CLIMATE FINANCE

Yale SCHOOL OF MANAGEMENT

Stefano Giglio

Yale School of Management

CLIMATE CHANGE

- **Climate change** is a fundamental issue facing society for the close and more distant future

- Complex phenomenon, that requires many complementary approaches

- **Approaches** typically classified as:
  - Mitigation
  - Adaptation
  - Monitoring

- **Climate finance:** how can financial markets contribute to a solution?

CLIMATE CHANGE AND FINANCIAL MARKETS

- **Financial markets** play several important roles in addressing climate change
  1. **Information**: provide important inputs for economic and policy decisions (mitigation, adaptation, monitoring)
  2. Allocation of **funds** to sustainable investments and promoting technological transition (mitigation)
  3. Managing and **sharing climate risks** (adaptation)

- Recent explosion of research on all three aspects

FINANCIAL MARKETS

- Today's talk will revolve around **prices**, and the role they play in determining how finance can contribute to a solution
  1. Are **climate risks reflected in asset prices**? By how much?
  2. How can we use financial markets to **hedge and share** climate risks? (adaptation)
  3. How can **information** from financial markets be useful for climate decision-making? (mitigation)

1. HOW ARE CLIMATE RISKS REFLECTED IN ASSET PRICES?

CLIMATE RISK AND ASSET PRICES

Main challenges in understanding the effect of climate change on asset prices:

1. **What climate risk?** How to measure it?
   - Physical risk
   - Transition risk
2. How to **measure** climate risk exposures (betas)?
3. How to properly **identify** the price effect of climate exposure (vs. confounders)?

WHAT CLIMATE RISK?

Most important risk sources depends on the asset class

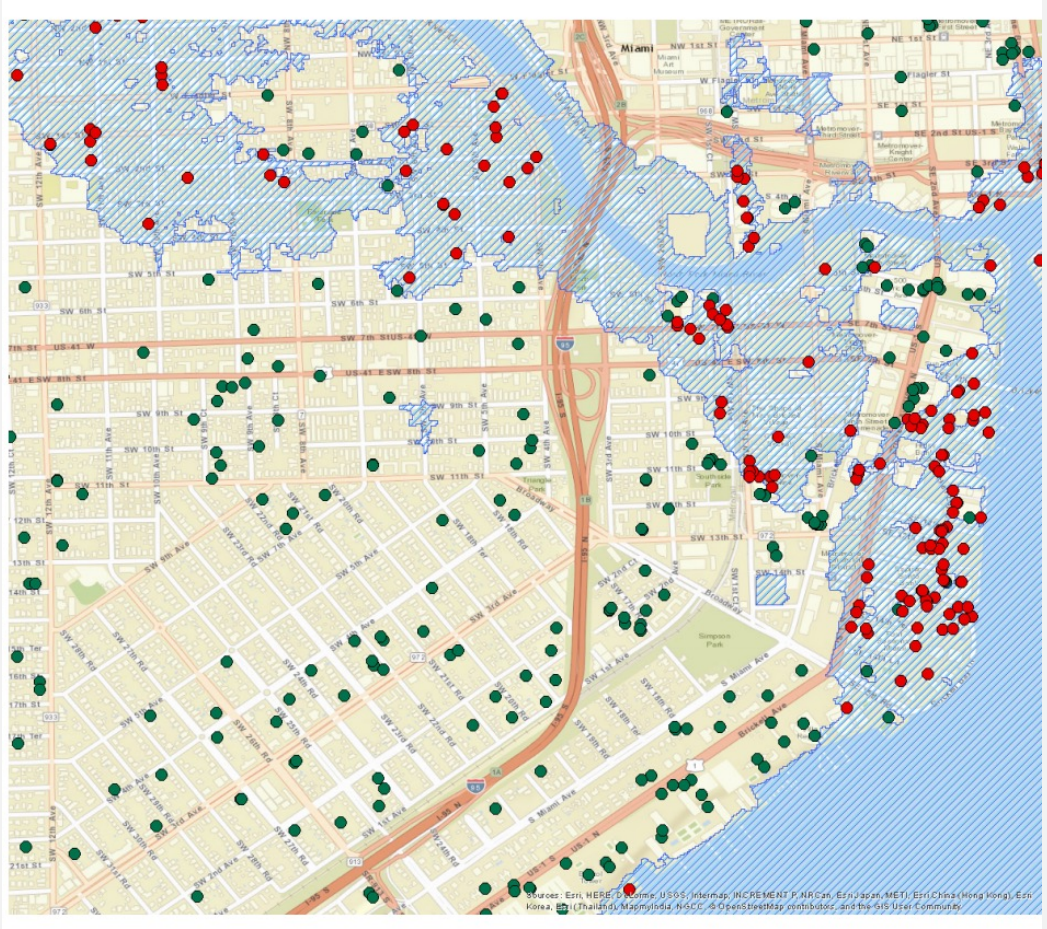
- **Real estate**: Exposure to physical risks through sea level rises or wildfire
  - Giglio, Maggiori, Rao, Stroebel, Weber (2021)
- **Equities**: Exposure to transition/regulatory risks through carbon emissions intensity
  - Engle, Giglio, Kelly, Lee and Stroebel (2020)
  - Bolton and Kacperczyk (2020)
- **Municipal bonds**: Physical risks because of location of tax base
- **Sovereign debt**: Physical risk (Bangladesh); Transition risk (UAE)

IDENTIFYING CLIMATE EXPOSURES

- The hardest step is to identify and measure **risk exposures** and their price effects
- Issues:
  - Scarcity of **historical data** (limited awareness of climate risk by investors in the past)
  - Climate risk exposures **correlated** with other (potentially unobservable) characteristics: for example, houses on the beach are more exposed but offer better amenities
- A variety of possible **identification strategies** that apply methods in asset pricing and corporate finance

EXAMPLE: HOUSING MARKET

- Giglio et al. (2021): look at 4 states on the east coast of the US
- Compute exposure to 6-feet sea level rise for all houses using NOAA maps
- Example of downtown Miami
- Can we compare price **levels**?

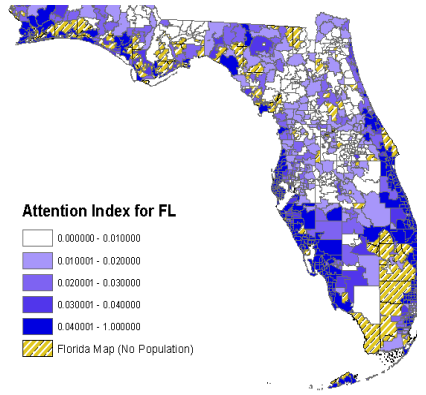


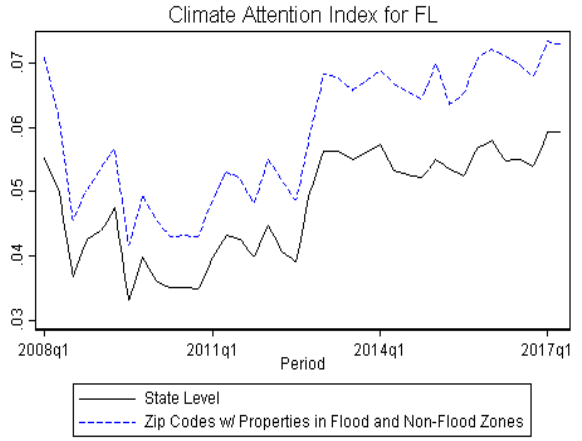
Giglio, Maggiori, Rao, Stroebel, and Weber (2021), "Climate change and long-run discount rates: Evidence from real estate", Review of Financial Studies

EXAMPLE: HOUSING MARKET

- Instead of comparing price levels, we can compare how house prices react differentially as people's **perception** of climate risks changes
- Build a measure of local attention to climate change by studying real estate listings
- **Result:** when climate attention increases, houses exposed to sea level rise drop in value relative to those not exposed

Example 1: Diamond in the Rough on water with pier and dock! **Owner holds letter of expemption from FEMA, stating high elevation, flood insurance may not be required,** minutes to area beaches, Close to Jacksonville and Wilmington.





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OTHER ASSET CLASSES

- A blooming literature has expanded the study to many other asset classes beyond real estate
- Other asset classes: equities, sovereign, corporate, municipal bonds, mortgages
- Identification strategies vary by asset class

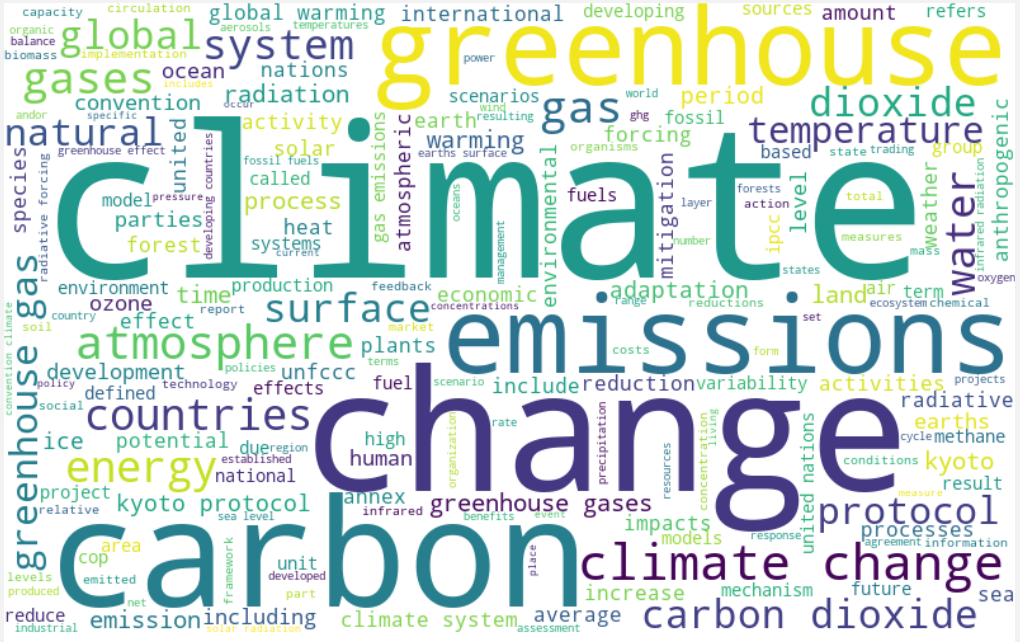
EQUITIES

- For **equities** we can have direct proxies for climate risk exposures using firm characteristics (e.g., **ESG scores**)
- Idea: if climate risk is priced in equities, and ESG scores capture that, then we should see high-ESG score companies do better than low-ESG score companies when **climate events** occur
- Two main issues
  1. Are ESG scores reliable? Berg et al. (2022)
  2. What is a "climate event" that should affect the prices of green and polluting companies differently?

Engle, Giglio, Lee, Kelly, and Stroebel (2020) "Hedging climate change news"

EQUITIES

- Build a climate index from **newspapers**
- First, we build a climate change **vocabulary**
  - 19 climate change white papers on from the IPCC, EPA, USGCRP
  - 55 climate change glossaries (UN, BBC, IPCC, NASA, EPA, etc.)
- Then look at **cosine similarity** between WSJ text and the vocabulary in each day



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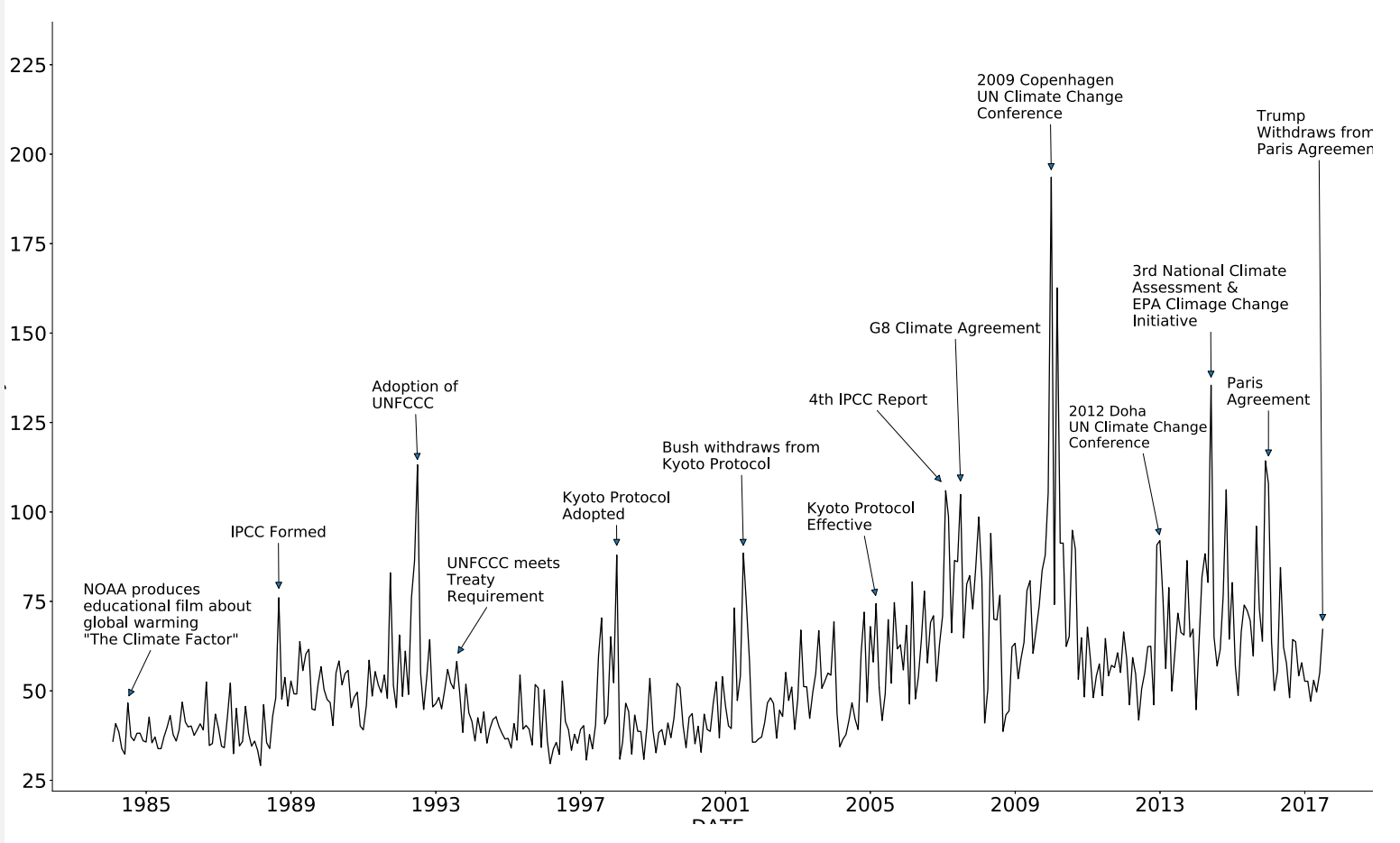
EQUITIES



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EQUITIES

- Indeed, we find that a portfolio that goes long high-E score companies and short low-E score companies makes money when this index spikes, a sign that the market has incorporated the climate effects in asset prices

- So in equities, just as in real estate, **prices reflect climate exposures!**

Engle, Giglio, Lee, Kelly, and Stroebel (2020) "Hedging climate change news"

HOW MUCH?

- By now, very convincing evidence that climate change is priced across asset classes
- Can we say it's priced **correctly?**
- **Two (equivalent) ways** to think about this:
  1. When prices of an asset are lower because of climate risk exposure, are they **low enough?**
  2. Are the **expected returns** of high-climate-risk (polluting) companies high enough? Are those of green companies low enough, reflecting negative exposure to climate risks?
- Fundamental **short-sample** problem.
  - Climate risk has been recognized in financial markets only recently, say 10-15 years.
  - Suppose you observe green investments do well in this period. Is it that they have a high expected return, or a low expected return but our sample contains many bad climate news events?
  - Can't properly compute expected returns from short samples

2. HEDGING CLIMATE RISKS

HEDGING CLIMATE RISKS

- What to do with the information contained in prices?
- An important use is **sharing and hedging** climate risks
- Idea is simple: once I have identified assets (e.g., equities, houses, bonds, etc) with high/low beta with respect to climate risks, I can build a **synthetic insurance**
  - Long-short portfolio which appreciates when bad climate events happen
- Why is this useful?
  - For many important risks (e.g., inflation) we have derivative markets that can help share those risks, transferring them to whoever is best suited to hold them
  - Not for climate change
  - Yet, important part of **adaptation**, since notwithstanding our mitigation efforts, some residual risk will remain

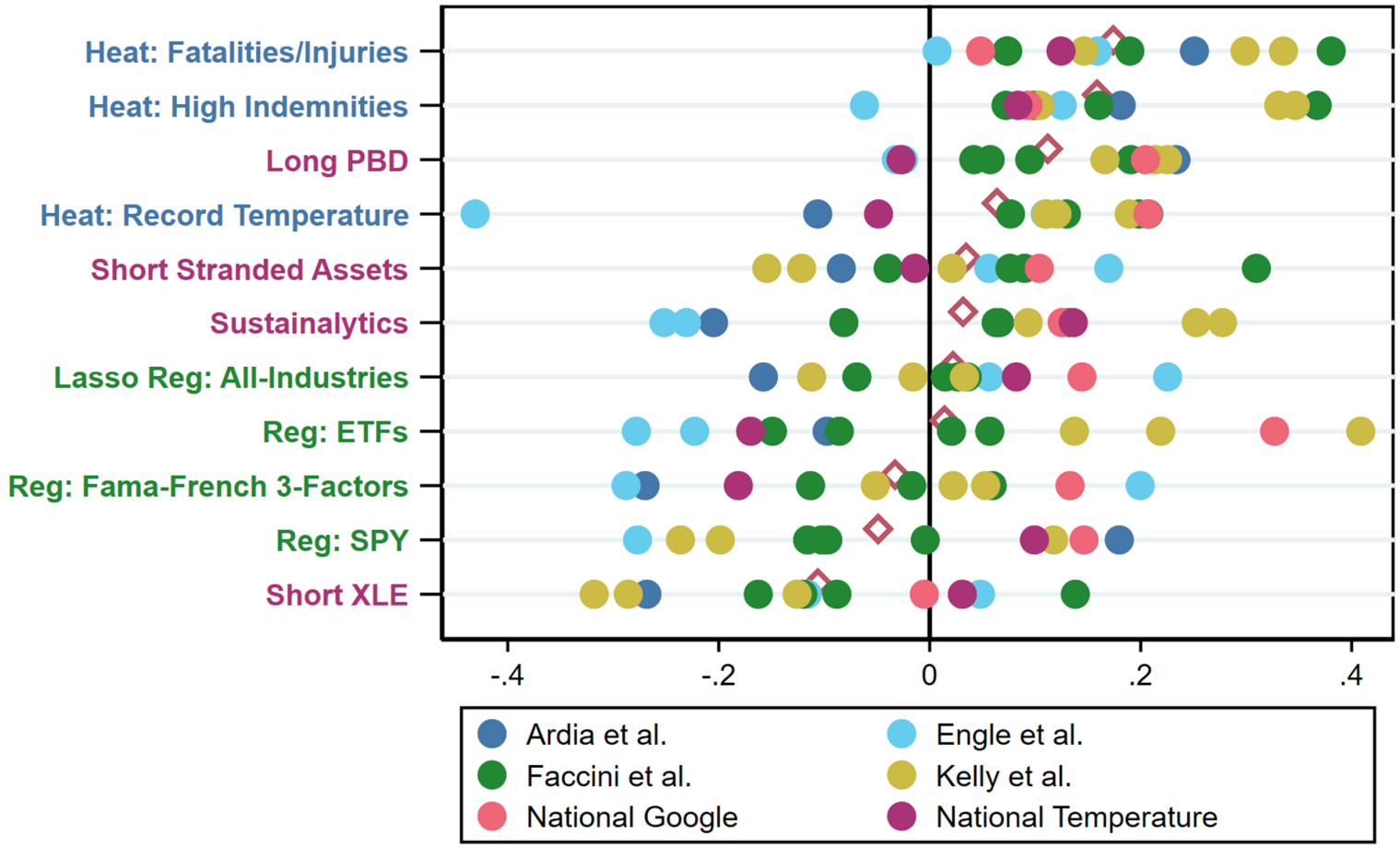
HEDGING CLIMATE RISKS

- Two traditional approaches to climate risk hedging:
  1. "**Narrative**" approach: use prior intuition on which stocks will appreciate or lose value when climate events occur
     - What if the prior is wrong?
     - E.g., natural to short XLE, but actually it did well over the last few years in response to climate news
  2. "**Mimicking-portfolio**" approach: look at which stocks did well **historically**, use this information to build a portfolio
     - Relies on prices reflecting climate risks, suffers from short time series

BUILDING A HEDGING PORTFOLIO

- New "**quantity-based**" approach (Alekseev, Giglio, Maingi, Selgrad and Stroebel 2020):
  - Study how fund managers react to **local heat shocks** that affect them directly
  - What stocks do they buy? What do they sell?
  - Anticipate similar behavior when the shocks are **global** (e.g., change in global temperatures)
- Adds large **cross-sectional** information to the short time series, and yields better hedging portfolios

BUILDING A HEDGING PORTFOLIO



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3. MARKET PRICES AS INPUTS FOR POLICY DECISIONS

INFORMATION IN ASSET PRICES

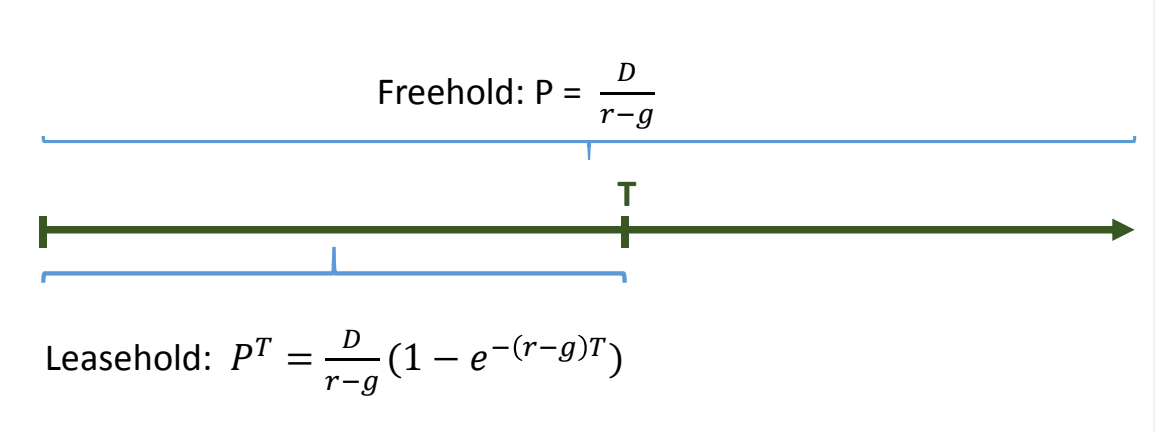
- Asset prices can be important inputs in deciding **production** and **investment** (where to build houses? What sectors to invest in?)
- Also: **input** for **policy** (deciding the optimal transition path): in addition to risk exposures, financial markets reflect people's preferences over time and risk, which are central elements to plan an optimal path forward
- Example: Learning about very long-run discount rates

LONG-RUN DISCOUNT RATES

- Policy decisions (e.g., carbon tax, investment in mitigation technology, etc.) require deciding on a **discount factor** to discount benefits arising in the distant future
- What determines the "**right**" discount rate r? "Pure" Intertemporal preferences, expected growth, **risk**
- Financial markets can give us some guidance

LONG-RUN DISCOUNT RATES

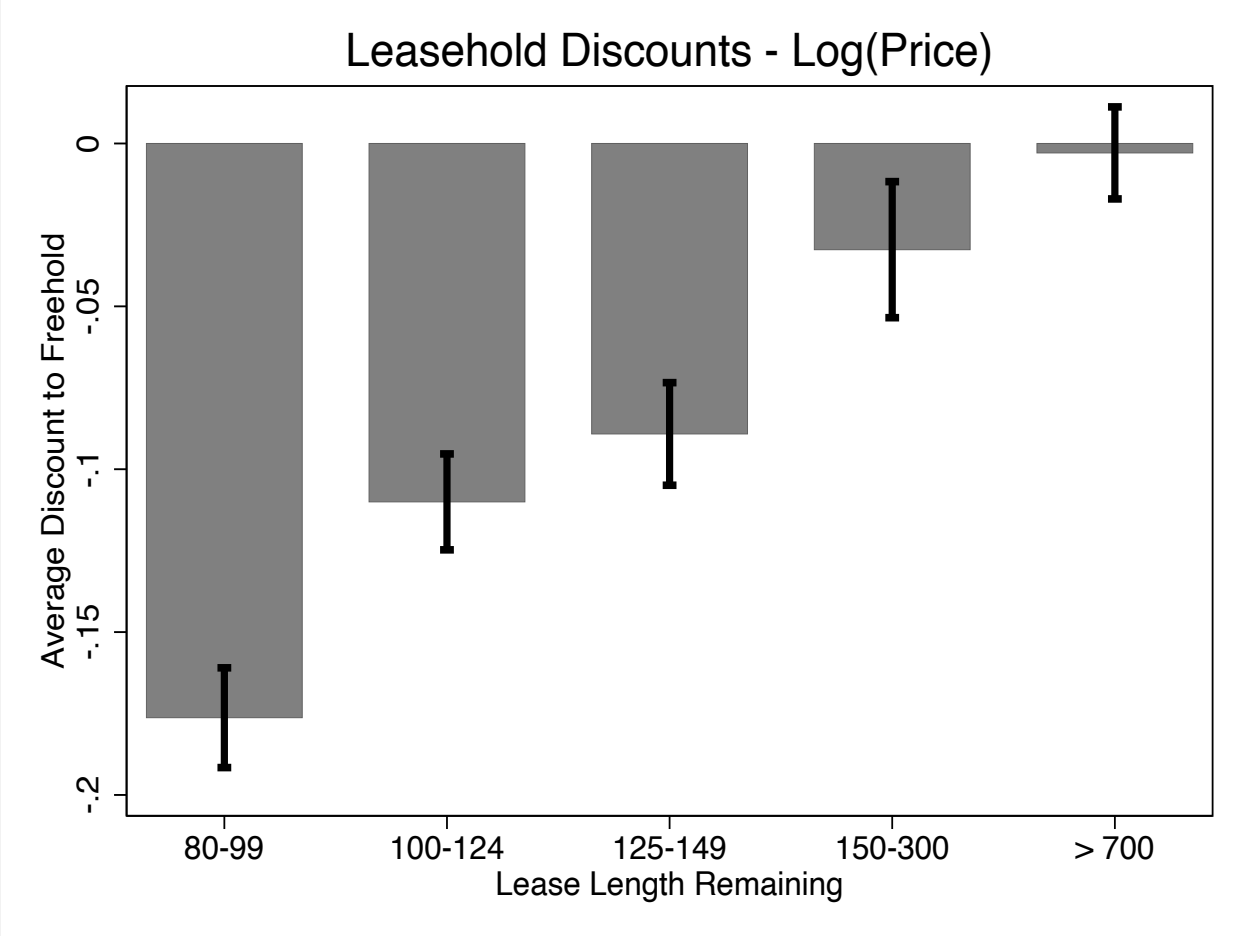
- Giglio, Maggiori and Stroebel (2015): housing market in the UK and Singapore
- Two ways to buy a house
  1. «Freehold»: permanent ownership
  2. «Leasehold» ownership for up to 100, 125, or 999 years.
- The difference in the prices is the present value of owning the house at the end of the leasehold! So it reveals the discount rate for horizons of 100, 125, etc, years



Giglio, Maggiori, Stroebel (2015), "Very long-run discount rates", Quarterly Journal of Economics

LONG-RUN DISCOUNT RATES

- Estimated discounts on the right
- Implied discount rate of 2.6%
- Much lower than what typically used in climate-change discounting
- But wait, housing is a risky asset! Should the **same** discount rate be used for climate change mitigation? **No!**



Giglio, Maggiori, Stroebel (2015), "Very long-run discount rates", Quarterly Journal of Economics

RISK AND RETURN

- A fundamental principle in finance is that a riskier investment should command a higher discount rate (to compensate investors)
- On the contrary, a climate mitigation investment should be discounted at a rate **r** **below** the risk-free rate (**rf**)
- So the 2.6% at 100+ years is an **upper bound** for climate mitigation: **r < rf < 2.6%**
- Another important lesson (from Weitzman) is that **uncertainty** about the potential for extreme negative events should have large effects on the discount rate
- Even the upper bound of 2.6% is lower than what has been often used
- Would lead to more aggressive action today

CONCLUSIONS

- What role should financial markets play in addressing climate risks?
  - **Mitigation**: transfer resources to sectors that promote transition
  - **Adaptation**: deal with sharing the (residual) risks
  - **Information** aggregation for optimal decision-making
- Research has started addressing some basic, but important, questions: e.g., are climate risks priced?
  - These answers are not sufficient
  - Fundamental problem: to give **quantitative** answers with so much uncertainty about the process, the response of the economy, etc.
  - Many open avenues for research

REFERENCES

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