Climate and Real Estate (3)
Topical discussions

Siqi Zheng

March 2023
(MIT Center for Real Estate)
Outline

- Climate risks in commercial real estate markets
- Insurance market crisis
- Climate resiliency investments in coastal areas
CLIMATE RISKS IN COMMERCIAL REAL ESTATE MARKETS
Commercial Real Estate vs. Residential

Common ground
- Physical damage
- Increased insurance costs
- Reduced demand

What are the differences?
1. CRE: more sophisticated investors

Survey of 439 executives about the role of climate risks for their institutions

Expectations of Institutional Investors for the global temperature rise by the end of this century

Real Estate Investors Want to Know What Cities Are Doing About Climate Risks

The real estate industry is increasingly looking at how resilient communities are to natural disasters before deciding whether to buy or develop land.
2. CRE: Corporation Image and Fiduciary Responsibility

Navigating the Transition: Managing Climate Risks and Opportunities
Morgan Stanley’s Task Force on Climate-related Financial Disclosures Report, 2020

From Our CEO
Our world faces great uncertainty as the impacts of a global pandemic, changing climate and growing inequalities unfold simultaneously. Against this backdrop, it is increasingly clear that business must engage, not stand apart from, the pressing environmental and societal issues facing us all.

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3. CRE: Higher Regulatory and Industry Standard Bars

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Reduced income

Increased cost

Discount rate i (cost of capital)

Cash flow

Higher discount rate

Higher finance cost

Equity

Debt


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MIT/CRE + Moody’s Analytics

Using Measured Impact + Expected Increase of Hazards to Model NOI

We adjust our baseline forecast for each submarket accounting for:

- Disaster impact (derived from empirical analysis)
- Event likelihood (derived from our climate hazard risk scores)

The analysis is available through Moody’s CMM (Commercial Mortgage Metrics)

Source: Moody’s Analytics CRE

Translate NOI Impact to Loan EL

1) Empirical disruption from disasters
2) Forward looking frequency & magnitude scoring
3) Model loan EL impact

Moody’s Commercial Mortgage Metrics (CMM) Output

Source: Moody’s Analytics CRE (output from Commercial Mortgage Metrics CRE loan risk model)
Siqi’s Research: Hurricane and CRE

• Quantifying the Impacts of Climate Shocks in Commercial Real Estate Markets (Hurricane Sandy, 2012; Hurricane Harvey, 2017)

• Authors: Rogier Holtermans, University of Guelph; Dongxiao Niu, Maastricht University; Siqi Zheng, MIT

○ Commercial real estate transactions (Real Capital Analytics)
  Transaction date, price, location, property type, quality, buyer and seller characteristics, etc.

○ Hurricanes (3-meter surge map from FEMA Modeling Task Force)
  Final sample: 10,359 transactions in New York and 15,312 in Texas State

Notes: This Figure shows the surge level of inundation area by Census block group in Texas and New York, with a focus on Houston and New York City. The blue shades indicate surge level (feet).
Siqi’s Research: Hurricane and CRE

- DID model using hurricanes as a climate shock (Ortega and Taşpinar, 2018; Gibson and Mullins, 2020, Meltzer et al., 2021)

\[
\text{Price}_{it} = \alpha_0 + \alpha_1 \cdot \text{Post}_t + \alpha_2 \cdot \text{Surge}_i + \alpha_3 \cdot \text{Surge}_i \cdot \text{post} + \beta \cdot \text{Hedonics}_{it} + T_t + \sigma_c + \mu_{ict}
\]

- Property transaction price per sq. ft. for property \(i\) at time \(t\)
- Property damage measure (i) surge dummy; (ii) average surge level (feet) at census block level; (iii) high surge (>3 feet) and low surge dummies
- Hedonics: property types, building attributes, such as age, size, number of stories, building quality, etc.
- Year-quarter time trends, Census tract fixed effects
Baseline results – decrease in transaction price

<table>
<thead>
<tr>
<th></th>
<th>Texas</th>
<th>New York</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
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<td>Post</td>
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<td>-0.040</td>
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<td></td>
<td>(0.049)</td>
<td>(0.048)</td>
<td>(0.048)</td>
<td>(0.033)</td>
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<td></td>
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<td>Post × Surge dummy</td>
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<tr>
<td></td>
<td>(0.017)</td>
<td>(0.021)</td>
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<tr>
<td>Mean surge</td>
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<td>0.004</td>
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<tr>
<td>Post × Mean surge</td>
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<td>(0.008)</td>
<td>(0.008)</td>
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<tr>
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<tr>
<td></td>
<td>(0.042)</td>
<td>(0.033)</td>
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<tr>
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<td>0.057*</td>
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<tr>
<td></td>
<td>(0.043)</td>
<td>(0.031)</td>
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<tr>
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<td>(0.022)</td>
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<tr>
<td></td>
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<tr>
<td>R²</td>
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<td>0.703</td>
<td>0.703</td>
<td>0.912</td>
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</table>

Notes: Standard errors are reported in brackets. Significance at the 0.10, 0.05, and 0.01 level is indicated by *, **, and ***.
Inconsistency between ex ante information on underlying climate risk and ex post damage from actual events

Heterogeneity: Place – Price of New news

**Inundated Area**
- FEMA floodplain
- Non floodplain

**Off-Floodplain**
- Inundation
- No inundation

**Texas**
- Inundation: 9%
- No inundation: 91%

**New York**
- Inundation: 16%
- No inundation: 84%
Heterogeneity: Place – Price of New news

- Hurricane discount mainly observed outside of flood zones (New news can be costly).
- Investors already capitalize flood risks into their asset value based on the flood zone designation.

<table>
<thead>
<tr>
<th></th>
<th>Dependent Variable: Log (Price/sq. ft.)</th>
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<tr>
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<td>Inside-zone (1)</td>
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<td>R²</td>
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</table>

Notes: Standard errors are reported in brackets. Significance at the 0.10, 0.05, and 0.01 level is indicated by *, **, and ***.
Hurricane and CRE

- Proximity (to coast, elevation) lowers commercial real estate price after Hurricane Sandy
  - New York directly hit by Sandy and damaged
  - Boston spared by Sandy but at risk
  - Chicago unaffected due to in-land waterfront location

<table>
<thead>
<tr>
<th></th>
<th>Main Effect</th>
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<tbody>
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<td></td>
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<td>Boston (2)</td>
<td>Chicago (3)</td>
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<td>Proximity</td>
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<td>-0.095***</td>
<td>-0.004</td>
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<td>(-2.579)</td>
<td>(-3.346)</td>
<td>(-0.082)</td>
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<td>-0.687**</td>
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<td>(-2.697)</td>
<td>(1.730)</td>
<td>(-2.448)</td>
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<td>0.781</td>
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<td>(0.762)</td>
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<td>Year-Fixed Effects</td>
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<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Zip Code-Fixed Effects</td>
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<td>Yes</td>
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<tr>
<td>Observations</td>
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<td>1,394</td>
<td>951</td>
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<td>Adj. R-squared</td>
<td>0.190</td>
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INSURANCE MARKET CRISIS
The National Flood Insurance Program (NFIP)

Introduction to the NFIP program.

- Insurance rate is determined by the location of your property with respect to the **flood zones**.
- Homeowners can reduce the insurance premium by **elevating the building** (example presented on the right).

Note: Calculation based on $250,000 building coverage only (does not include content). AE (high to moderate) zone, single-family, one-story structure without a basement. The calculation is based on standard NFIP deductible.

Left: © source unknown; right: © Flood Proof. All rights reserved. This content is excluded from our Creative Commons license. For more information, see [https://ocw.mit.edu/help/faq-fair-use/](https://ocw.mit.edu/help/faq-fair-use/).
The National Flood Insurance Program (NFIP)

Introduction to the NFIP program.

- Other mitigation efforts: Example of a New York building (link)
Can we insure against Climate Risk?

Discussion about the possibility of owners to insure properties against climate change.

- The prevailing strategy among real estate investors to use insurance as their primary means to protect their properties against extreme weather and climate events (ULI & Heitman, 2020).

- The number of disasters is growing, and the losses for insurance companies are also growing
  - The basic economics of insurance companies is to stabilize income: transfer money from good times (no disaster) to bad times (disaster period)
  - The increase in frequency and severity of disasters challenges the traditional business model. Consequences: Rise premiums and rise in number of uninsured properties.

Source: Swiss re (2020) Natural catastrophes in times of economic accumulation and climate change

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Hurricane Harvey resulted in significant home price discounts inside the 100-year floodplain.

- Before Harvey, homes inside the flood zone in Harris County, which is home to Houston, sold for 2.3 percent less than those outside the area. After Harvey hit, that discount more than doubled to 5.5 percent.

Fannie Mae and Freddie Mac, the government-sponsored, taxpayer-backed enterprises that stand behind roughly half of the nation’s $11 trillion in residential mortgages.

However FMs don’t price differently loans with and without climate risk in the finance houses

- Pricing those risks is likely to introduce discrimination into the housing markets, and compromise social justice since minorities are overly exposed to certain climate risks.
Climate change threatens U.S. mortgage market

Are we creating a new housing bubble?

- Fannie and Freddie rely on another government enterprise, the National Flood Insurance Program (NFIP), to cover the cost of flood damage to homes with their mortgages. But the flood insurance program itself is insolvent after years of paying out more than it collects.

- Homes in flood plains are **overvalued by $34 billion** because homebuyers don’t fully price in the high risk of climate-related disasters.

- Mortgage in floodplains are rising steadily from 2006 onwards:
  - Nearly 600,000 houses were built in 100-year floodplains, bringing to 7 million homes
  - 300,000 mortgages were added to homes in floodplains, bringing the total number of loans to 4.1 million.

- However, insurance policies in floodplains shrunk: 2.5 million residential structures insured in 2008. Which had fallen to fewer than 1.8 million in 2019.
SUL Research: Climate Risk and Appraisal Values

How climate risks lead to mis-valuation of single-family homes in climate-vulnerable neighborhoods in the appraisal process

- **Step 1**: comparing the appraisal value of homes under high climate risk with homes with low risk and otherwise similar attributes. By comparing the “climate risk discount” in the appraisal value and in the transaction value, we can examine how climate risks affect the deviation of appraisal value to the transaction value, i.e., *appraisal bias*.

- **Step 2**: studying the heterogeneity in the appraisal value difference regarding information provision, actual climate shocks, and neighborhood attributes.

**Data:**
1. Appraisal record and transaction record
2. Climate risk/shocks data
3. Regulatory and socio-economic data

Team: Siqi Zheng (MIT), Nils Kok (UM), Juan Palacios (MIT/UM), Dongxiao Niu (UM)
Low Take-up of Flood Insurance

The New York Times

Hurricane Ian’s Toll Is Severe. Lack of Insurance Will Make It Worse.

In Florida’s hardest-hit counties, fewer than 1 in 5 homes have flood insurance. That means communities will struggle to rebuild, experts warn.
Low Take-up of Flood Insurance

Low take-up rate and inequality.

- Low insurance take-up: Only 20%, among the households flooded in New York City during Hurricane Sandy and in the greater Houston area during Hurricane Harvey.
- Higher take-up rate for highly educated group and for people getting mortgage within the Special Flood Hazard Area (SFHA, “flood zone”).
- Problems beyond low take-up: NFIP uses broad, outdated, and inaccurate flood zone designation
  - Adverse selection: High-risk households get insured.
  - Rainfall-related flood risks are not considered.
    - 1/3 of flood claims are out of the SFHA


Insurance Market Regulation

“Risk Rating 2.0”: More accurate flood risk assessment and fairer price.

The New York Times

The Cost of Insuring Expensive Waterfront Homes Is About to Skyrocket

New federal flood insurance rates that better reflect the real risks of climate change are coming. For some, premiums will rise sharply.

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Insurance Market Regulation

“Risk Rating 2.0”: More accurate flood risk assessment and fairer price.

- Public flood insurance payouts in the US have increased **twentyfold** in the past two decades.
- High claims years beginning in 2005 and continuing with major storms in 2008, 2012, and 2017 have led the NFIP program to **carry a debt exceeding $20 billion** despite Congressional approval for $16 billion in debt forgiveness after Hurricane Harvey in 2017.
- Since October 1, 2021 (for new policies) or Apr 1, 2022 (for renew policies): “**Risk Rating 2.0**”
  
  (1) Will reflect individual property’s flood risk; (2) use the latest actuarial practices to set risk-based rates.

Source: [https://www.fema.gov/flood-insurance/risk-rating](https://www.fema.gov/flood-insurance/risk-rating). Public domain image courtesy of FEMA.
Insurance Market Regulation

“Risk Rating 2.0”: More accurate flood risk assessment and fairer price.

- A more accurate mapping of the actual flood risk for properties will create major shifts in pricing. (picture on the right shows the NFIP mispricing)
  - Largest gaps in the **Southeast and Mid-Atlantic regions** in places such as Florida, South Carolina and New Jersey.

- However, even a modest increase could prove difficult for **lower-income** communities.
  - Three hours to the southwest in Monongalia County, West Virginia, more than a fifth of households fall below the federal poverty level. The most severe flood-prone homes there would have to pay premiums 527% higher than today to cover the risk.

Insurance rate regulations cause private insurance companies to leave.

- State regulations on insurance rate: Change premiums (rates) needs lengthy regulatory review and approval.
- Some regulators require home-insurance rates based on **historical loss experience**, not **projections of future losses** that are determined by catastrophe modeling.

- "**high friction**" drives the decoupling of insurance rates from underlying risks.
- Insurance companies are **leaving**:
  E.g., Insurance giants Chubb, Liberty Mutual, and AIG have announced plans to scale back their homeowner coverage in California, where they insist future climate-related losses will likely prevent them from turning a profit.


Source 2: https://jacobin.com/2022/02/california-wildfires-home-insurance-coverage-fossil-fuel-industry

Public domain content courtesy of Federal Reserve Board.
CLIMATE RESILIENCY INVESTMENTS IN COASTAL AREAS
Expanding Coastal Population Escalates the Risk
Building Back Bigger

Expanding coastal population escalates the risk.

- Despite decades of regulatory efforts in the US, exposure of residential assets to hurricane damage is increasing.
- Comparing plan-view footprints of individual residential buildings before and long after major hurricane strikes, the authors find a systematic pattern of ‘building back bigger’ among renovated and new properties.

Developers Went to Locations with Low Climate Beliefs

Climate belief also plays a role.

Climate Resiliency Investment Strategies

Source: https://miami-dade-county-sea-level-rise-strategy-draft-mdc.hub.arcgis.com/. © Miami-Dade County, FL. All rights reserved. This content is excluded from our Creative Commons license. For more information, see https://ocw.mit.edu/help/faq-fair-use/.
Leave or Rebuild? Striking Inequality

Miami Says It Can Adapt to Rising Seas. Not Everyone Is Convinced.

Officials have a new plan to manage rising water. Succeed or fail, it will very likely become a case study for other cities facing climate threats.

Climate Change Is Bankrupting America’s Small Towns

Repeated shocks from hurricanes, fires and floods are pushing some rural communities, already struggling economically, to the brink of financial collapse.
A Tale of Two Towns: Miami-Dade and NC- Fair Bluff

Rich coastal regions are also acting to prevent population loss.

- Disaster experts have increasingly urged local officials to reduce their exposure by encouraging people to leave vulnerable areas. But cities and counties often resist that advice, worrying that retreat would hurt their economies and upset voters.

- Example: Miami-Dade County
  - An upbeat strategy for living with more water.
  - With some of the most expensive coastal real estate in the world, it has an ample tax base to experiment with solutions — and also enormous economic incentive to dissuade buyers and investors from leaving.

Source: [https://www.nytimes.com/2021/03/02/climate/miami-sea-level-rise.html?searchResultPosition=62](https://www.nytimes.com/2021/03/02/climate/miami-sea-level-rise.html?searchResultPosition=62) © New York Times. All rights reserved. This content is excluded from our Creative Commons license. For more information, see [https://ocw.mit.edu/help/faq-fair-use/](https://ocw.mit.edu/help/faq-fair-use/).
Repeated climate disasters cause small towns to face existential threats.

- Climate shocks are pushing small rural communities, many of which were already struggling economically, to the brink of insolvency.

- Example: Downward spiral of the Fair Bluff
  
  - A small town in eastern North Carolina, hit by 19 hurricanes between 1954 and 2016
  
  - Rather than bouncing back, repeated disasters cause residents and employers leave (aided by buyout programs), the tax base shrinks and it becomes even harder to fund basic services.

  - Rebuild plan: Turn the old downtown into park and build a new downtown. Yet $10M is too much.
Leave or Rebuild? Striking Inequality

Income and race inequality in WTP and sorting.

- Low income and minority residents are more likely to move into high risk flood zones.
  - White/Asian people with low incomes are willing to pay $710 per year to avoid living in an area at high risk of flooding. Black: $500; Hispanic: $618.
  - The WTP is rising with income.

- The costs of insurance price reform fall more heavily on low income and Black/Hispanic residents as a fraction of annual income.

FEDERAL INFRASTRUCTURE INVESTMENT
Federal Infrastructure Investment

Federal grey infrastructure reinforces coastal development.

- The **2021 Bipartisan Infrastructure Act**: Allocate $47 billion over several years for climate resiliency. Mostly to protect existing infrastructure.
- **Moral Hazard**
  Would government spending reinforce the expansion of high-risk zone?

- **Example: In Charleston, S.C.**
  - The city is considering a $1.1 billion project, largely funded with federal money, to build an eight-mile-long sea wall to protect infrastructure.
  - It also has approved a development on what is largely Guggenheim family land to place thousands of new structures in the flood plain.


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Federal Infrastructure Investment

Billions for climate protection fuel new debate: Who deserves it most?

- Historically, it is wealthier, white communities — with both high property values and the resources to apply to competitive programs — that receive the bulk of federal grants.

- The new climate provisions in the infrastructure bill inject billions of dollars into competitive grant programs. Cities/counties submit applications and federal agencies rank.
  - The ability of local officials to use sophisticated tools and resources to write successful applications differs.
  - Communities are required to pay a share of the project — often 25 percent, which is unaffordable for struggling towns/counties.
  - Cost-effective: Governments need to demonstrating the value of the property that would be protected is greater than the cost of the project, giving disadvantage to low-income neighborhoods.

Is Managed Retreat an Option?

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Is Managed Retreat an Option?

- What is different for managed retreat?
  1. Buyouts on a much **larger scale** (greater numbers of people/whole neighborhoods)
  2. Ideally doing it **before disaster strikes**.

- The Obama administration began experimenting with relocation after Hurricane Sandy in 2012. The program ended by President Trump.
- The Federal Emergency Management Agency detailed a new program, worth an initial **$500 million**, with billions more to come, for large-scale relocation nationwide; A similar $16 billion program is started by The Department of Housing and Urban Development.
- New Jersey has bought and torn down some 700 flood-prone homes around the state and made offers on hundreds more

Discussion: *What would be the pros and cons of managed retreat?*