real estate in the U.S., 55% of it is equity-financed, and 60% of the equity shares are held by public and private institutional investors with the remaining held by other professional investors. Second, building codes for commercial properties, especially for high-rise properties, are very different from those for housing units, which may lead to large differences in terms of a building's resistant to hurricane related damages. Additionally, insurance programs for commercial and residential real estate are also different.

The disastrous impacts of hurricanes may affect commercial real estate markets through different channels; the first is the contagion channel. Physical damage to properties and reduced amenities brought by the hurricane coupled with the destruction of the facilities supporting the operations of the property (e.g., powerline, water and sewer system) and the interruptions to the local transportation system would all affect

the activities of the tenants occupying the property and the property's ability to generate cash flows in the near future. The second channel is the perception of flood risk. A major climate event like a hurricane may represent a discrete and unexpected situation that would raise the perception of flood risk by real estate investors. In addition, with the media providing extensive coverage during and immediately following the hurricane, it is possible that even those investors of commercial real estate in areas unaffected by the hurricane areas may raise their perception of flood risk. If price impact is observed in both the hurricane affected areas and unaffected areas, the second channel can be identified. If the price impacts are found only in affected areas, we can assume pricing effects would be largely due to the contagion channel.

Most prior studies focus on how the occurrence of a major hurricane affects property prices in hurricane affected areas (e.g., Ortega and Taşpınar, 2018; Yi and Choi, 2020). However, little attention has been paid to the impact on real estate buyer/investor attitudes towards climate risk in areas not affected by the hurricane. In this study, we focus on commercial real estate and investigate whether the occurrence of a major hurricane affects how flood risk is capitalized in property prices in areas hurricane affected and unaffected by the hurricane.

We selected Sandy as our subject event for several reasons. First, Sandy was one of the most disastrous hurricanes in the U.S. this century bringing unexpected structural and economic damage to properties in the New York Metro Area. The economic impact of the storm is estimated at $19 billion in damages and lost economic activity across the New York City. Second, Sandy represents an unexpected event that may raise investors' perception of flood risk. Prior to Sandy, New York was believed to be immune from strong hurricanes due to its location far north of the tropical regions where hurricanes typically occur; this belief was shattered when Sandy hit New York. The hurricane also brought significant economic challenges to many coastal urban areas (Baldini et al., 2016). Moreover, Sandy's impact was not felt in areas that are normally vulnerable to storm risk, such as Miami-Dade and Tampa Bay in Florida, and Houston in Texas. Therefore, those areas unaffected by Sandy are included in our study to test whether the occurrence of a

large-scale, but distant, hurricane would raise concerns regarding flood risk by commercial real estate investors and in-turn impact commercial real estate prices in those unaffected areas.

The data used for this study is obtained from Real Capital Analytics (RCA). Our study regions include the NYC metro (the directly affected area), along with Philadelphia – Baltimore – Washington DC metros which were only slightly affected by Sandy, and the unaffected areas of Miami, Tampa, Orlando metros in Florida and Houston and San Antonio metros in Texas. A Diff-in-Diff approach is adopted for our empirical analysis. We focus on the four major commercial real estate types – office, retail, industrial, and apartment, and apply our empirical analysis to each property type separately.

Overall, the results show that whether and to what extent a major hurricane's flood risk is capitalized in commercial real estate prices varies significantly across property types. In the office submarket, prior to the event, we do not observe any price discount for flood risk in any of our study regions. After the event, we find a significant price discount for properties exposed to high flood risk in the NYC metro area directly affected by the hurricane. However, the impact lasted for only two years, and was not found in any of the other regions. Regarding retail and industrial properties, we do not find any evidence that Sandy significantly affected prices in hurricane-affected or unaffected areas.

Meanwhile, in the apartment submarket in NYC we document a significant price discount associated with flood risk prior to Sandy. However, following the hurricane we see significant price appreciation across the NYC metropolitan area; a similar impact was not found in areas unaffected by Sandy. One possible explanation for this finding is the substitution effect where the hurricane leads some households to move from single-family homes to apartments. This explanation is supported by Fang, Li and Yavas (2022) who studied the impact of Sandy on single family homes and reported that the hurricane had a negative effect on home prices even in unaffected high risk areas, such as Miami-Dade County, FL.

To the best of our knowledge, this work provides the most thorough analysis of the impact of climate risk on commercial real estate. Most relevant to our work are two earlier studies that examine the impact of

hurricanes on commercial real estate prices. Fisher and Rutledge (2021) use individual property data from the National Council of Real Estate Investment Fiduciaries database and find that hurricanes affect property values and returns for all types of commercial real estate negatively. The authors focus on the markets affected by hurricanes while we include multiple hurricane unaffected areas that are vulnerable to storm risk to disentangle the two possible price impact channels. In addition to differences in results and methodologies in Fisher and Rutledge (2021) it is also noteworthy that their study uses appraised property values rather than actual transaction prices and hence is subject to smoothing and other issues related to appraisals. Addoum et al. (2021) uses the sales data from Costar to study the impact of Sandy on NYC, Boston and Chicago office markets. Compared to Addoum et al. (2021), we include all four major commercial property types and use a data set that offers more detailed coverage of various variables of interest, including location, building age, tenant, buyer/seller, etc. As verified by our findings, differentiating among different commercial property types is important for an accurate assessment of hurricane impact.

The rest of the paper is organized as follows. The section following provides a summary of prior related studies. The third section describes the methodology while the fourth section describes the data and provides summary statistics. The fifth section presents the major results, and is followed by our concluding remarks.

2. Literature review

Over the past two decades extreme weather events (e.g., hurricanes, wildfires, heatwaves), have become more frequent and has galvanized popular interest in climate risk has increased dramatically. As scientific forecasts of future climate events have become more dire (e.g., Bender et al., 2010) this trend is likely to continue. While the climate risk literature has explored how residential real estate prices reflect emerging climate risk (e.g., Ortega and Taşpınar, 2018; Bernstein et al., 2019; Baldauf et al., 2020; Fang et al.,2022;

Mahmoudi 2021), little is known about how commercial real estate markets respond (Addoum et al., 2021; Rehse et al., 2019; Fisher and Rutledge 2021).

The literature offers mixed findings concerning the impact of climate risk on residential real estate market. For instance, Harrison et al. (2001), Atreya et al. (2013), and Murfin and Spiegel (2020) show limited price effects of flood risk on properties prices. Meanwhile, Bernstein et al. (2019) find that homes exposed to sea level rise (SLR) sell at a discount of around 7% compared to those observably equivalent, but unexposed, properties equidistant from the beach. The authors argue that this discount is driven by sophisticated buyers and communities worried about global warming. Giglio et al. (2021) show that housing markets provide information about the appropriate discount rates for valuing investments in climate change abatement. Focusing on Sandy in the New York housing market, they find that when the fraction of property listings that mention climate change doubles, there is a 2% to 3% relative decrease in the average price of properties in the flood zone compared to otherwise comparable properties in the same ZIP code that are not in a flood zone. Fang et al. (2022) investigate whether the local housing markets can be affected by the occurrence of a large-scale but distant hurricane. The authors show that the impact of flood risk exposure on its value varies over time, with a price penalty of 4% during the hurricane period. They argue that the occurrence of a major hurricane impacts faraway regions by raising local home buyers' perception of flood risk, though the effect is felt for only a short period of time. Mahmoudi (2021) shows that a local credit shock, induced by hurricane Katrina, propagated through banks' internal networks induces demand and supply effects in distant regions. Driven by abnormal mortgage and housing demand in Katrina-hit areas, financially constrained multi-market banks re-allocated resources towards the damaged areas leading to credit tightening in unaffected markets which results in a mix of housing prices and a decline in housing supply.

Despite increasing interest in the impact of natural disasters on residential property market activity and valuation, the literature that focuses on commercial real estate markets is limited. Fisher and Rutledge (2021) analyze the impact of major hurricanes on property values and returns across the United States over the last 30-plus years. Using appraisal based individual property data from the National Council of Real Estate

Investment Fiduciaries database, the authors show a significant negative impact on values and rates of return for properties that are in areas impacted by hurricanes relative to areas that were not impacted. Rehse et al. (2019) compare the market reactions of Real Estate Investment Trusts (REITs) with and without properties in the widely published evacuation zone of New York City prior to landfall using Sandy as a natural experiment. They show relatively less trading and wider bid-ask spreads among affected REITs, confirming theory on the detrimental effects of uncertainty on market functioning. Focusing on office properties, Addoum et al. (2021) document that Sandy affects distant locations, beyond those that experienced significant damage in the storm. The authors show that properties exposed to flood risk experience slower price appreciation post-storm event as compared to equivalent unexposed properties. This time persisting price effect is not driven by the structural damage incurred from Sandy, nor by concurrent unrelated pricing trends for waterfront properties, but rather by higher risk premiums for exposed properties.

In this study, we investigate the impact of a major hurricane on commercial real estate transaction prices in both hurricane affected area and unaffected regions using RCA transaction level data on four commercial real estate sectors between Jan. 2004 to Oct. 2016, controlling for measures of property's sensitivity to climate risk as well as property physical characteristics and financial information. Instead of using an appraisal-based dataset which suffers from bias and may not truly reflect the real market, we rely on market transactions. As well, and contrary to the focus on a single property type found in previous work, our study provides a better picture of the impact of a major hurricane on the commercial real estate market by differentiating among the four major types of income properties. Given the increasing trend in the frequency and intensity of hurricanes, it is of great importance for market players and policy makers to understand how hurricanes affect commercial real estate markets.

3. Methodology

We employ a Diff-in-Diff approach in our empirical analysis specified as in Equation (1).

$$\log(PSF) = \alpha + \beta * Floodrisk + \gamma * Post + \lambda * Floodrisk * Post + \xi * \boldsymbol{Z} + \varepsilon \quad (1)$$

The dependent variable is the log of the transaction price of a commercial property per square footage. $Floodrisk$ is an indicator variable that takes value of 1 if the commercial property is located in a high-flood risk zone. $Post$ is an another indicator variable that takes the value of 1 if the sale occurred after Sandy. $Floodrisk * Post$ is the interaction term of the variable $Floodrisk$ and the variable $Post$. $\boldsymbol{Z}$ represents a vector of covariates including 1) a property's SLR risk exposure, 2) its physical characteristics 3) its transaction features, 4) its location characteristics including measures of water-associated amenities, 5) its tenant characteristics, 6) the traits of both buyer and seller, 7) property county Fixed Effects (FE), and 8) sale year-quarter FE.

One challenge in this Diff-in-Diff analysis is that it is not clear how long the impact of this hurricane event on each commercial real estate submarket would last for. This impact may persist or diminish fast. In order to solve this issue, we interact the flood risk exposure indicator variable with a series of post event year dummies. With post year dummies, the Diff-in-Diff model is specified as in Equation (2).

$$\log(PSF) = \alpha + \beta * Floodrisk + \sum_{l=1}^{2} \gamma_l * Post\_Y_l + \sum_{l=1}^{2} \lambda_l * Floodrisk * Post\_Y_l + \xi * \boldsymbol{Z} + \varepsilon \quad (2)$$

Where $Post\_Y_1$ is an indicator variable indicating whether this commercial sale occurred within the first two-year window of Sandy, and $Post\_Y_2$ is another one indicating whether the transaction occurred during the third and fourth-year window after this event. The coefficient β thus measures any price premium or discount for those commercial properties located in high-flood risk zones compared to median-to-low flood risk zones prior to the event. The two coefficients λ_l ($l = 1,2$) are of our major attention as they measure upon this event, whether the impact of a commercial property's flood risk exposure on its sale price changes. The setup of this Diff-in-Diff model thus allows us to explore whether Sandy brought any changes to each commercial real estate submarket. We conducted this Diff-in-Diff analysis for both hurricane affected areas and unaffected areas respectively.

We conduct our analysis for each property type separately first because Sandy may affect each commercial real estate submarket in a different way; and secondly the way each value factor (including flooding risk) impacting the transaction price of commercial property may vary across commercial property submarkets.

4. Data & Descriptive Statistics

4.1. Data

Our analysis is based on a pool of commercial real estate transactions in the U.S. obtained from Real Capital Analytics (RCA). As our focus is Sandy, based on the moving path of this hurricane, we have identified 1) hurricane directly affected areas, 2) slightly affected areas, and 3) hurricane unaffected areas but with a potential flooding risk.[1] Specifically, hurricane directly affected areas include all the counties in the NYC metropolitan area. Hurricane slighted affected areas include counties in Philadelphia metropolitan areas, Baltimore metropolitan area, and Washington DC metropolitan area.[2] Meanwhile, hurricane unaffected areas cover Miami, Tampa, Orlando metropolitan areas in FL, as well as Houston and San Antonio metropolitan areas in TX. Our sample period is from Jan. 2004 to Oct. 2016 – four years after Sandy.

Our RCA data set includes detailed information on each transaction including whether this sale is a portfolio sale, the objective of the purchase (investment/occupancy/redevelopment/renovation), whether the transaction is a property sale or an entity sale, the type of the buyers (institutional/private/public buyers), and the type of the seller (institutional/private/public seller), etc. Information on the characteristics of the property can also be found in our data including property size, age, street address, whether the property is within the CBD, the number of buildings within this transaction, the number of floors of each building, whether there is an excess land potential, and so forth. In addition, different from other commercial real

[1] We did not include those metropolitan areas that were not affected by Sandy and would normally not struck by a large-scale hurricane like those metropolitan areas in the West Coast or those in the Midwest of U.S. In addition, small-size metropolitan areas are not included either because we did not observe many commercial real estate transactions in those areas during our study period.
[2] We did not include the Boston metropolitan area because our original RCA dataset does not cover it.

estate sale data sets, our data also covers detailed information on the tenants including the type of the tenant (single tenant/multiple tenants/vacant tenant, etc.) as well as whether the property will be leased back to the tenants which would all have impacts on the cash flows generated by the property, and thus its value.

As the detailed street address of each property is included in our property dataset, we geo-coded the address of each property to obtain its geographic latitude and longitude, based on which this RCA dataset was merged with other datasets to measure each property's exposure to flooding risk and Sea Level Rising (SLR) risk, its distance from the nearest coastline, and its elevation.

For each county included in our analysis, we manually collected the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) from FEMA to identify each property's exposure to the flooding risk.[3] Various categories of flood zones are defined by FEMA based on varying levels of flood risk, with each zone reflecting the severity or type of flooding in the area. In this study, following the definitions by FEMA, high flood risk areas are those beginning with the coding letters 'A' or 'V' in which there is at least a 1 in 4 chance of flooding during a 30-year mortgage. By contrast, in moderate-to-low flood risk areas which are shown on flood maps as zones beginning with the letters starting with 'B', 'C' or 'X', flood risk is reduced but not completely removed.

Meanwhile the potential impact of SLR risk on property value has drawn a lot of attention from both real estate investors and scholars. One concern about the SLR risk is a property's SLR risk might be correlated with its exposure to flooding risk, especially for those coastal areas. Failure to control for SLR risk may result in biased estimate of the impact of the flood risk on property value. In order to disentangle the impact of flood risk on property value from that of SLR risk, we measure and incorporate the SLR risk exposure in our analysis. Specifically, we manually collected the SLR raster data map from the National Oceanic and Atmospheric Administration (NOAA) for each state and mapped each property (based on its latitude and longitude) to this SLR raster map. Following prior studies (Bernstein et al., 2019; Baldauf et al., 2020), it

[3] The FEMA webpage is https://msc.fema.gov/portal/advanceSearch

is defined that a property is exposed to SLR risk if the property would be inundated at highest high tide with a 6-foot global average SLR.

As discussed in prior studies (e.g., Atreya and Czajkowski, 2019), a challenge in studying the impact of flood risk on property value is the concurrent existence of positive water-related amenities and negative flood risk for properties near water. In order to account for those water-related amenities in our empirical analysis, we obtained the shapefile of the U.S. coastline to map all of the commercial properties in our dataset to measure each property's nearest distance from the coastline. In addition, considering the possible correlation between a property's elevation and amenity level, we measure the elevation of each property by mapping the property to a national map of 1-meter Digital Elevation Model (DEMs) provided by the United States Geological Survey (USGS).

4.2. Descriptive Statistics

We only include non-distressed sales in our analysis, and only focus on those properties within 150 miles of the coastline. In our final sample, there are 37,472 commercial property sales covering the office, retail, industrial, and apartment submarkets. Table 1 provides the summary statistics of our final sample, with each panel for each property type. Table 2 provides the statistics of each subsample by location.

1) Office

Panel A of Table 1 shows that in the office market, the transaction price per square footage varies from $10 per sq. ft. to $5,440 per sq. ft. Accordingly, the variation of the size of those office buildings in our sample is also large. The median age of the offices is 30 years old, and the median distance of each property to the coastline is 1.7 miles indicating that a large portion of the office properties are close to the coastline. Approximately 8.3% of the office buildings are located in high flooding risk zones, and only 4.6% of them are exposed to SLR risk. Additionally, buyers purchase those office buildings mainly for investment purpose and most of them (60.5%) are private buyers.

Panel A of Table 2 shows that the office market performs very differently at different locations. On average, the office property is most expensive at NYC Metro and least expensive at TX metros in terms of sale price per square footage. Meanwhile, offices at NYC metropolitan area are of the largest size, oldest age, shortest distance from the coastline, and probably the highest (indicated by the number of floors). In metros in FL, roughly 20.8% of the offices are within the high flooding risk zones, while this proportion is only 2.1% in the Philadelphia metropolitan areas, Baltimore metropolitan area, and Washington DC metropolitan area. The tenant characteristics of the office buildings in our sample also seem to vary across the regions.

2) Retail

Panel B of Table 1 shows that in the retail market, the median sale price is around $291 per square footage, slightly higher than that in the office market. This price also varies a lot. The median size of the retail properties is 17,000 sq. ft., much smaller than that of office buildings. Relatively, compared to office buildings, retail properties tend to be more spread out with the median number of floors as one. In our final sample, approximately 8.8% of retail properties are within high flood risk zones, while about 5.5% of them are exposed to SLR risk.

Similarly, Panel B of Table 2 shows that the performance of retail properties also varies dramatically across regions. On average, retail properties at NYC metro tend to be the most expensive and the highest, are of the smallest size, oldest age, with the largest portion for redevelopment purpose. Those metros in FL have the largest proportion of the retail properties in the sample located in high flood risk zones, while the metros around Philadelphia and Washington DC have seen the smallest proportion.

3) Industrial

Panel C of Table 1 shows the price per square footage for industrial buildings range from $10 per sq. ft. to $2,925 per sq. ft. Accordingly, there is also large variation in terms of building size. The median age of the industrial buildings is 31 years old, and the median distance of each property to the coastline is 3.36 miles indicating that the industrial properties are located further from the coastline than office or retail.

Approximately 12.8% of the industrial buildings are in high flooding risk zones, and 8.7% of them are exposed to SLR risk. Additionally, 77.4% of buyers for industrial buildings are for investment purpose with 60% of private buyers.

Panel C of Table 2 shows the variation of industrial building across different locations. The price for industrial building is the most expensive at NYC and cheapest in TX. Meanwhile, industrial buildings at NYC metropolitan area are of the largest size, oldest age, shortest distance from the. In metros in FL, roughly 23.7% of the industrial buildings are within the high flooding risk zones, while this proportion is only 2.5% in the Philadelphia metropolitan areas, Baltimore metropolitan area, and Washington DC metropolitan area. The tenant characteristics also vary across the regions.

4) Apartment

Panel D of Table 1 shows that in the apartment market, the median sale price is around $138 per square footage, lower than the price for office and retail and higher than that in the office market. There is also large variation in price. The median size of the retail properties is 51,000 sq. ft., much smaller than that of office buildings, but bigger than retail and industrial building. Relatively, similar to office buildings, the number of floors varies. In our final sample, approximately 8.5% of retail properties are within high flood risk zones, while about 5.5% of them are exposed to SLR risk.

Similarly, Panel D of Table 2 shows that the performance of apartments also varies dramatically across regions. On average, apartment properties at NYC metro tend to be the most expensive and the highest, are of the smallest size, oldest age, with the largest portion for redevelopment purpose. FL have the largest proportion of apartments located in high flood risk zones (29%), while the metros around Philadelphia and Washington DC and NYC have seen much smaller proportion.

5. Results

Table 3 reports the empirical results of the Diff-in-Diff model applied to the office submarket. Please note that for our analysis on the metros in FL, we only included sales since Nov. 2007 because the State of FL

was directly struck by a series of disastrous hurricanes in 2004 and 2005 which may have an impact on the local property market for a few years. Similarly, we included sales till Oct. 2014 for the TX region analysis because Houston was heavily flooded during the Memorial Day in 2015, one of the worst flooding histories in the U.S.

The results in Table 3 overall show that prior to Sandy, we did not see any price premium or discount associated with high flood risk on those office buildings in any of the metropolitan areas included in our study. Upon this event, we have seen a price discount on those office buildings located in high flood risk zones compared to those in median-to-low flood risk zones at the NYC metropolitan area which was directly struck by this hurricane. This price discount, however, only lasted for two years and diminished quickly. By contrast, we did not see any price impact on the office market brought by Sandy in either the slightly affected areas or those unaffected areas including metropolitan areas in FL and TX. This finding overall indicates that for office properties, a large-scale disastrous hurricane did bring a significant impact on the local market through the contagion channel. We failed to see any evidence of the channel via an update of the perception of the flood risk by real estate investors.

One potential concern about our study period is the prior event period covers the last financial crisis during years 2008-2010. In order to address this concern, we conducted our Diff-in-Diff empirical analysis excluding those sales between year 2008 and 2010. The results are very consistent and available upon requests.

This finding is partially consistent with the results found in Addoum et al. (2021), one of the few studies so far focusing on the impact of a hurricane on commercial real estate market, specifically the office market. Similar to their findings, we find that office buildings exposed to flood risk at NYC traded at a large discount following Sandy. By contrast, we did not see those office properties with high flood risk at Philadelphia, Washington DC, and Baltimore metros which largely escaped direct hurricane-related damages exhibit significant post-Sandy price penalties. The difference might be due to a couple of reasons. First, our study

areas of those slightly hurricane affected metros are different from theirs.[4] Second, our analysis is based on a very different data set. In our data set, in addition to the property physical and location characteristics which are also included in their study, we have detailed information on the nature of the transaction, the characteristics of the tenants and leases, as well as the traits of both the buyer and the seller, which are shown to have significant impacts on the sale price.[5]

Table 4 and Table 5 demonstrate the price impact by Sandy to retail and industrial properties respectively. Please note that for the retail submarket, we did not conduct the Diff-in-Diff analysis for those slightly hurricane affected areas (Philadelphia, Washington DC, and Baltimore metros) just because in those areas there are too few retail sales located in high flood risk zones following Sandy. Overall, we did not find any empirical evidence that retail properties exposed to high flood risk at either NYC or in those hurricane unaffected areas traded at a discount after before the event. Besides, we did not see that Sandy shifted the impact of flood risk on property transaction price in a significant way. The same conclusion can also be found in the industrial submarket. Similar to our analysis on the office submarket, we implemented the same Diff-in-Diff analysis excluding sales between years 2008 and 2010 for the retail submarket and industrial submarket respectively, the conclusions remain.

Different from prior studies that have shown significant and persistent negative price impacts on housing units brought by a disastrous hurricane (e.g., Ortega and Taṣpınar, 2018), we did not see such an impact for retail and industrial properties. Several possible explanations might explain. One possible explanation could be the difference in building codes for single family houses vs. for retail/industrial properties. Relatively, retail/industrial properties tend to be more resistant to a storm, resulting in less physical damages and economic loss. Although the occurrence of a disastrous hurricane may interrupt the normal business operation of the tenants, this event is rare which would not much affect the stabilized NOI generated from the property, especially given the fact that leases for retail/industrial properties usually last for multiple

[4] Unfortunately, the original data set we obtained from RCA does not cover Boston.
[5] The results on the covariates in the Diff-in-Diff model are available upon request.

years. Moreover, commercial properties are usually protected by insurances to a larger extent compared to single family houses. Those insurances to commercial properties include commercial property insurance,[6] hurricane insurance or flood insurance for properties located in high flood risk zones,[7] and a business interruption insurance[8]. As a result, the occurrence of a disastrous hurricane may not significantly affect the retail/industrial market, as opposed to what we have observed in the housing market.

Table 6 reports our empirical analysis based on the apartment transactions in our study. Similar to our analysis on the retail submarket, we did not perform the Diff-in-Diff analysis for the hurricane slightly affected areas because there are too few apartment sales located in high flood risk zones there after the event. Focusing on NYC – the hurricane directly affected areas, prior to Sandy, apartment buildings exposed to high flood risk traded at a significant and large price discount of about 16.5%. Upon this event, we have seen a significant region-wide increase in apartment sale price (per sq. ft.) at NYC regardless of the apartment property's exposure to flood risk. Specifically, within the first two years of the event, apartment buildings at NYC appreciated at a rate as high as 15.3% compared to the prior event period. During the third and fourth-year window following Sandy, this price gap expanded to 31.8%. Please note that we have controlled for sale year-quarter fixed effects (FE), and we did not see such a price appreciation in the office/retail/industrial submarkets. Meanwhile, it seems that the occurrence of Sandy significantly changed the impact of flood risk on apartment transaction price. During the first two years after the event, the large price discount of high flood risk shown prior to the event disappeared. However, this impact is a temporal one and only existed during the first two years.

This finding seems very interesting to us and may be attributed to the substitute relationship between apartments and single-family houses. As found in prior studies (e.g., Ortega and Taşpınar, 2018), Sandy brought a persistent negative impact of high food risk exposure on the value of single-family houses, and

[6] This commercial property insurance helps pay to repair or replace those damaged physical properties.
[7] This hurricane insurance helps pay for losses or damages caused by water entering the building.
[8] This business interruption insurance rider can help owner or landlord to pay for ongoing expenses when a hurricane keeps the business from operating

this persistent negative impact applies to not only properties that were damaged by Sandy but also properties located in high flood risk zones that were not damaged by Sandy. Given the fact that many single-family houses at NYC were severely damaged or flooded during Sandy and residents who lived in those damaged or affected houses suddenly had a large demand for temporal living space while repairing their houses, it is not surprising to see that price appreciation. Additionally, the fact that, compared to single-family houses, apartment buildings especially mid- or high-rise apartment buildings are more resistant to damages brought by a hurricane or flooding, may also accelerate this price appreciation. When the temporal supply of apartment space could not come up with the rising demand, the price discount of high flood risk prior to the event may disappear. We further test this possible explanation by including only mid- or high-rise apartment buildings in our Diff-in-Diff analysis as this type of apartment buildings are least vulnerable to flooding risk and might become more attractive after the event.[9] The results are reported in Table 7. The results show that the large price discount of high flood risk before the event in the mid- or high-rise apartment building submarket (roughly 25.4%) disappeared upon the event, and this impact lasted longer – at least four years.

Turning our attention to the hurricane unaffected areas, we did not observe any price discount associated with high flood risk in either metros in FL or those in TX before the event. Meanwhile, we have not seen any region-wide apartment building price appreciation upon the event at those areas either. However, in FL, within the first two years after the event, Sandy brought a significantly positive impact on the relationship between high flood risk and sale price. As shown in Fang et al. (2022), the occurrence of distant hurricane negatively affects the price of single-family properties with high flood risk. The authors argue that the change in the perceptions of flood risk caused by a distant hurricane could explain this finding. Our finding is consistent with Fang et al. (2022) who reports that the occurrence of a distant hurricane changes the perception of the flood risk in the local housing market and imposes a discount on single-family residence

[9] Apartment building are classified into two subtypes: garden apartments and mid- or high-rise apartments. At NYC, approximately 95% of the apartments fall in the mid- or high-rise category.

with high flood risk. In this paper, we show that the drop in demand for single family homes translates to an increase in demand for apartment buildings in the area, which in turn leads to a positive price impact for multifamily properties. We also find that results are consistent if apartment transactions between years 2008 and 2010 are excluded.

6. Conclusion

Selecting Sandy as the catastrophic event of interest for this study, we investigate whether commercial real estate markets are affected by the occurrence of destructive hurricanes. Our empirical analysis is based on a sample of commercial property transactions from Jan. 2004 to Oct. 2016 in the following areas: NYC metro (directly affected area), the Philadelphia – Baltimore – Washington DC metros areas (only slightly affected areas), and Miami, Tampa, Orland metros in Florida along with Houston and San Antonio metros in Texas (unaffected areas). We conduct empirical tests for each of the four major commercial real estate submarkets: office, retail, industrial, and apartment. We show that the impact of Sandy on commercial real estate transactions in the above regions vary by property type. Following the hurricane, we observe a price discount in office buildings located in high flood risk zones compared to those in median-to-low flood risk zones in the NYC metropolitan area. This impact lasted for only two years before quickly diminishing. By contrast, we do not observe any price impact in offices in either the slightly affected or unaffected areas. For retail and industrial submarkets, we did not find any empirical evidence that retail/industrial properties exposed to high flood risk in either NYC or in those hurricane unaffected areas traded at a discount after the event.

The results for apartments, however, are strikingly different than other property types. We discover that the occurrence of Sandy had a significant affect on the transaction prices of apartment buildings in our sample. Prior to Sandy, apartment buildings exposed to high flood risk traded at a significant price discount of approximately 16.5%. Following the hurricane, we observe a significant region-wide increase in apartment sale prices (per sq. ft.) in NYC regardless of the property's exposure to flood risk. Specifically, within the

first two years of the event, apartment buildings in NYC appreciated at rates as high as 15.3%. One explanation may be the substitution effect between single family properties and apartment buildings. Significant damage to the structure of single-family properties during the hurricane could affect people's preferences for these two types of properties. Moreover, the hurricane may further increase demand for apartment buildings while damaged single-family properties are undergoing repair.

This exploration of the effects of a major hurricane on different commercial real estate markets and property types is of interest to market players and policy makers. We offer an important first step in addressing this question and hope that the current study stimulates more studies in this area in the near future.

The authors thank Real Capital Analytics for the provision of data required to undertake this study.

Table 1 Summary Statistics - Full Sample

Panel A - Office

Variable	Min.	Max.	Mean	Median	Std Dev
Price per sq. ft. (in dollar)	10.186	5440.230	314.838	202.577	351.892
Property Size (in 1,000 sq. ft.)	1.004	3000.000	154.605	73.400	249.805
Property age	0.000	298.000	39.341	30.000	30.941
Distance from the nearest coastline	0.000	120.291	7.239	1.696	16.624
Number of the floors	1.000	80.000	7.365	4.000	8.774
Elevation	-2.000	382.836	37.915	17.000	52.494
Within CBD (0,1)	0.000	1.000	0.347	0.000	0.476
Within high flood risk zone (0,1)	0.000	1.000	0.083	0.000	0.276
With high SLR (0,1)	0.000	1.000	0.046	0.000	0.209
Post event (0,1)	0.000	1.000	0.409	0.000	0.492
Portfolio sale (0,1)	0.000	1.000	0.199	0.000	0.399
Purchase Objective					
Investment (0,1)	0.000	1.000	0.784	1.000	0.412
Occupancy (0,1)	0.000	1.000	0.077	0.000	0.267
Redevelopment (0,1)	0.000	1.000	0.069	0.000	0.253
Renovation (0,1)	0.000	1.000	0.070	0.000	0.255
Transaction type - Sale (0,1)	0.000	1.000	0.970	1.000	0.170
Leaseback (0,1)	0.000	1.000	0.038	0.000	0.191
Tenancy Info					
Single tenant (0,1)	0.000	1.000	0.106	0.000	0.307
Multiple tenants (0,1)	0.000	1.000	0.552	1.000	0.497
Vacant (0,1)	0.000	1.000	0.099	0.000	0.299
Tenant info missing (0,1)	0.000	1.000	0.243	0.000	0.429
Excess land potential (0,1)	0.000	1.000	0.028	0.000	0.164
Buyer group					
Institutional (0,1)	0.000	1.000	0.214	0.000	0.410
Private (0,1)	0.000	1.000	0.605	1.000	0.489
Public (0,1)	0.000	1.000	0.090	0.000	0.286
Others (0,1)	0.000	1.000	0.091	0.000	0.288
Seller group					
Institutional (0,1)	0.000	1.000	0.207	0.000	0.405
Private (0,1)	0.000	1.000	0.586	1.000	0.493
Public (0,1)	0.000	1.000	0.109	0.000	0.312
Others (0,1)	0.000	1.000	0.097	0.000	0.297
# of Observations			9,849		

Table 1 Summary Statistics - Full Sample

Panel B - Retail

Variable	Min.	Max.	Mean	Median	Std Dev
Price per sq. ft. (in dollar)	10.000	9980.810	562.633	290.964	823.160
Property Size (in 1,000 sq. ft.)	0.573	2613.476	57.139	17.961	125.954
Property age	0.000	260.000	40.975	29.000	35.374
Distance from the nearest coastline	0.002	121.725	8.372	1.767	19.048
Number of the floors	1.000	90.000	2.137	1.000	3.497
Elevation	-2.000	428.746	32.419	14.629	51.631
Within CBD (0,1)	0.000	1.000	0.299	0.000	0.458
Within high flood risk zone (0,1)	0.000	1.000	0.088	0.000	0.284
With high SLR (0,1)	0.000	1.000	0.055	0.000	0.228
Post event (0,1)	0.000	1.000	0.519	1.000	0.500
Portfolio sale (0,1)	0.000	1.000	0.173	0.000	0.378
Purchase Objective					
Investment (0,1)	0.000	1.000	0.870	1.000	0.337
Occupancy (0,1)	0.000	1.000	0.038	0.000	0.191
Redevelopment (0,1)	0.000	1.000	0.067	0.000	0.250
Renovation (0,1)	0.000	1.000	0.025	0.000	0.157
Transaction type - Sale (0,1)	0.000	1.000	0.966	1.000	0.180
Leaseback (0,1)	0.000	1.000	0.037	0.000	0.189
Tenancy Info					
Single tenant (0,1)	0.000	1.000	0.277	0.000	0.448
Multiple tenants (0,1)	0.000	1.000	0.571	1.000	0.495
Vacant (0,1)	0.000	1.000	0.087	0.000	0.282
Tenant info missing (0,1)	0.000	1.000	0.064	0.000	0.245
Excess land potential (0,1)	0.000	1.000	0.023	0.000	0.150
Buyer group					
Institutional (0,1)	0.000	1.000	0.113	0.000	0.316
Private (0,1)	0.000	1.000	0.731	1.000	0.443
Public (0,1)	0.000	1.000	0.100	0.000	0.299
Others (0,1)	0.000	1.000	0.056	0.000	0.231
Seller group					
Institutional (0,1)	0.000	1.000	0.110	0.000	0.312
Private (0,1)	0.000	1.000	0.730	1.000	0.444
Public (0,1)	0.000	1.000	0.091	0.000	0.287
Others (0,1)	0.000	1.000	0.070	0.000	0.255
Retail Type					
Center (0,1)	0.000	1.000	0.421	0.000	0.494
Shops (0,1)	0.000	1.000	0.579	1.000	0.494
# of Observations			8,968		

Table 1 Summary Statistics - Full Sample

Panel C - Industrial

Variable	Min.	Max.	Mean	Median	Std Dev
Price per sq. ft. (in dollar)	10.044	2925.100	125.865	80.000	179.074
Property Size (in 1,000 sq. ft.)	2.250	4000.000	117.323	68.761	174.709
Property age	0.000	202.000	34.424	31.000	22.931
Distance from the nearest coastline	0.000	115.760	8.387	3.361	16.466
Number of the floors	1.000	68.000	1.350	1.000	1.280
Elevation	-2.000	314.282	33.470	15.818	47.378
Within CBD (0,1)	0.000	1.000	0.147	0.000	0.354
Within high flood risk zone (0,1)	0.000	1.000	0.128	0.000	0.334
With high SLR (0,1)	0.000	1.000	0.087	0.000	0.282
Post event (0,1)	0.000	1.000	0.451	0.000	0.498
Portfolio sale (0,1)	0.000	1.000	0.187	0.000	0.390
Purchase Objective					
Investment (0,1)	0.000	1.000	0.774	1.000	0.418
Occupancy (0,1)	0.000	1.000	0.131	0.000	0.338
Redevelopment (0,1)	0.000	1.000	0.070	0.000	0.255
Renovation (0,1)	0.000	1.000	0.025	0.000	0.156
Transaction type - Sale (0,1)	0.000	1.000	0.970	1.000	0.171
Leaseback (0,1)	0.000	1.000	0.046	0.000	0.210
Tenancy Info					
Single tenant (0,1)	0.000	1.000	0.188	0.000	0.390
Multiple tenants (0,1)	0.000	1.000	0.262	0.000	0.440
Vacant (0,1)	0.000	1.000	0.185	0.000	0.388
Tenant info missing (0,1)	0.000	1.000	0.365	0.000	0.481
Excess land potential (0,1)	0.000	1.000	0.029	0.000	0.167
Buyer group					
Institutional (0,1)	0.000	1.000	0.150	0.000	0.357
Private (0,1)	0.000	1.000	0.600	1.000	0.490
Public (0,1)	0.000	1.000	0.081	0.000	0.272
Others (0,1)	0.000	1.000	0.169	0.000	0.375
Seller group					
Institutional (0,1)	0.000	1.000	0.112	0.000	0.315
Private (0,1)	0.000	1.000	0.632	1.000	0.482
Public (0,1)	0.000	1.000	0.081	0.000	0.274
Others (0,1)	0.000	1.000	0.175	0.000	0.380
Industrial Type					
Flex (0,1)	0.000	1.000	0.282	0.000	0.450
Warehouse (0,1)	0.000	1.000	0.718	1.000	0.450
# of Observations			6,790		

Table 1 Summary Statistics - Full Sample

Panel D - Apartment

Variable	Min.	Max.	Mean	Median	Std Dev
Price per sq. ft. (in dollar)	15.323	2999.910	244.072	137.996	278.829
Property Size (in 1,000 sq. ft.)	1.465	1925.050	115.105	50.976	144.132
Property age	0.000	207.000	61.103	65.000	34.702
Distance from the nearest coastline	0.001	118.627	6.462	0.819	18.700
Number of the floors	1.000	76.000	4.757	4.000	3.986
Elevation	-2.000	386.634	30.648	17.791	47.933
Within CBD (0,1)	0.000	1.000	0.552	1.000	0.497
Within high flood risk zone (0,1)	0.000	1.000	0.087	0.000	0.282
With high SLR (0,1)	0.000	1.000	0.055	0.000	0.227
Post event (0,1)	0.000	1.000	0.474	0.000	0.499
Portfolio sale (0,1)	0.000	1.000	0.266	0.000	0.442
Purchase Objective					
Investment (0,1)	0.000	1.000	0.883	1.000	0.322
Occupancy (0,1)	0.000	1.000	0.005	0.000	0.068
Redevelopment (0,1)	0.000	1.000	0.019	0.000	0.136
Renovation (0,1)	0.000	1.000	0.059	0.000	0.235
Transaction type - Sale (0,1)	0.000	1.000	0.990	1.000	0.098
Leaseback (0,1)	0.000	0.000	0.000	0.000	0.000
Tenancy Info					
Multiple tenants (0,1)	0.000	1.000	0.980	1.000	0.140
Vacant (0,1)	0.000	1.000	0.018	0.000	0.132
Tenant info missing (0,1)	0.000	1.000	0.002	0.000	0.046
Excess land potential (0,1)	0.000	1.000	0.014	0.000	0.116
Buyer group					
Institutional (0,1)	0.000	1.000	0.129	0.000	0.336
Private (0,1)	0.000	1.000	0.830	1.000	0.375
Public (0,1)	0.000	1.000	0.028	0.000	0.166
Others (0,1)	0.000	1.000	0.012	0.000	0.108
Seller group					
Institutional (0,1)	0.000	1.000	0.113	0.000	0.316
Private (0,1)	0.000	1.000	0.826	1.000	0.379
Public (0,1)	0.000	1.000	0.047	0.000	0.212
Others (0,1)	0.000	1.000	0.014	0.000	0.117
Apartment Type					
Garden (0,1)	0.000	1.000	0.399	0.000	0.490
Mid/Highrise (0,1)	0.000	1.000	0.601	1.000	0.490
# of Observations			11,865		

Table 2 Summary Statistics by Region

Panel A - Office

	Mean			
	NYC	Philadelphia - DC	FL	TX
Price per sq. ft. (in dollar)	518.218	250.712	205.714	151.836
Property Size (in 1,000 sq. ft.)	193.285	148.439	93.889	202.619
Property age	59.758	33.094	27.009	25.748
Distance from the nearest coastline	1.981	6.686	4.573	31.153
Number of the floors	10.431	6.131	4.806	7.893
Elevation	23.797	65.486	7.544	73.605
Within CBD (0,1)	0.660	0.283	0.126	0.126
Within high flood risk zone (0,1)	0.051	0.021	0.208	0.063
With high SLR (0,1)	0.035	0.002	0.132	0.000
Post event (0,1)	0.401	0.387	0.433	0.437
Portfolio sale (0,1)	0.135	0.281	0.183	0.191
Purchase Objective				
Investment (0,1)	0.691	0.801	0.846	0.866
Occupancy (0,1)	0.101	0.066	0.071	0.053
Redevelopment (0,1)	0.120	0.053	0.041	0.027
Renovation (0,1)	0.088	0.080	0.043	0.054
Transaction type - Sale (0,1)	0.984	0.950	0.980	0.963
Leaseback (0,1)	0.044	0.031	0.040	0.035
Tenancy Info				
Single tenant (0,1)	0.079	0.123	0.107	0.134
Multiple tenants (0,1)	0.540	0.565	0.520	0.622
Vacant (0,1)	0.152	0.077	0.080	0.054
Tenant info missing (0,1)	0.229	0.236	0.294	0.190
Excess land potential (0,1)	0.040	0.021	0.025	0.018
Buyer group				
Institutional (0,1)	0.178	0.304	0.166	0.175
Private (0,1)	0.645	0.487	0.678	0.653
Public (0,1)	0.063	0.124	0.073	0.114
Others (0,1)	0.115	0.085	0.082	0.059
Seller group				
Institutional (0,1)	0.185	0.250	0.179	0.222
Private (0,1)	0.621	0.486	0.656	0.604
Public (0,1)	0.059	0.189	0.079	0.098
Others (0,1)	0.135	0.076	0.085	0.076
# of Observations	3,179	3,069	2,547	1,054

Table 2 Summary Statistics by Region

Panel B - Retail

	Mean			
	NYC	Philadelphia - DC	FL	TX
Price per sq. ft. (in dollar)	1006.9900	357.9722	344.3328	201.8538
Property Size (in 1,000 sq. ft.)	29.6333	82.1256	63.7777	79.3503
Property age	66.3470	34.8586	26.0453	18.7041
Distance from the nearest coastline	1.5764	6.9717	5.9714	34.7251
Number of the floors	3.7189	1.4416	1.2550	1.0697
Elevation	20.2014	65.5577	9.0434	77.3282
Within CBD (0,1)	0.7088	0.1631	0.0433	0.0272
Within high flood risk zone (0,1)	0.0441	0.0223	0.1813	0.0672
With high SLR (0,1)	0.0265	0.0042	0.1363	0.0000
Post event (0,1)	0.5373	0.4946	0.5015	0.5502
Portfolio sale (0,1)	0.0990	0.2383	0.1704	0.2832
Purchase Objective				
Investment (0,1)	0.8229	0.8700	0.8854	0.9566
Occupancy (0,1)	0.0394	0.0373	0.0473	0.0111
Redevelopment (0,1)	0.1109	0.0554	0.0453	0.0204
Renovation (0,1)	0.0268	0.0373	0.0220	0.0119
Transaction type - Sale (0,1)	0.9902	0.9561	0.9669	0.9158
Leaseback (0,1)	0.0331	0.0529	0.0321	0.0391
Tenancy Info				
Single tenant (0,1)	0.2452	0.3496	0.2878	0.2364
Multiple tenants (0,1)	0.4951	0.5584	0.6084	0.6998
Vacant (0,1)	0.1472	0.0517	0.0592	0.0459
Tenant info missing (0,1)	0.1125	0.0403	0.0446	0.0179
Excess land potential (0,1)	0.0419	0.0114	0.0172	0.0034
Buyer group				
Institutional (0,1)	0.0867	0.1360	0.1130	0.1480
Private (0,1)	0.7958	0.6408	0.7186	0.7185
Public (0,1)	0.0656	0.1552	0.1001	0.1114
Others (0,1)	0.0520	0.0680	0.0683	0.0221
Seller group				
Institutional (0,1)	0.0797	0.1468	0.1130	0.1293
Private (0,1)	0.8078	0.6360	0.7464	0.6088
Public (0,1)	0.0362	0.1227	0.0842	0.2083
Others (0,1)	0.0763	0.0945	0.0565	0.0536
Retail Type				
Center (0,1)	0.1841	0.4711	0.5357	0.7049
Shops (0,1)	0.8159	0.5289	0.4643	0.2951
# of Observations	3,173	1,662	2,957	1,176

Table 2 Summary Statistics by Region

Panel C - Industrial

	Mean			
	NYC	**Philadelphia - DC**	**FL**	**TX**
Price per sq. ft. (in dollar)	199.581	96.691	105.693	71.327
Property Size (in 1,000 sq. ft.)	98.806	132.657	106.774	152.109
Property age	50.081	29.976	27.895	24.444
Distance from the nearest coastline	2.742	8.987	5.442	27.986
Number of the floors	1.723	1.276	1.177	1.082
Elevation	23.998	59.252	7.158	62.346
Within CBD (0,1)	0.412	0.036	0.048	0.032
Within high flood risk zone (0,1)	0.129	0.025	0.237	0.087
With high SLR (0,1)	0.075	0.010	0.205	0.000
Post event (0,1)	0.425	0.438	0.439	0.578
Portfolio sale (0,1)	0.108	0.249	0.166	0.285
Purchase Objective				
Investment (0,1)	0.654	0.804	0.831	0.839
Occupancy (0,1)	0.153	0.120	0.121	0.131
Redevelopment (0,1)	0.160	0.043	0.030	0.022
Renovation (0,1)	0.033	0.033	0.017	0.007
Transaction type - Sale (0,1)	0.988	0.961	0.965	0.961
Leaseback (0,1)	0.056	0.039	0.048	0.036
Tenancy Info				
Single tenant (0,1)	0.187	0.211	0.155	0.217
Multiple tenants (0,1)	0.197	0.323	0.227	0.364
Vacant (0,1)	0.239	0.143	0.178	0.174
Tenant info missing (0,1)	0.376	0.323	0.440	0.244
Excess land potential (0,1)	0.024	0.025	0.043	0.013
Buyer group				
Institutional (0,1)	0.113	0.191	0.134	0.185
Private (0,1)	0.642	0.541	0.631	0.561
Public (0,1)	0.038	0.115	0.080	0.104
Others (0,1)	0.207	0.153	0.156	0.150
Seller group				
Institutional (0,1)	0.064	0.144	0.111	0.151
Private (0,1)	0.675	0.576	0.666	0.573
Public (0,1)	0.036	0.142	0.054	0.115
Others (0,1)	0.225	0.138	0.169	0.161
Industrial Type				
Flex (0,1)	0.235	0.328	0.286	0.272
Warehouse (0,1)	0.765	0.672	0.714	0.728
# of Observations	1,943	1,938	2,094	815

Table 2 Summary Statistics by Region

Panel D - Apartment

				Mean
	NYC	Philadelphia - DC	FL	TX
Price per sq. ft. (in dollar)	339.829	168.975	131.346	79.891
Property Size (in 1,000 sq. ft.)	51.045	200.986	173.549	226.042
Property age	83.746	43.265	32.269	26.107
Distance from the nearest coastline	0.826	6.686	4.996	33.426
Number of the floors	6.042	4.746	2.763	2.591
Elevation	22.076	66.665	8.481	77.868
Within CBD (0,1)	0.941	0.199	0.032	0.029
Within high flood risk zone (0,1)	0.018	0.014	0.290	0.094
With high SLR (0,1)	0.007	0.003	0.229	0.000
Post event (0,1)	0.441	0.507	0.479	0.589
Portfolio sale (0,1)	0.343	0.195	0.154	0.179
Purchase Objective				
Investment (0,1)	0.926	0.810	0.786	0.920
Occupancy (0,1)	0.006	0.007	0.003	0.000
Redevelopment (0,1)	0.019	0.012	0.027	0.011
Renovation (0,1)	0.038	0.148	0.069	0.060
Transaction type - Sale (0,1)	0.997	0.952	0.987	0.995
Leaseback (0,1)	0.000	0.000	0.000	0.000
Tenancy Info				
Multiple tenants (0,1)	0.974	0.982	0.987	0.992
Vacant (0,1)	0.023	0.018	0.010	0.008
Tenant info missing (0,1)	0.003	0.000	0.002	0.000
Excess land potential (0,1)	0.020	0.006	0.009	0.001
Buyer group				
Institutional (0,1)	0.102	0.222	0.136	0.165
Private (0,1)	0.873	0.686	0.811	0.794
Public (0,1)	0.014	0.070	0.040	0.037
Others (0,1)	0.011	0.023	0.013	0.004
Seller group				
Institutional (0,1)	0.081	0.154	0.128	0.194
Private (0,1)	0.890	0.689	0.779	0.740
Public (0,1)	0.014	0.143	0.079	0.058
Others (0,1)	0.015	0.014	0.013	0.007
Apartment Type				
Garden (0,1)	0.047	0.583	0.894	0.938
Mid/Highrise (0,1)	0.953	0.417	0.106	0.062
# of Observations	6,572	1,190	2,598	1,505

Table 3 Hurricane Sandy - Price Impact (Office)

	Directly Affected Areas: NYC Metro (1)		Slightly Affected Areas: DC & Philadelphia Metros (2)		Unaffected Areas: FL[a] (3)		Unaffected Areas: TX[b] (4)	
Variable	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.
Intercept	12.9165***	0.5702	14.5946***	0.7486	17.1141***	0.9497	15.1682***	1.8158
High flood risk zone	0.0705	0.0746	-0.1239	0.0981	0.1066*	0.0612	-0.1446*	0.0779
Post event 1-2 years	0.1878	0.1392	0.0033	0.1420	-0.2830*	0.1716	0.3135*	0.1835
Post event 3-4 years	0.5005**	0.1992	-0.2502	0.1887	-0.1527	0.2010		
High flood risk zone × post event 1-2 years	-0.2486**	0.1237	-0.0373	0.1437	0.0054	0.0846	-0.0241	0.1291
High flood risk zone × post event 3-4 years	-0.1455	0.1143	0.0597	0.1880	-0.0142	0.0740		
Physical characteristics	YES		YES		YES		YES	
Location characteristics	YES		YES		YES		YES	
Transaction characteristics	YES		YES		YES		YES	
Tenant characteristics	YES		YES		YES		YES	
Buyer & Seller characteristics	YES		YES		YES		YES	
SLR Risk	YES		YES		YES		YES	
County – Fixed effects	YES		YES		YES		YES	
Sale year-season – Fixed effects	YES		YES		YES		YES	
Adjusted R^2	0.6563		0.5634		0.4766		0.4860	
# of Observations	3,158		3,047		1,607		805	

[a]. We only included office sales since Nov. 2007 for the FL region analysis because the State of FL was directly struck by a series of disastrous hurricanes in 2004 and 2005 which may have an impact on the local property market for a few years.

[b]. We included office sales till Oct. 2014 for the TX region analysis because Houston was heavily flooded during the Memorial Day in 2015, one of the worst flooding histories in the U.S.

Statistical significance is indicated as follows: * p<0.1; ** p<0.05; *** p<0.01

Table 4 Hurricane Sandy – Price Impact (Retail) [a]

	Directly Affected Areas: NYC Metro (1)		Unaffected Areas: FL[b] (2)		Unaffected Areas: TX[c] (3)	
Variable	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.
Intercept	12.4340***	0.6611	21.2906***	0.8309	18.1901***	1.4920
High flood risk zone	0.0262	0.0932	0.0383	0.0691	-0.0680	0.0709
Post event 1-2 years	0.1849	0.1333	0.1760	0.1635	0.5394**	0.2390
Post event 3-4 years	0.2283	0.1740	-0.2548	0.2032		
High flood risk zone × post event 1-2 years	-0.1686	0.1392	0.0308	0.0842	0.0259	0.1582
High flood risk zone × post event 3-4 years	-0.0802	0.1257	0.0150	0.0823		
Physical characteristics	YES		YES		YES	
Location characteristics	YES		YES		YES	
Transaction characteristics	YES		YES		YES	
Tenant characteristics	YES		YES		YES	
Buyer & Seller characteristics	YES		YES		YES	
SLR Risk	YES		YES		YES	
County- Fixed effects	YES		YES		YES	
Sale year-season -- Fixed effects	YES		YES		YES	
Adjusted R^2	0.6172		0.6343		0.5853	
# of Observations	3,173		2,047		747	

[a.] We did not perform the Diff-in-Diff analysis for the DC & Philadelphia Metros because

[b.] We only included sales since Nov. 2007 for the FL region analysis because the State of FL was directly struck by a series of Hurricane in 2004 and 2005 which may have an impact on the local property market for a few years.

[c.] We included sales till Oct. 2014 for the TX region analysis because Houston was heavily flooded during the Memorial Day in 2015, one of the worst flooding histories in the U.S.

Statistical significance is indicated as follows: * p<0.1; ** p<0.05; *** p<0.01

Table 5 Hurricane Sandy - Price Impact (Industrial)

	Directly Affected Areas: NYC Metro (1)		Slightly Affected Areas: DC & Philadelphia Metros (2)		Unaffected Areas: FL [a] (3)		Unaffected Areas: TX [b] (4)	
Variable	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.
Intercept	17.1201***	0.8770	18.8989***	1.1056	22.1614***	1.1244	18.7876***	2.3001
High flood risk zone	0.0373	0.0516	-0.0132	0.0847	-0.0717	0.0532	0.1188	0.0769
Post event 1-2 years	-0.1468	0.1480	-0.0038	0.1432	-0.1882	0.1576	0.2311*	0.1177
Post event 3-4 years	-0.1420	0.2079	0.0947	0.1943	0.0057	0.2014		
High flood risk zone × post event 1-2 years	-0.0456	0.0846	0.2688	0.1684	0.0334	0.0717	-0.0505	0.1250
High flood risk zone × post event 3-4 years	0.0581	0.0817	0.1801	0.1649	0.0793	0.0670		
Physical characteristics	YES		YES		YES		YES	
Location characteristics	YES		YES		YES		YES	
Transaction characteristics	YES		YES		YES		YES	
Tenant characteristics	YES		YES		YES		YES	
Buyer & Seller characteristics	YES		YES		YES		YES	
SLR Risk	YES		YES		YES		YES	
County- Fixed effects	YES		YES		YES		YES	
Sale year-season -- Fixed effects	YES		YES		YES		YES	
Adjusted R^2	0.7289		0.6159		0.6507		0.5273	
# of Observations	1,943		1,933		1,311		485	

[a]. We only included sales since Nov. 2007 for the FL region analysis because the State of FL was directly struck by a series of Hurricane in 2004 and 2005 which may have an impact on the local property market for a few years.

[b]. We included sales till Oct. 2014 for the TX region analysis because Houston was heavily flooded during the Memorial Day in 2015, one of the worst flooding histories in the U.S.

Statistical significance is indicated as follows: * p<0.1; ** p<0.05; *** p<0.01

Table 6 Hurricane Sandy - Price Impact (Apartment) [a]

	Directly Affected Areas: NYC Metro (1)		Unaffected Areas: FL [b] (2)		Unaffected Areas: TX [c] (3)	
Variable	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.
Intercept	18.8180***	0.5598	18.8108***	0.9165	8.9037***	3.5029
High flood risk zone	-0.1653**	0.0713	0.0050	0.0504	-0.0657	0.0521
Post event 1-2 years	0.1531**	0.0733	-0.2107	0.1315	-0.0052	0.1324
Post event 3-4 years	0.3177***	0.1081	-0.2182	0.1619		
High flood risk zone × post event 1-2 years	0.2811***	0.1066	0.1272**	0.0594	0.0751	0.0835
High flood risk zone × post event 3-4 years	0.0996	0.1137	0.0869	0.0562		
Physical characteristics	YES		YES		YES	
Location characteristics	YES		YES		YES	
Transaction characteristics	YES		YES		YES	
Tenant characteristics	YES		YES		YES	
Buyer & Seller characteristics	YES		YES		YES	
SLR Risk	YES		YES		YES	
County- Fixed effects	YES		YES		YES	
Sale year-season -- Fixed effects	YES		YES		YES	
Adjusted R^2	0.7128		0.6454		0.6134	
# of Observations	6,554		1,672		1,000	

[a.] We did not perform the Diff-in-Diff analysis for the DC & Philadelphia Metros because there are too few apartment sales located in high flood risk zones after the event.

[b.] We only included sales since Nov. 2007 for the FL region analysis because the State of FL was directly struck by a series of Hurricane in 2004 and 2005 which may have an impact on the local property market for a few years.

[c.] We included sales till Oct. 2014 for the TX region analysis because Houston was heavily flooded during the Memorial Day in 2015, one of the worst flooding histories in the U.S.

Statistical significance is indicated as follows: * p<0.1; ** p<0.05; *** p<0.01

Table 7 Hurricane Sandy - Price Impact - NYC Metros

	All		Mid/Highrise	
Variable	Coeff.	Std. Err.	Coeff.	Std. Err.
Intercept	18.8180***	0.5598	19.1448***	0.6017
High flood risk zone	-0.1653**	0.0713	-0.2536***	0.0780
Post event 1-2 years	0.1531**	0.0733	0.1480*	0.0761
Post event 3-4 years	0.3177***	0.1081	0.2935***	0.1115
High flood risk zone × post event 1-2 years	0.2811***	0.1066	0.3452***	0.1142
High flood risk zone × post event 3-4 years	0.0996	0.1137	0.2720**	0.1315
Physical characteristics	YES		YES	
Location characteristics	YES		YES	
Transaction characteristics	YES		YES	
Tenant characteristics	YES		YES	
Buyer & Seller characteristics	YES		YES	
SLR Risk	YES		YES	
County- Fixed effects	YES		YES	
Sale year-season -- Fixed effects	YES		YES	
Adjusted R^2	0.7128		0.7185	
# of Observations	6,554		6,242	

Statistical significance is indicated as follows: * p<0.1; ** p<0.05; *** p<0.01

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