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Municipal Bonds & Climate Hearing
United States Senate Committee on the Budget
January 10, 2024

Good morning, Chairman Whitehouse, Ranking Member Grassley, and Members of the Committee. Thank you for inviting me to testify at this hearing to explore the implications of climate risk on the municipal bond market. It is an honor to do so, and to represent the hard work of many colleagues and collaborators.

My name is Chris Hartshorn, and currently I serve as an advisor to numerous environmental data science-enabled starts-ups focusing on nature and biodiversity, carbon credits and markets, and a NASA spin-out focused on next generation weathering modeling and forecasting. I also advise a venture capital firm that has most recently closed a fund focused on decarbonization of hard to abate industries, wherein the limited partners are comprised of corporations from those very industries, as well as a start-up developing a new carbon capture material.

More relevant for this hearing were my many years fully dedicated to building two start-ups focused on climate risk to US fixed income debt instruments, risQ and Level 11 Analytics, both now acquired by Intercontinental Exchange. risQ, in particular, became the leading provider of physical climate risk data for the municipal bond market and a large number of its participants.

I'd note at the outset how much of the discussion at this committee's July 26th, 2023 hearing on The Fiscal Consequences of Climate Change on Infrastructure is pertinent here, given how much infrastructure is provided as a part of municipal services. The insights of that hearing don't need my regurgitation. It is important to note, however, that the municipals as defined by the *municipal bond market*, rather than "just" cities or the infrastructure discussed that day, is a vast diaspora of overlapping debt issuers covering states, counties, utilities, school districts, transit systems, airports, hospital systems, charter schools, retirement communities, cities and many more. The implications of climate-mitigative, -adaptive and -resilient actions to the population are even broader and starker under this financial market municipal definition.

With respect to climate risk, it is easiest to conceptualize property-destroying, evacuation-invoking perils - hurricanes, wildfires, floods, and the like - as these "acute" events happen quickly, catalyze local and often federal emergency responses, have quantifiable economic consequences and replacement costs, and leave single name scars – Katrina, Sandy, Paradise – to name just three. The National Oceanic and Atmospheric Administration (NOAA) documented 25 such acute events in the US each with at least $1 billion in costs in 2023 – a CPI-adjusted record for any year.[1]

Climate risks are clearly material to municipal finance. Taking wildfires as one example, in the five years after a fire the net fiscal effect of wildfires on a municipality is a decline in excess revenues of $97 per capita – equivalent to 10.7% the per capita budget size – and a 25% increase in the probability of a budget deficit.[2] For hurricanes, local governments experience significant declines in revenues, expenditures, and debt in the 10 years after a hurricane strike. These declines are initially offset by intergovernmental transfers in the immediate aftermath of a hurricane but ramp up significantly after 6–10 years post hurricane.[3] The impacts of past floods – inland and coastal – also litter the Official Statements of the bond issuing community. In our own analysis over multiple years of each week's bond offerings to the market and the Preliminary Official Statements from issuers that accompany them, we saw case after case where the financial remnants of floods and hurricanes could be seen, and where impacts on population size and property – two of the critical indicators for revenues for the bond issuers – where apparent.

Across the key acute perils, rebuilding costs have been underpinned by FEMA DRF funding that has been on an admittedly bumpy but nonetheless upward trajectory over recent decades.[4] Another key constituent has been property insurers that help reestablish the property value; the taxes thereon are a key revenue stream from which debt servicing of municipal general obligation bonds occurs. It is noteworthy, therefore, that in many higher climate risk states – Florida, Louisiana, California – that major insurers are withdrawing from those markets,[5] and those that remain are ramping up policy premiums, an outcome that will inevitably lead to a decrease in coverage, and anecdotally already has. The diminishing of this historically critical pillar of past disaster recovery will only heighten the post-disaster financial pressure on the municipal (and federal) system. Relatedly, the impact of insurance coverage and costs flows through to mortgages and even further into the financial system via mortgage-backed securities (MBS). risQ and Level 11 Analytics were also providing climate risk data to the US fixed income investor community for agency and non-agency residential MBS debt instruments.

Other perils must also be accounted for which the impacts are more "chronic" in nature: heat, drought and even sea level rise on water supply in many coastal areas. Heat is a good example to focus on given we just experienced the hottest year on record globally, with July 2023 the hottest month ever recorded,[6] and cities such as El Paso and Phoenix shattered records for consecutive days above 100 ^{o}F and 110 ^{o}F, respectively.[7]

This is a critical issue across much of the municipal US, for the health and safety of their served populations and the municipal workforce, and for municipal infrastructure. Mitigating the impacts of urban heat islanding is an active effort for many cities including my own hometown of Boston, and no doubt top of mind for the Chief Heat Officers in the likes of Phoenix, Los Angeles and Miami Dade county. Municipal sectors beyond just cities and counties also feel this heat. At extreme temperatures, not only are airport personnel at greater risk but aircraft aerodynamics can be negatively impacted.[8] At least one credit rating agency I am aware of has expressed interest in heat projections for airports over time.

School districts' exposure to heat risk may be a greater systemic risk, noting that September, the start of the typical US school year, also set new records in 2023 according to the NOAA.[9] My former colleagues at risQ have published a comprehensive study focused on this very topic.[10] Temperature has been shown to have a direct impact on educational performance.[11] In schools without functioning air-conditioning, a 1 °F hotter school year reduces test scores by 1% of the expected learning gain for that year, and notably on a given day once daytime heat indexes exceed only 80 °F. By some estimates, around $40 billion of new air conditioning installation is required across US K-12 schools to address this.[12] As an example of the gap that exists, when the Department of Energy awarded the first tranche of grants through its Renew America's Schools program in 2023, over 1,000 concept papers, totaling nearly $5.5 billion in requests were received.[13] Close to 90% of selected proposals included HVAC upgrades. In one such case, a $2 million grant to Natick School District augmented $627K of its own funding.[14]

As always, funding represents a bottleneck and catalyst. Improved access to debt is one critical path to explore. As of January 1, 2024, K-12 public school districts represent around 15% of the total municipal bond market.[15] Access to debt has been shown to improve K-12 educational outcomes in general,[11] but there is now potentially a climate-driven educational performance imperative to add to this funding vs outcome mix.

There are already proven mechanisms for lowering the cost of such debt: school districts in states without credit enhancement programs could have saved between $383 million and $1 billion in debt service payments from 2009 to 2019 if their states had enhancement programs.[16] It is noteworthy that states with such enhancement programs very rarely experience negative fiscal side-effects of doing so. Such credit enhancement mechanisms also have current precedent at the federal level for charter schools, another sector within the municipal bond issuer universe.

In reality, any combination of a given climate peril and a given sector within the municipal universe can be explored for underlying materiality, but the themes of climate risk, trajectory of risk and cost implications would remain. More broadly, and critically, mitigation funding can save the nation $6 in future disaster costs, for every $1 spent on hazard mitigation.[17] That 6x multiple needs to be seen in the context the American Society of Civil Engineers (ASCE) estimate that the infrastructure deficit in the US is around $2.59 trillion over the next 10 years, or about $259 billion per year.[18] The question is how to maximize those upfront dollars for an adaptive and resilient municipal sector versus continuing to spend a multitude more on post-event recovery and where dollars for doing so are increasingly stretched.

This, of course, sets aside a still broader question of how the different sectors and jurisdictions within the municipal bond issuing community – with all their regiospecific idiosyncrasies – prepare for and participate in a transition away from fossil fuels, the need for which was unanimously agreed to at COP28 in December 2023.[19] Commercial buildings are responsible for approximately 17% of the total energy consumed in the US.[20] Local government alone represents more than 10% of total commercial building ownership across the country, and state government adds a further 1/3 to this number.[21] These amounts exclude significant building

occupying sectors also operating within the municipal bond issuing universe. Transportation represents 37% of the total energy consumed in the US,[22] a number in which municipal bond issuing influence is clear via mass transit availability and fleets, road infrastructure and investment, zoning decisions (that influence urban density vs sprawl), and broader issues of urban design and use. In this regard, high resolution geospatial data is now available to city planning and project siting decision makers to optimize any given decarbonization strategy.[23] There is also obvious interaction to be found between physical climate risk, carbon transition, housing affordability in decisions within municipal purview.[24] It is also important to remember that utilities themselves represent a non-trivial sector of debt issuance within the municipal bond market.[25] Finally, local governments also need to consider the potential impacts of any given carbon transition path on their own revenue streams and local economies, a topic we initially explored at risQ and put in the context of potential financial risk.[26]

This does not need to be a monolithic draw on the federal purse. The municipal bond market has held steady at $3.8-$4.1 trillion over the last 15 years,[27] but that apparent stasis is misleading. There is willing capital just sitting on the sidelines. In the multitude of municipal bond conferences I – and colleagues - have attended, and conversations with many more clients also show, there is more demand for municipal bonds than there is supply. Prospective municipal debt issuers are often reluctant to take on more debt to address these infrastructure needs, often driven by the perception that they might get penalized by credit rating agencies for being over leveraged – but so many, almost all, large metros in good standing could still borrow money at a AAA interest rate and meet the investment grade requirements of a large swath of the municipal bond investor market. This is without the extra fuel of aforementioned enhancement programs or relevant support mechanisms such as the The Clean Water State Revolving Fund or the Building Resilient Infrastructure and Communities grant program.

Again, thank you for the opportunity to address the critical issue of climate and municipals. I look forward to addressing any questions the committee may have.

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