TESTIMONY of Dr. Clifford V. Rossi[1]

Addressing Climate as a Systemic Risk: The Need to Build Resilience within Our Banking and Financial System

June 30, 2021

Chair Perlmutter, Ranking Member Luetkemeyer and Members of the Subcommittee, I am Dr. Clifford Rossi, Professor-of-the-Practice and Executive-in-Residence at the Robert H. Smith School of Business at the University of Maryland.

I am here today to inform the Subcommittee that imposing climate risk mandates on regulated banking institutions at this time would be detrimental to consumers, the financial services sector, and economy at-large. Let me be clear, climate change is a real risk that requires a firm understanding of the current limitations of climate models, underlying data, how those data do and do not integrate with standard financial and risk models, and numerous other components—in order to craft effective solutions to the underlying risk.

I offer a unique perspective on this issue having worked for 23 years in the financial services industry, first as a regulator during the S&L Crisis and then at both Fannie Mae and Freddie Mac—pre-conservatorship, as well as at one of the largest commercial banks, the then largest savings and loan and the largest nonbank mortgage company during my tenure as a C-level risk management executive, and now as a finance professor working on climate risk issues and banking.

I am not here to dismiss the reality of climate change and its potential risks, but rather to shed light on the state of climate risk assessment in banking and its implications for banking policy and regulation. While I am not a climate scientist, the preponderance of research suggests that long-term changes to Earth systems is evident as shown in Figure 1.[2] Across a range of key attributes such as land and sea surface temperatures, sea levels and arctic sea ice, the trends since the late 19th century to the present day indicate that the climate is indeed changing.

Models in use today for climate scenario analysis are designed to represent the physics of a complex Earth system well into the future and their output is of limited near-term use by financial institutions. It is essential that a better understanding of the limitations of these models and scenarios be gained to guide a pragmatic approach to climate risk policy for regulated depository institutions. A key question for policy makers is what actions can be taken to mitigate this trend that will not impose severe unintended consequences on markets, consumers, and the economy. Policy makers should abide by the adage in medicine, “first do no harm.”

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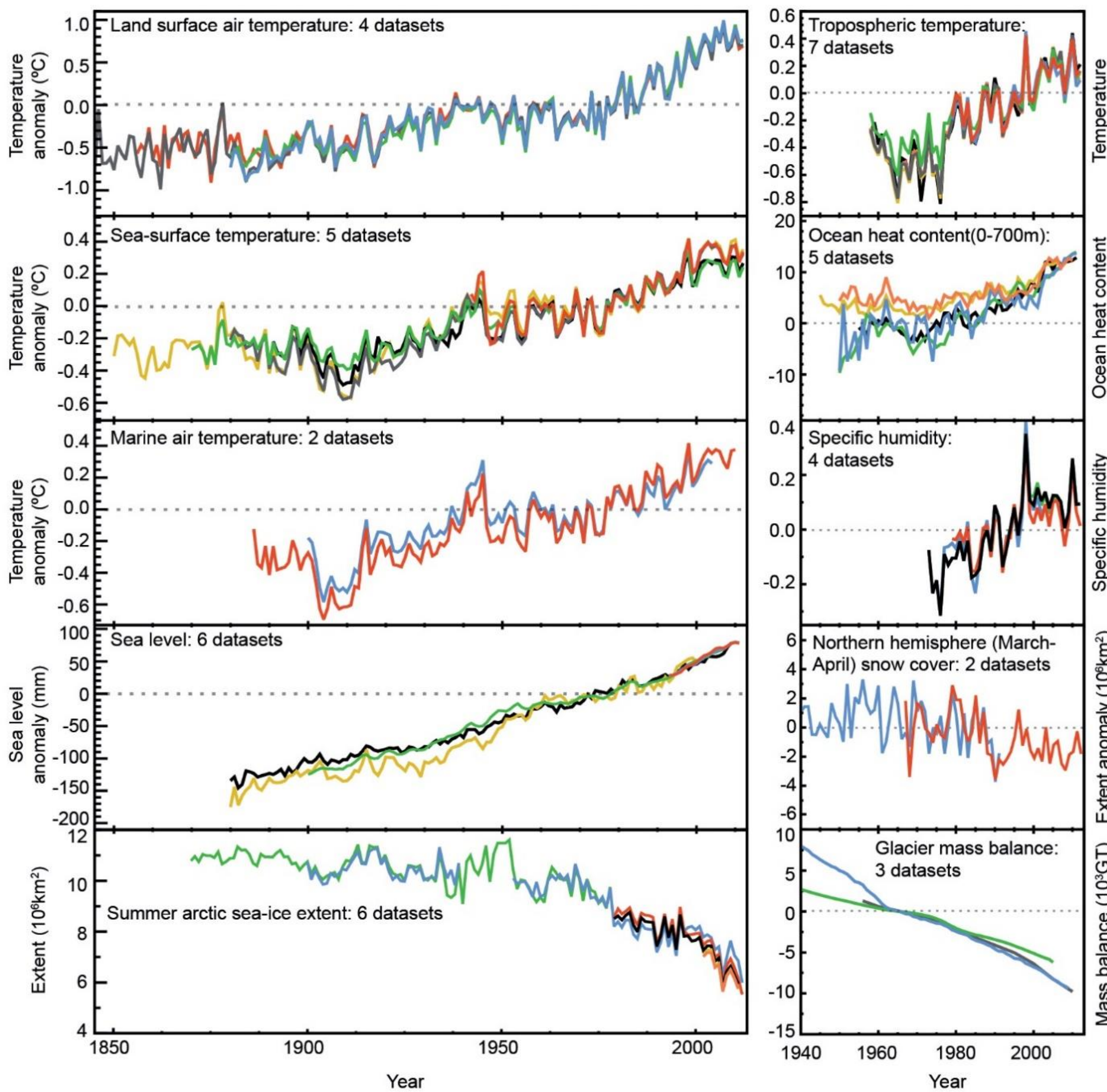
[1] The views and opinions expressed in this testimony do not reflect those of the Robert H. Smith School of Business or the University of Maryland.
[2] Intergovernmental Panel on Climate Change, Climate Change 2013, The Physical Science Basis, 2013.

Climate-Related Financial Risk

A pivotal study released by the United Nations' Intergovernmental Panel on Climate Change (IPCC) in 2018 noted that CO_2 emissions would need to fall nearly 50% by the year 2030 in

Figure 1: Long-term Changes in the Earth System



order to prevent global temperatures from rising more than 1.5 degrees Celsius; a goal of the Paris climate agreement.[3] This study and the Paris climate agreement have spurred calls of urgency among climate risk advocates and others. As I will outline in more detail, the models upon which such urgent demands for public policy response are based are subject to significant model risk. Model risk can be defined as the risk associated with errors in data, methods or assumptions used to generate output from analytical models used for decision-making. Effective public policy must be based on a sound understanding of the state of climate change risk assessment. Forcing financial institutions and their regulators toward expansive climate risk regulation based on effects that are not well understood presents more risk to the financial system than a staged and methodical approach. I applaud the intent of the Biden Administration in its Executive Order on Climate-related Financial Risk to assess climate-related financial risks and data, however, I would caution policy makers and regulators from imposing measures on regulated depositories based on current climate analytics.[4] The output from climate and associated integrated assessment models is not close to being ready for use in bank financial and risk analytics and suffers from the "square peg in the round hole" syndrome.

Square Peg and Round Hole Problem of Climate and Financial Risk Models

Banks, particularly the largest and most complex institutions engage in a variety of risk analyses leveraging large databases and complex models for underwriting, loan loss reserving and loss forecasting, capital allocation, and asset and liability management and pricing, among other key banking activities. I have either developed such models or overseen the development and use of those models in my industry experience. In the years following the Global Financial Crisis, these large institutions were subject to annual regulatory stress tests designed to assess these companies' ability to withstand a variety of adverse economic events.[5] Stress tests rely on a set of macroeconomic forecasts provided by regulators that are used as inputs into financial and risk models of banks. These projections are relatively short-term in nature, going out only nine quarters. There is a reason for such a short planning horizon; longer financial forecasts are much less accurate, and the composition of bank balance sheets change over a longer horizon. In their 2020 TCFD climate change disclosure, Citigroup acknowledged these issues in the following statement describing their experience in conducting transition risk analysis: "*The long-term nature of these scenarios was also not well aligned with the time horizon of our lending portfolio*."[6] Moreover, significant inconsistencies and data integrity issues exist between climate model output and financial and risk models. For these reasons and others, conducting stress

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[3] IPCC, 2018: Summary for Policymakers. In: *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. *World Meteorological Organization, Geneva, Switzerland, 32 pp.*
[4] The White House, Executive Order on Climate-Related Financial Risk, May 20, 2021.
[5] The Comprehensive Capital Analysis and Review (CCAR) stress tests conducted by large bank holding companies and the Dodd-Frank Act Stress Tests (DFAST) for large commercial banks.
[6] Citigroup, Finance for a Climate-Resilient Future II, Citi's 2020TCFD Report, p. 21.

and/or scenario analysis over a longer period is simply not reliable in understanding and managing a bank's risk profile today.

In contrast with what is done today in regulatory stress testing, climate scenarios today are drawn up by entities such as the Network of Central Banks and Supervisors for Greening the Financial System (NGFS) and rely on projections extending decades into the future. The NGFS' 6 climate scenarios characterizing the effects of transition and physical risks to the financial system from changes in public policy, temperature and emissions extend out to the year 2100.[7] These climate and socio-economic models operate on a global scale and with a level of complexity and long-term horizon that is incompatible with the level of granularity required and relatively shorter-term focus of bank stress tests to reliably assess risk in bank portfolios. The linkages between long-term climate effects and short- to intermediate-term financial and risk factors are not sufficiently reliable, at present, to properly assess physical or transition risk impacts to the banking system from climate change.

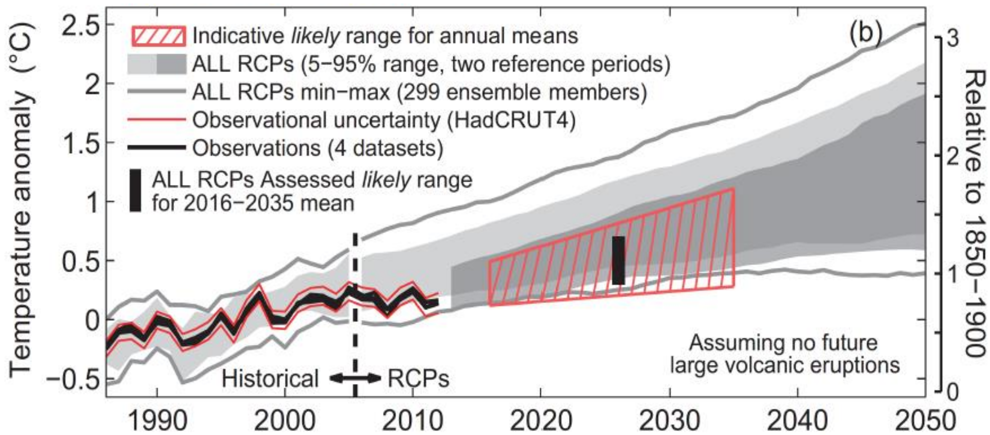
Climate and Socio-economic Model Limitations

Climate scenarios such as those proposed by the NGFS are dependent on output from global climate models and large-scale Integrated Assessment Models (IAMs) that incorporate scientific and socio-economic relationships. Both model types pose significant uncertainty in their results. This is acknowledged by those organizations developing and/or leveraging these models. For instance, the NGFS revealed in their discussion of climate scenario development that "*Modelling the GDP impacts from transition risk and physical risk is subject to significant uncertainty.*"[8]

To gain a sense of the issues associated with the climate models consider Figure 2, which is from the IPCC's 2013 report on climate change.[9] The graph depicts a range of actual and projected estimates of global temperature anomaly over time. These estimates are drawn from 299 climate model simulations. The first takeaway is that there is a significant amount of uncertainty in the combined model results and that uncertainty increases over time (widening of the area between the gray lines over time). The second takeaway is that the IPCC acknowledges that the model projections tend to overpredict the temperature anomaly. This is seen by the heavy black line tilted toward the bottom gray line indicating the lower end of the models' predictions. What this means is that climate scientists developing the models acknowledge that there is potentially great error in their estimates. Why is this important? Requiring banks to make hard-money strategic decisions on lending, capital allocation, pricing and other activities that have long-term consequences for consumers, the financial system and economic growth based on models with a high degree of uncertainty is not at all consistent with prudent model risk management practices.

[7] Network for Greening the Financial System, NGFS Climate Scenarios for central banks and supervisors, June 2021.
[8] Network for Greening the Financial System, NGFS Climate Scenarios for central banks and supervisors, June 2020, p. 26.
[9] IPCC, 2013.

Figure 2: Climate Model Temperature Anomaly Projections



Climate model projections such as those provided by the IPCC in the Fifth Assessment Report (AR5) are represented by an average of results from multiple climate models.[11] Modeling at a global scale requires the use of multiple models taking into account a multitude of earth system dynamics and accordingly supercomputing power to generate model outputs on such a scale. However, the old adage—all models are wrong, but some are useful—applies in the world of climate modeling. Some climate models perform better than others in certain geographical areas but the approach to generating climate results has tended to average good and bad models together, which can generate misleading results.[12] This reminds me of the old modeling joke that if you put your head in the oven and your arms in the refrigerator then on average you feel fine.

While the climate models have come a long way over the last decade, they are still subject to uncertainties related to the proper quantification of feedback mechanisms, which remains one of the biggest unknowns in climate modeling. One of these feedback mechanisms is the ice-albedo effect: albedo refers to the reflectivity properties of materials. Ice is highly reflective of incoming solar energy. If climate models project more greenhouse gases and thus higher temperatures, ice will melt leading to a darker surface. Darker surfaces (low albedo) absorb more solar energy resulting in a further increase in temperature, more ice melt, more absorption, even warmer temperatures and so on and so on. Climate scientists acknowledge that quantitative assessment of this effect is inadequate.[13] This is just one example of the complex issues

[11] IPCC, AR5 Synthesis Report: Climate Change 2014, 2014.
[12] Eyring, V., Cox, P.M., Flato, G.M., et al., Taking Climate Model Evaluation to the Next Level, Nature Clim. Change, 9, 102-110, 2019.
[13] Kashiwase, H., Ohshima, K., Nihashi, S., and Eiken, H., Evidence for Ice-Ocean Albedo Feedback in the Arctic Ocean Shifting to a Seasonal Ice Zone, Sci. Rep., 7, 8170, 2017.

associated with climate models and should engender a healthy dose of skepticism before accepting the results of any model: climate, socio-economic or financial for that matter.

The IAM models used in developing climate scenarios are likewise fraught with error. These models attempt to integrate scientific and socio-economic analysis to produce a variety of projections such as economic growth, population shifts, carbon and energy prices, and sectoral changes in key industries such as energy and agricultural, among others. While carbon prices are key inputs to climate scenarios, significant variability exists in estimating these prices. In a study using a well-known IAM for their analysis, Moore and Diaz estimated that the social cost of carbon was $220 per ton not $37 per ton as estimated in a study by the federal government.[14] This has enormous implications for financial institutions and their customers. In their 2020 TCFD climate change disclosure report, Citigroup conducted carbon price sensitivity analysis on their oil and gas company portfolio using a range of prices from $50-$100 per ton. While this might be a useful analysis in theory, there is considerable uncertainty in applying such an analysis; ultimately rendering it of limited value for financial and risk decision-making.

In his seminal article, the Use and Misuse of Models for Climate Policy, Pindyk levies a damning indictment of IAMs including the arbitrary parameterization and assignment of model input functional forms, difficulty in understanding climate sensitivity impacts to the models, a paucity of data relating to damage functions and poor characterization of tail risk associated with climate outcomes.[15] He goes further and makes the following statement; "*In fact, I would argue that the problem goes beyond their "crucial flaws": IAM-based analyses of climate policy create a perception of knowledge and precision that is illusory and can fool policymakers into thinking that the forecasts the models generate have some kind of scientific legitimacy."*[16] If models developed in my organization as a former risk executive in the financial services industry had such claims leveled against them, it would be difficult to support using them in the business.

My points here are not meant to disparage the enormous effort by teams of scientists, economists and others to understand the effects of climate change; this is critical work that must be done. However, there are far too many issues associated with the reliability of the climate and IAM model outcomes to use in making financial and risk decisions today.

Model Bias and Its Effect on Decisions

It is well-established in the psychology and economics literature that decision-making is affected by a number of cognitive biases. One of these is what I refer to as model, or shiny object bias; something that Pindyk implies in his assessment of IAMs. Model bias occurs when decisionmakers embrace the results from highly sophisticated quantitative models based on perceptions that the apparent analytical rigor in those models necessarily translates into accurate

[14] Diaz, D and Moore, F., Quantifying the Economic Risks of Climate Change, Nature Clim. Change, 7, 774-782, 2017.
[15] Pindyk, R.S., The Use and Misuse of Models for Climate Policy, Review of Environmental Economics and Policy, 11, 1, Winter 2017, 100-114
[16] Pindyk, 2017.

and reliable outputs. An example of this was the wide use of a method (Gaussian copula methodology) by traders in pricing mortgage-based credit default swaps (CDS) during the years leading up to the Great Financial Crisis. The underlying mathematics of the copula method used to value CDS is quite complicated and is dependent on the nature of correlations in underlying assets. The method took off among trading departments and helped fuel an explosion in trading of CDS during that period. The problem was that this very elegant and, on its face, mathematically rigorous model, was seriously flawed by underlying assumptions made with regard to asset correlations. The model's Achilles Heel was an assumption that correlations did not change. Unfortunately, they did change and in a way that led the copula model to vastly underestimate risk, thus resulting in a crash in CDS values. Traders and other key decisionmakers who became enamored with the technical elegance of the Gaussian copula were drawn in by shiny object bias; that the mathematical rigor associated with the model boosts the confidence of nontechnical decisionmakers to use such models in financial decision-making.

There is already a widespread shiny object bias in the use of climate and IAM models today among policymakers worldwide. This poses serious concerns regarding the use of these models for anything other than research applications at this time as described earlier. Placing bets in financial markets on such models invites a host of long-term unintended consequences on the financial system.

A Path Forward in Assessing Climate Financial Risk

Having laid out the issues on the state of climate and IAM models and their lack of direct integrability with financial and risk analytics, I have several recommendations for how banks should proceed to understand their resiliency to climate change:

Recommendation 1: Risk Identification & Governance

Prudent risk management practices start and end with effective governance and controls. Climate risk should be integrated into bank risk taxonomies and assessed in terms of other top risks of these firms such as credit, market, operational and strategic. Climate risk must also be incorporated into board and executive risk and business committee discussions with dedicated resources having subject matter expertise in climate risk assessment.

Recommendation 2: Risk Measurement

Banks should undertake an assessment of current exposures to physical risk from climate change in their portfolios and facilities and do so on a periodic basis as needed. This could entail understanding where loan and investment portfolios are exposed to certain climate events and estimating the likelihood of such events and loss potential to the firm. Banks should also embark on a process to develop empirical linkages between climate events and key financial and nonfinancial risks. An example of such analysis is described in my forthcoming article in the

Journal of Risk Management in Financial Institutions on estimating the impact of hurricane frequency and intensity on mortgage default.[17] The data and analytical linkages between climate risk and financial and nonfinancial risks are not well understood, thus making this a priority. As these analytics are being developed, firms should develop risk metrics and targets based on available information and risk assessments even if these are qualitatively oriented. Regulators should focus their attention on understanding the limitations of climate and IAM models, data and associated outputs and facilitate the development of data and analysis that could one day be used by banks to manage climate risk more effectively. Now is not the time to impose mandates for scenario or stress testing analysis or other restrictions on bank activities based on climate and IAM models that would not meet regulatory standards for model validation required by banks.

Recommendation 3: Risk Mitigation

While many financial instruments exist in the market to absorb natural disaster risk such as reinsurance and catastrophe risk bond structures, further work should be done to build out alternative ways for portfolio holders of risk to transfer such exposures off their balance sheet efficiently. An example of such a structure I have developed is a climate credit default swap (CCDS) that could be used to mitigate credit-related losses across multiple asset classes. To illustrate how this could work, imagine a regional bank with significant exposure to hurricane risk along Florida's Gold Coast. Knowing that the spring NOAA hurricane forecast calls for a well above average number of hurricanes rated 3-5 on the Saffir-Simpson Wind Scale, the bank enters into a CCDS to protect against defaults that occur up to 12 months after the formal designation by FEMA of a disaster. Other structures such as residual climate tranches of Fannie Mae and Freddie Mac credit risk transfer (CRT) securities could also be developed to address credit risk exposure from an increase in climate-related events.

Recommendation 4: Risk Disclosure

Today, financial institutions such as publicly traded banks disclose a significant amount of information with regard to key risks, their approach to risk management and governance in their financial statements. Climate risk should be incorporated as another important risk into bank financial disclosures along with credit, market and liquidity risk, for example. Recommendations made by the Task Force on Climate-Related Financial Disclosures (TCFD) regarding climate risk disclosures would be useful in guiding institutions in how they could integrate this in with their existing risk disclosure process. Banks should not, however, be required to report climate-based physical or transition risks given the range of uncertainty of such analyses and data. At this time, if I were a Chief Risk Officer at a bank, I would have

[17] Rossi, C., Assessing the Impact of Hurricane Frequency and Intensity on Mortgage Delinquency, forthcoming Journal of Risk Management in Financial Institutions, 2021.

difficulty signing any attestations or sub attestations associated with these aspects of climate risk for financial disclosures.

Summary

Climate change is a real risk that banks and other financial institutions should actively incorporate in with their existing risk management processes. However, such firms must take measured steps to understand these risks and not be forced into conducting analyses for which the models and outputs are not well understood as they relate to financial services. Banks should instead focus attention on bolstering their risk awareness to climate change starting with enhancing their risk governance, process and controls, data and analytics. Quantifying with a reasonable degree of confidence the impacts of physical and transition risk from climate change will require significant efforts and time and a true interdisciplinary approach between climate scientists and financial institutions in gathering additional data and modifying existing models. This work should commence and only when the results have been deemed to conform to regulatory model risk standards should consideration of their disclosure and use in financial decision-making be permitted.

Prudent risk management depends on identifying inherent risks, gathering appropriate data and developing analytics to accurately measure risks and taking actions based on the results of well-tested analytics to mitigate and control risks. Requiring banks to implement and disclose the results from climate scenario analysis based on models that represent the state-of-the-art but have significant underlying deficiencies has great potential to destabilize markets, harm consumers and lead to unintended economic and financial turbulence.