BANK POLICY INSTITUTE

Are Banks' Operational Risks Significantly Affected by Climate Change?

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Introduction

Regulatory bodies, standard-setting organizations, NGOs, policymakers and banks themselves have increasingly focused their attention on how banks should disclose their climate change risks. Implicit in this interest is an assumption that climate change risks are potentially significant enough to pose safety and soundness issues for banks or stability issues for the financial system. For example, a recent BCBS consultative document on climate risk disclosure asserts that climate risks "...result in financial risks to banks … potentially affecting the safety and soundness of banks and the stability of the broader banking system."[1] That said, research on the magnitude of climate change risk for banks has so far not identified significant effects. Recognizing the lack of empirical evidence, the BCBS proposed a climate risk research program in 2021,[2] noting that most research to date has been on credit risk with little analysis or attention devoted to market, liquidity and operational risks.

A recent study by Berger et al.[3] adds to the climate change evidence by quantifying the effects of extreme storms on large U.S. banks' operational risk losses. The study finds that a doubling of its proposed deposit-weighted measure of large banks' exposure to storm damage would result in an increase in operational risk losses of $22 million on average.

Berger et al. conclude their analysis by suggesting that the effects of climate change on op risks should be included in regulatory frameworks. However, in absolute terms, $22 million is a very small increase in operational risk losses that would not affect the capital adequacy of a bank or impose systemic risks on the banking system. Furthermore, even the immaterial $22 million estimate is significantly overstated. This overstatement arises because approximately 80 percent of these operational risk losses result from "Clients, Products and Business Practices," the majority of which originate from agreements with the Department of Justice and other organizations to settle allegations that banks misled residential mortgage-backed securities investors in the years before the financial crisis. Thus, the largest operational risk losses composing the $22 million estimate were unrelated to climate events. Leaving aside the RMBS issue, the $22 million estimate overstates the effect on most banks. Extreme hurricanes are geographically concentrated in Florida, Louisiana and Texas. (And presumably banks in those states are more experienced in and focused on managing that risk.) Similarly, flood risk and other physical risks, such as

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[1] Basel Committee on Banking Supervision, Consultative document, "Disclosure of climate-related financial risks," November 2023, available at https://www.bis.org/bcbs/publ/d560.pdf

[2] Basel Committee on Banking Supervision, "Climate-related financial risks – measurement methodologies," April 2021, available at https://www.bis.org/bcbs/publ/d518.pdf

[3] Berger, A, Curti, F, Lazaryan, N, Mihov, A and Roman, R, "Climate Risks in the U.S. Banking Sector: Evidence From Operational Losses and Extreme Storms," December 2023, Federal Reserve Bank of Philadelphia Working Paper WP 23-31, available at https://www.philadelphiafed.org/-/media/frbp/assets/working-papers/2023/wp23-31.pdf

wildfire risk, are confined to specific geographic locations and do not affect all banks equally (or at all), and thus do not pose systemic risk.

Berger et al.'s estimate of $22 million followed from using a doubling of storm damage as a proxy for the effect of climate risk, a proxy they did not justify. As a result, Berger et al. did not answer the question whether an extreme storm as specified in a stress test, such as the recent Federal Reserve climate risk stress test exercise, would have significantly increased their $22 million average estimate. If the estimate did increase to a significant level under such a stress test, the greater op risk loss would need to be balanced against the overstatement of risk in the data to judge whether the net effect is material enough to create safety and soundness concerns. If the estimate did not increase (or decreased) under a severe climate risk stress test, the effect of climate change risk on operational risk would clearly be *de minimis*.

The purpose of this note is to use the results in Berger et al. to estimate how much banks' operational risks might be expected to increase under the climate risk stress test the Federal Reserve recently asked banks to perform. In contrast to Berger et al., we provide a range of estimates along with their likelihoods. Our estimates indicate that the increased operational risk loss under the Fed climate scenario is small most of the time: less than or equal to $18 million 84 percent of the time and less than or equal to $340 million 99.6 percent of the time. Like the Berger et al. estimates, these climate-scenario-adjusted estimates are also significantly overstated, since we used "as is" the Berger et al. analysis, not correcting for RMBS op risk losses or geographic location. Even under the recent Fed climate risk scenario, the increase in operational risk losses is very small, calling into serious question the view that climate change poses any material operational risk.

Background

What did the Berger et al. study find?

Using banks' operational risk loss data collected by the Federal Reserve as part of its supervisory stress test exercises, Berger et al. found a statistically significant effect of extreme storm damage on the magnitude of bank operational risk losses. Their data set covers 24 large U.S. bank holding companies over the period 2000:Q1 to 2019:Q4. In general, the analysis indicates that a doubling of storm damage[4] leads to an 8.4 percent increase in operational risk losses, which, when applied to the average loss of $262 million, yields an expected loss of 8.4 percent X $262 million = $22 million.[5] For large storms that have been designated disasters by the President, a doubling of storm damage would lead to a 10.6 percent increase in operational risk losses, potentially suggesting a non-linear effect. As already mentioned, the study did not analyze how much storm damage would increase under a stressed climate change scenario.

The Fed Climate Risk Stress Test

In January 2023, the Federal Reserve asked large banks to perform a climate risk stress test.[6] The test was divided into a physical risk and a transition risk section. In the physical risk section, which encompassed extreme storms, the Federal Reserve asked banks to perform a physical risk climate stress test of a once-in-a-century as well as a once-in-two-centuries hurricane in the Northeast of the United States. Banks were also asked to conduct an additional stress test on another physical risk (such as a wildfire, flood or another hurricane) under the same

[4] Berger et al. construct the hurricane damage variable as a weighted average of storm damage over all counties in which a bank has deposits, with the amount of deposits determining the weights.

[5] Although Berger et al. demonstrate a statistically significant relationship between the size of extreme weather damage and operational risk losses, the estimates are likely pointing to a more general phenomenon. Any widespread disruption of the business environment, whether produced by extreme weather or by some other cause, will interact with poor management or governance practices to increase operational risk losses.

[6] Board of Governors of the Federal Reserve System, "Pilot Climate Scenario Analysis Exercise: Participant Instructions, January 2023, available at https://www.federalreserve.gov/publications/files/csa-instructions-20230117.pdf

relative severity assumptions for a U.S. geographic area outside the Northeast. Banks were asked to incorporate the effects of extreme physical risks on portfolios as they existed in 2023, but assuming 2050 rather than 2023 climate conditions. The goal was to estimate the effects of extreme physical risk produced by climate change on the creditworthiness of residential and commercial real estate transactions. Although the Fed stress test instructions mentioned operational risks as being affected by climate change, the stress test did not formally consider operational risks.

Operational Risk Physical Risk Stress Test

Data

To perform an operational risk climate stress test under the Fed stress test requirements, we need to estimate the damage resulting from a once-in-a-century and a once-in-two-centuries hurricane. For that purpose, we use the ICAT data set[7] for hurricanes that made landfall in the U.S. from 1900 to 2017. The data consist of total hurricane damage estimated in 2021 dollars along with maximum wind speeds. The data were adjusted for comparability of damage across time and changing economic conditions by ICAT using a methodology similar to Weinkle et al.[8] To include the years 2018-2023, we supplemented the ICAT data with hurricane damage estimations culled from the National Hurricane Center[9].

Estimation Strategy

We need to estimate damage from a once-in-a-century and a once-in-two-centuries hurricane using only 123 years of data. It is therefore necessary to extrapolate the observed hurricanes' damage distribution to more extreme values not yet observed. This is a standard problem in physical risk climate research as well as in operational risk modeling. To perform this extrapolation, we use extreme value theory (EVT), a branch of probability and statistics focused on estimating rare events. To implement EVT, we model the tail of the hurricane losses above some threshold value using a Generalized Pareto Distribution.[10] Below that value we use the empirical observations. When we combine the GPD estimation for hurricane damage above the threshold value with the observed values below it, we have a complete description of the hurricane damage distribution over the past century (without any effects of climate change).

To create an equivalent distribution of hurricane damage from the 123 years of data that includes projected climate change by 2050, we adjust the data to incorporate the effects of climate change using the consensus evidence reported in Knutson et al.[11] For a 2°C increase in temperature, wind speeds of hurricanes are projected to increase 5 percent on average. Although this increase may seem small, hurricane wind speed is non-linearly related to hurricane damage. A 5 percent increase in wind speeds would increase hurricane damage by about 23 percent.[12] We therefore scale up all damage in the 123-year hurricane damage data set by 23 percent. Knutson et al. also report that the proportion of Category 4 and 5 hurricanes, which are the most damaging storms, is expected to go up by 13 percent, while the hurricane frequency for all storms would be expected to decline or stay the same. To avoid underestimation, we assume that the overall hurricane frequency will stay the same in 2050,

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[7] The data set is currently not available on the ICAT website.

[8] Weinkle, J, Landsea, C, Collins, D, Musulin, R, Crompton, R, Klotzbach, P, and Pielke, R, "Normalized hurricane damage in the continental United States 1900–2017," 2018, Nature Sustainability, available at https://www.aoml.noaa.gov/hrd/Landsea/weinkle-et-al-natsus-2018.pdf

[9] See https://www.nhc.noaa.gov/data/tcr/

[10] For a discussion of EVT that focuses on climate examples, see Coles, S, *An Introduction to Statistical Modeling of Extreme Values,* 2001, Springer Series in Statistics, Springer-Verlag Ltd, London

[11] Knutson, K, Carmargo, S, Chan, J, Emanuel, K, Ho, C, Kossin, J, Mohapatra, M, Satoh, M, Sugi, M, Walsh, K, and Wu, L, "Tropical Cyclones and Climate Change Assessment: Part II: Projected Response to Anthropogenic Warming," 2020, Bulletin of the American Meteorological Society, available at https://journals.ametsoc.org/view/journals/bams/101/3/bams-d-18-0194.1.xml

[12] We use the model $D = aW^b$, where D is damage and W is wind speed. Estimating the regression $\ln(D_t) = a + b ln(W_t) + \epsilon_t$, we find that b = 4.22, which is strongly significant using HAC standard errors

implying that the proportion of Category 4 and 5 hurricanes will rise by 13 percent. Because weaker storms are expected to decrease, we reduce the proportion of Category 1 and 2 hurricanes, which are the least damaging storms, to keep the overall frequency, i.e., the number of data points, constant. To increase the proportion of Category 4 and 5 hurricanes in the 123-year data set by 13 percent, we repeat in the data the observed Category 4 and 5 hurricanes with the largest losses, increasing the number of these storms in the data set. Using this modified data set, we then model the tail of the 123-year climate-adjusted data using a GPD distribution as before.

Since hurricanes have occurred 2.14 times a year on average over the last 123 years, we simulate multiple hurricanes per year with an average of 2.14 occurrences per year and some variation around the average.[13] We then determine the once-in-a-century and the once-in-two-centuries hurricanes for the climate-adjusted and unadjusted data sets by simulating 10,000 years of hurricane damage data. The results are reported in Table 1.

Table 1

Stress Test	Current Climate Damage ($2021 bil)	2050 Climate Damage ($2021 bil)	Percentage Increase	Operational Risk Damage Increase Percentage
Once per Century Hurricane	208	341	64%	6.8%
Once per Two Centuries Hurricane	314	502	60%	6.3%

To understand where the numbers in Table 1 come from, we calculated the once-per-century and once per-two-centuries hurricanes from the 10,000 years of simulated hurricane damage with and without the effects of climate change. We then calculated the percentage increase in damage for each case: 64 percent for the once-per-century hurricane and 60 percent for the once-per-two-centuries hurricane. Finally, the effect on operational risk losses is derived from the estimates in Berger et al. For large hurricanes, they estimate that a doubling of the damage would increase operational risk losses by 10.6 percent; a 64 percent increase in damage from the effects of climate change would therefore increase operational risk losses by 64 percent X 10.6 percent = 6.8 percent.

To translate these percentages into absolute dollar amounts, we need to know how large and how likely operational risk losses would be for a bank when a very large hurricane strikes. Berger et al. do not report any estimate of the banks' operational risk loss distribution that would allow us to estimate the likelihood of different op risk loss levels. However, they do report a quarterly mean and standard deviation of operational risk losses. We can use that information to calibrate a log-normal distribution to represent banks' quarterly operational risk losses.[14] The log-normal distribution has the advantage that it is positive, fat-tailed and can be characterized by the mean and standard deviation of the data. Table 2 reports the results.

[13] We simulate the number of hurricanes per year using a Poisson process with $\lambda = 2.14$

[14] This calibration is for the purpose of illustration. A typical op risk analysis would likely use a fatter-tailed distribution over the entire data set. However, the log-normal distribution is a reasonable choice to maintain the Berger et al. assumptions without exaggerating the effect of fat tails, given that the fat tails in the op risk distribution are caused by RMBS settlements that are not affected by climate change. A refined analysis to fit a distribution to the op risk data using the entire data set would need to adjust the underlying data for the large op risk losses unaffected by climate change.

Table 2

Operational Risk Loss L ($ mil)	Probability	Increase Z in operational risk loss ($ mil)	Increase Z in operational risk loss ($ mil)
L <= 262	83.7%	Z <= 18	Z <= 17
262 < L < =1685	13.8%	18 < Z <= 115	17 < Z <= 106
1685 < L < = 5000	1.9%	115 < Z <= 340	106 < Z <= 315
L > 5000	0.6%	> 340	> 315

In Table 2, we used three thresholds to depict operational risk losses. The first threshold, $262 million, is the average quarterly operational risk loss reported by Berger et al. The second threshold, $1,685 million, is the quarterly standard deviation of operational risk loss from Berger et al. The third threshold, $5,000 million, was selected to represent a large loss that might have resulted from a legal settlement. As discussed previously, these large settlement losses were not affected by climate events, but we include them to maintain the assumptions in the Berger et al. analysis.

Using the log-normal calibration for operational risk losses, 84 percent of the time, quarterly losses are lower than the average quarterly loss of $262 million. The increase in operational risk losses is therefore less than or equal to $18 million (6.8 percent times 262) 84 percent of the time, given a once-in-a-century hurricane. The other entries in the table are calculated in the same way.[15] For example, the log-normal estimate shows that the probability that operational risk losses are between $1,685 million and $5,000 million is 1.9 percent. Thus, the increase in operational risk losses is between $115 million and $340 million 1.9 percent of the time. ($1,685 million X 6.8 percent = $115 million and $5,000 million X 6.8 percent = $340 million)

Table 2 suggests that climate change does not create safety and soundness concerns in the financial system in the form of operational risk. The estimates in Table 2 have been overstated by using the Berger et al. analysis to produce them. Even then, the combination of a very rare, extremely intense storm and an extremely rare but bad quarter of operational risk losses does not result in an increase in operational risk losses that is even close to the magnitude necessary to affect capital adequacy materially. The risks are further overstated since the Fed climate stress test assumption of 2050 climate conditions happening today is an impossible scenario for most operational risks, other than for operational risks associated with banks' long-term commitments to buildings and other infrastructure.

[15] Berger et al. also consider the effect of a large hurricane that is also large relative to the assets of a bank. For banks in the 99th percentile of the ratio of hurricane damage to assets, they estimate that op risk losses would rise 12.2 percent for a doubling of losses, rather than 10.6 percent. Using this larger estimate would make a trivial difference in Table 2.

Conclusions

The evidence presented in this note indicates that the effect of climate change on banks' operational risks is likely to be very small, and not a potential safety and soundness concern for the banking system. These small risks suggest that imposing on banks onerous external climate change reporting requirements on operational risk would be unwise by any cost-benefit analysis. Climate change creates an important new set of risks for banks to measure and manage, but, like any other risks, climate risks may matter for banks' day-to-day risk management without necessarily rising to the level of creating systemic risk issues. Continued research is necessary to determine whether the size of climate risks in the financial system merits safety and soundness concerns. Unless climate risks can be shown to be of sufficient magnitude to threaten the capital adequacy of banks, there would seem to be little justification for highlighting them more prominently than other, potentially more material risks by imposing bespoke reporting requirements on them.