STATEMENT OF
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to the COMMITTEE ON the BUDGET
of the UNITED STATES SENATE

HEARING on
Investing in the Future: Safeguarding Municipal Bonds from Climate Risks
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Does climate change pose a major risk for America's municipal bond sector? My short answer is "no". My optimism is based on two points. First, global greenhouse gas emissions are likely to rise but the pessimistic RCP8.5 model scenario over-states likely future global emissions growth.[1] Second, our economy's capacity to adapt to emerging climate risks will vastly expand in the coming decades.[2]

Bond buyers have an incentive to do their "due diligence". If a municipality faces rising climate impacts that imperil its ability to repay debt, bond buyers will recognize this and they will offer lower prices for bonds. Places that fail to adapt to new risks will thus pay higher interest rates and insurance rates. While bond defaults are rare, there have been high profile cases such as Detroit's default in 2013.[3]

To see why climate risk does not imperil the financial system via municipal bond defaults, let's play out a hypothetical Doomsday Scenario. What does it take for a "climate event" to cause a financial crisis?

A Doomsday Scenario

The year is 2034. Over the last decade, the climate has gotten worse, storms are more frequent. The city of Chicago issues new bonds each year. A new batch of bonds are rated at Baa3/BAA- (i.e., the lowest notch in the investment grade category) and the majority of the bonds are purchased by a hedge fund. While well below the median bond rating for a municipal bond of

[1] Kahn, Matthew E., and Somik Lall. *Will the Developing World's Growing Middle Class Support Low Carbon Policies?*. No. w30238. National Bureau of Economic Research, 2022.
https://www.budget.senate.gov/imo/media/doc/Dr.%20Roger%20Pielke%20-%20Testimony%20-%20Senate%20Budget%20Committee.pdf
https://www.aei.org/wp-content/uploads/2022/06/Zycher-comment-SEC-climate-risk-disclosures-file-S7-10-22-RIN-3235-AM87-6-17-2022.pdf
[2] Anderson, Sarah E., Terry L. Anderson, Alice C. Hill, Matthew E. Kahn, Howard Kunreuther, Gary D. Libecap, Hari Mantripragada, Pierre Mérel, Andrew J. Plantinga, and V. Kerry Smith. "The critical role of markets in climate change adaptation." *Climate Change Economics* 10, no. 01 (2019): 1950003.
[3] Holian, Matthew J., and Marc D. Joffe. "Assessing municipal bond default probabilities." *Available at SSRN 2258801* (2013).

around Aa3/AA-, the hedge fund is familiar with the financial woes of Chicago. It thinks these bonds are a good opportunity to earn high returns.[4] This hedge fund uses the City of Chicago bonds as collateral to borrow at a short term low interest rate from banks.

Suppose that an unprecedented storm strikes the City of Chicago in mid-2034. This storm floods the city and tax revenue plummets as this becomes the straw that breaks the camel's back, following years of financial mismanagement and crime waves and warnings from credit rating agencies. Tourists do not visit the city and work dinners and office hotels are vacant. Sports teams relocate to safer jurisdictions. Major firms depart for other locations. Suppose that the storm also severely impacts other areas in the Midwest and the local service economy stalls out. Local infrastructure is overwhelmed such that the power supply and water treatment systems and roads are left heavily damaged.

As the short run damage from the shocks materialize, the governor of Illinois and the federal government chooses not to offer disaster relief to the city. Further, Chicago's feature powerful public sector unions refuse to take a short term earnings reduction to help balance the city's short run budget. Rating agencies see the federal government's refusal to step in and bail out the people of Chicago as a sign the city will be unable to repay its debts and the raters embark on a series of bond grade downgrades. This once mighty city comes to a decision point.

Chicago chooses to default on repaying all of its municipal debt. This causes downstream consequences. The hedge funds who own the bonds go under. Banks who lent them money now own worthless collateral and they fail. Still, only a few banks have failed. Suppose depositors at other banks, worried about hidden risks, run. For some reason, the federal government does not bail out the banks or depositors. Finally, we have a crisis.

An Economic Critique of the Doomsday Scenario

Based on my ongoing research in urban and environmental economics, I reject this Doomsday Scenario. Starting with my 2010 book Climatopolis: How Our Cities will Thrive in Our Hotter World and my 2021 book; Adapting to Climate Change: Markets and the Management of an Uncertain Future, I have argued that free market competition protects our economy from place-based extreme weather risks.

My critique has six sections.

[4] Longstaff, Francis A. "Municipal debt and marginal tax rates: Is there a tax premium in asset prices?." *The Journal of Finance* 66, no. 3 (2011): 721-751.

First, local property owners seek to enhance the value of their assets. They have an incentive to lobby local leaders to invest in resilience to reduce default risk. Property owners recognize that a municipal default leads to lower local quality of life and higher property taxes.

Second, if local property owners, insurers and municipal bond investors prioritize addressing local resilience challenges, then this provides mayors with an incentive to invest in resilience.

Third, in recent years the Federal Government has provided generous disaster relief. This aid reduced municipal default risk.

Fourth, portfolio theory warns against "putting all your eggs in one basket". Municipal bond investors do not hold concentrated risks in one city, such that a default will cause them to fail. They invest in spatially diversified asset portfolios. Banks do not make concentrated loans to hedge funds.

Fifth, a recent empirical research literature documents that the fiscal impacts of storms have been relatively small.

Sixth, as we grow richer, we are willing to pay more for products that enhance our safety such as anti-flood equipment, and stronger windows. Firms have a profit motive to design these climate resilient products. Competition in adaptation product markets leads to lower prices.

I predict that over time that the investments made by people, firms and local governments in building up their local resilience will translate into less damage and less municipal bond default risk being caused by future natural disasters. This is the core climate change adaptation hypothesis.

Critique #1: Local property owners form a powerful adaptation coalition

A central lesson in real estate valuation is the importance of "location, location, location". Those properties in areas with a booming local economy and objectively better quality of life sell for a price premium. Past economic studies have examined the relationship between local risk factors such as crime on home prices.[5] Real estate prices are higher in places with more pleasant weather.[6]

The owner of a property is entitled to its rental stream for the duration of the asset's life. Real estate scholars are now exploring how place based forecasts of future weather conditions are capitalized into current real estate prices. Such research finds evidence that areas expected to

[5] Bishop, Kelly C., and Alvin D. Murphy. "Estimating the willingness to pay to avoid violent crime: A dynamic approach." *American Economic Review* 101, no. 3 (2011): 625-629.
[6] Cragg, Michael I., and Matthew E. Kahn. "Climate consumption and climate pricing from 1940 to 1990." *Regional Science and Urban Economics* 29, no. 4 (1999): 519-539.

face more severe weather conditions feature lower current real estate prices.[7] This capitalization effect is not a "law of physics". Suppose that a given area is expected to face more severe weather over the next decade but that offsetting technological advances such as stronger windows protects local homes from such risks. In this case, basic real estate economics predicts that we will not observe large real estate price discounts in such areas. Investment in effective market products that offset local weather risk helps to boost real estate prices in areas facing more volatile weather.

Millions of Americans live near the coasts.[8] There are trillions of dollars of real estate invested in high quality of life areas that do face natural disaster risk.[9] Owners of these assets have an incentive to invest in private market precautions and to push for local public policies to protect their assets against anticipated risks. Their asset's value will decline if local insurance rates increase.

The American West features many growing cities that face extreme heat and drought risk. Some posit that Phoenix will soon face a "day of reckoning" as Phoenix will become too hot in summer and run out of water.[10] If quality of life declines in Phoenix, then firms and people will be less likely to locate there and the city's municipal default risk would rise. If property owners anticipate that water is becoming more scarce in Phoenix, then they may vote for a municipal bond to be issued to pay for an aqueduct to transport water they buy from nearby farmers. If Phoenix heat is rising, then new local initiatives will be explored such as tree planting to offset

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[7] Bernstein, Asaf, Matthew T. Gustafson, and Ryan Lewis. "Disaster on the horizon: The price effect of sea level rise." *Journal of financial economics* 134, no. 2 (2019): 253-272.

Gibson, Matthew, and Jamie T. Mullins. "Climate risk and beliefs in new york floodplains." *Journal of the Association of Environmental and Resource Economists* 7, no. 6 (2020): 1069-1111.

Kousky, Carolyn, Howard Kunreuther, Michael LaCour-Little, and Susan Wachter. "Flood risk and the US housing market." *Journal of Housing Research* 29, no. sup1 (2020): S3-S24.

Ortega, Francesc, and Süleyman Taşpınar. "Rising sea levels and sinking property values: Hurricane Sandy and New York's housing market." *Journal of Urban Economics* 106 (2018): 81-100.

Severen, Christopher, Christopher Costello, and Olivier Deschenes. "A Forward-Looking Ricardian Approach: Do land markets capitalize climate change forecasts?." *Journal of Environmental Economics and Management* 89 (2018): 235-254.

[8] Rappaport, Jordan, and Jeffrey D. Sachs. "The United States as a coastal nation." *Journal of Economic growth* 8 (2003): 5-46.

[9] Pielke Jr, Roger A., Joel Gratz, Christopher W. Landsea, Douglas Collins, Mark A. Saunders, and Rade Musulin. "Normalized hurricane damage in the United States: 1900–2005." *Natural hazards review* 9, no. 1 (2008): 29-42.

[10] https://www.theguardian.com/us-news/2023/jul/14/phoenix-heatwave-summer-extreme-weather-arizona

the summer heat. Such investments in creative solutions to local climate risks helps to reduce default risk.

Critique #2 Mayors Have a Growing Incentive to Invest in Climate Resilience

In the doomsday scenario, Chicago was not prepared for the intensity of the major storm. Those mayors that fail to invest in local resilience will lead cities that borrow at a higher interest rate, and pay more for city insurance. Such cities risk losing people and firms who will migrate away to higher quality of life areas featuring lower taxes and higher quality of services.[11] No mayor seeks to lead a declining city.

Mayors from Red states and Blue states have incentives to invest in local resilience. If their city's quality of life suffers, they face rising interest rate costs and rising insurance costs. The current mayor of Miami is a Republican. The city has implemented a bond selling program to invest in flood protection.[12] The open question here is how effective will this investment be in reducing flood risk? The answer depends on how the city oversees the construction work that seeks to reduce the flood risk. The cost of construction projects is lower in Red States because local public sector unions are less powerful.[13] Public sector wages are higher in places with more powerful local public sector unions and this reduces the real purchasing power of a given amount of capital invested in enhancing resilience.

Many cities seek to buy insurance for their municipal debt.[14] If insurers charge more such insurance in cities that face more objective climate risk, then this provides cities with an incentive to offset such risk through investments in natural capital and infrastructure projects because if these risk mitigation projects are successful then they will face lower insurance prices. Insurance markets and bond markets are the "adults in the room" whose pricing of insurance and bonds sends price signals that facilitate climate risk adaptation.

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[11] Gyourko, Joseph, and Joseph Tracy. "The structure of local public finance and the quality of life." *Journal of political economy* 99, no. 4 (1991): 774-806.

[12] https://www.miami.gov/My-Government/ClimateChange/Coastal-and-Stormwater-Infrastructure

[13] Jerch, Rhiannon, Matthew E. Kahn, and Shanjun Li. "The efficiency of local government: The role of privatization and public sector unions." *Journal of Public Economics* 154 (2017): 95-121.

[14] https://www.brookings.edu/articles/the-price-of-safety-the-evolution-of-municipal-bond-insurance-value/

Critique #3 The Federal Government's Disaster Relief Reduces Default Risk

In the midst of a Doomsday-like Shock, consider two different scenarios that can arise concerning the responses by the Governors and the Federal Government. In case #1, the governors and the Federal Government respond to the shock by sending in billions of dollars to rebuild the afflicted areas. In this case, bond default risk will be unlikely. This case does have fiscal implications for the state and the Federal Government as their respective deficits will increase.

The influx of disaster relief causes two unintended consequences. In the short run, the shocked place is awash in disaster relief funds. This raises the risk of corruption as accountability and oversight are less likely to be in place as new construction takes place.[15] A second unintended consequence of expected Federal Government bailouts of shocked places is to induce a moral hazard or "too big to fail" effect. Cities that anticipate that they will be rebuilt using "other people's money" will invest less of their own funds in protecting themselves.

In providing such disaster relief, the Federal Government must balance being compassionate with unintentionally encouraging excessive municipal risk taking. A Federal Government seeking to decentralize responsibility for paying for local defenses to municipalities might commit to offering no disaster relief to shocked places. If such a promise is credible, then this "tough" approach would cause localities to invest more of their own money in protecting the place.[16] This strategy poses major political risks for national leaders and they are unlikely to choose this path unless the Federal government faces extreme budget challenges.

Critique #4 Municipal Bond Investors Seek to Diversify Their Risk

The Doomsday Scenario becomes less likely if municipal bond investors hold a more spatially diversified portfolio. The first idea in portfolio theory is to avoid "putting all of your eggs in one basket". Investors have strong incentives to consider how a specific investment affects their overall portfolio's risk and return. If more investors fear emerging climate risks, then they will demand bond index funds that are spatially diversified. Wall Street's financial engineers will design these products. The profit motive helps to mitigate the risk of the Doomsday Scenario.

[15] https://www.npr.org/2014/02/12/275989820/face-of-katrina-recovery-found-guilty-of-corruption-charges
[16] Kydland, Finn E., and Edward C. Prescott. "Rules rather than discretion: The inconsistency of optimal plans." *Journal of political economy* 85, no. 3 (1977): 473-491.

The Doomsday Scenario is more likely to occur if bond investors naively trust the credit rating agency's ratings.[17] If the agencies give a city a "AAA" bond rating, is it really risk free? Humble investors are more likely to recognize that they know "that they do not know" all of the risks that may be materializing. They will seek out experts. For profit and non-profit climate risk firms are popping up offering risk maps that alert people and firms about local climate risks. Of course, these predictive maps feature unknowns but they do inform decision making under uncertainty. Climate science is making objective progress and this science forms the foundation for this new generation of climate risk models.

Cities differ with respect to their credit ratings because some cities such as Baltimore face large public pension obligations while simultaneously experiencing a shrinking population. Those cities facing a rising expenditure stream and declining revenues are at greater risk of default. Information about these pension obligations is known and market prices for bonds and insurance reflect these risks.[18] Those cities with the worst credit ratings are the most likely to default in the aftermath of a major local disaster. Bond buyers have strong incentives to consider how much to invest in these high risk/high returns assets in forming their optimal portfolios.

Municipal bonds have different maturity structures. If investors anticipate that a given city faces rising risks over the next 20 years, then this city will pay a lower interest rate for its short term bonds and will pay a higher interest rate for its 30 year bonds. This long term interest rate risk premium provides the city's Mayor with an incentive to work with the Army Corps of Engineers to upgrade local infrastructure. The financial sector's forward looking price signals provide an incentive for mayors today to invest more effort to adapt to medium term risks. These efforts defuse the "doomsday bomb".[19]

Critique #5 Past Disaster Shocks Have Not Caused Large Municipal Default Risk Increases

Environmental economists study how people and places are affected by natural disasters. In recent years, major weather related disasters have struck California, Florida, Louisiana and others states, and none have resulted in defaults of investment grade municipal bonds.

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[17] Kahn, Matthew E. "Climate change adaptation will offer a sharp test of the claims of behavioral economics." *The Economists' Voice* 12, no. 1 (2015): 25-30.

[18] Giesecke, Oliver, and Joshua Rauh. "Trends in state and local pension funds." *Annual Review of Financial Economics* 15 (2023): 221-238.

[19] Painter, Marcus. "An inconvenient cost: The effects of climate change on municipal bonds." *Journal of Financial Economics* 135, no. 2 (2020): 468-482.
Goldsmith-Pinkham, Paul, Matthew T. Gustafson, Ryan C. Lewis, and Michael Schwert. "Sea-level rise exposure and municipal bond yields." *The Review of Financial Studies* 36, no. 11 (2023): 4588-4635.

Several recent papers have examined the association between hurricane strikes and local public finance dynamics.[20] On average, these shocks have small quantitative effects on a city's fiscal health. Municipal bonds that are insured are more insulated from disaster risk. Measured municipal bond price declines are attenuated as Federal disaster aid inflows occur.[21]

In addition to studying the effects of hurricanes on municipal finance, new research is exploring the impacts of wildfires on places in the American West. Such wildfires tend to occur in ex-urban areas where relatively few people live. Recent research has documented that such wildfires increase the affected municipality's deficit but the magnitude per person is small.[22]

Critique #6 The Adaptation Menu of Market Products Keeps Growing

As we grow richer, we are willing to pay more to be safe. Those who live in hurricane prone areas will demand better anti-flood equipment, and stronger windows and roofs that can withstand extreme wind. This demand creates incentives for firms to innovate. This dynamic process increases our adaptation menu and reduces prices.[23]

Future innovation will help us to adapt to extreme heat, wind and flood risk. Think of the cell-phone and the personal computer. Over time, these products have featured quality improvements and price declines.[24] As municipal residents adopt improved safety products, more of them are protected from extreme weather shocks and the overall economy becomes more resilient.

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[20] Deryugina, Tatyana. "The fiscal cost of hurricanes: Disaster aid versus social insurance." *American Economic Journal: Economic Policy* 9, no. 3 (2017): 168-198.
Jerch, Rhiannon, Matthew E. Kahn, and Gary C. Lin. "Local public finance dynamics and hurricane shocks." *Journal of Urban Economics* 134 (2023): 103516.

[21] Auh, Jun Kyung, Jaewon Choi, Tatyana Deryugina, and Tim Park. *Natural disasters and municipal bonds*. No. w30280. National Bureau of Economic Research, 2022.

[22] Liao, Yanjun, and Carolyn Kousky. "The fiscal impacts of wildfires on California municipalities." *Journal of the Association of Environmental and Resource Economists* 9, no. 3 (2022): 455-493.
[23] Barreca, Alan, Karen Clay, Olivier Deschenes, Michael Greenstone, and Joseph S. Shapiro. "Adapting to climate change: The remarkable decline in the US temperature-mortality relationship over the twentieth century." *Journal of Political Economy* 124, no. 1 (2016): 105-159.
[24] Acemoglu, Daron, and Joshua Linn. "Market size in innovation: theory and evidence from the pharmaceutical industry." *The Quarterly journal of economics* 119, no. 3 (2004): 1049-1090.

Boskin, Michael J. "Causes and Consequences of Bias in the Consumer Price Index as a Measure of the Cost of Living." *Atlantic Economic Journal* 33 (2005): 1-13.

A Final Thought

Going forward, big city municipal bond risk will mainly be determined by public pension obligations and day to day quality of life concerns leading to suburban flight, not by a change in the frequency of bad weather events beyond that which cities and bond investors are already planning for.

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