WELLINGTON MANAGEMENT®

June 2020

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About the author

As director of Climate Research on the Sustainable Investment Team, **Chris** spearheads a collaborative initiative between Wellington Management and Woods Hole Research Center (WHRC) to integrate climate science and asset management. This alliance, launched in 2018, focuses on creating investor tools to help analyze and better understand how and where climate change may impact global capital markets.

Contributors

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Why aren't markets repricing rising climate risks?

KEY POINTS

- In many parts of the world, severe climate-related events that will affect capital markets are occurring more frequently.
- We believe policymakers, market participants, and the public underestimate the cumulative probability of climate events.
- We are developing tools that enable portfolio managers to assess the financial effects of climate risk at the security level.

MARK CARNEY, BANK OF ENGLAND GOVERNOR AND FORMER CHAIRMAN OF THE FINANCIAL STABILITY BOARD, ONCE STATED: "Past is not prologue, and the catastrophic norms of the future can be seen in the tail risks of today." This notion is readily apparent in the context of climate change, where physical risks are rising with each passing year.

Secular shifts in atmospheric conditions are increasing the risk of severe climate-related events. This trend, which shows no signs of mean reversion, is the basis of our ongoing research with Woods Hole Research Center (WHRC) on the physical effects of climate change and their impact on capital markets. Our work with WHRC has found evidence that in many parts of the world, the probability of so-called hundred-year events, including devastating hurricanes, supernormal rainstorms, and inland floods, is rising. Despite this trend, policymakers, market participants, and the general public appear to be underestimating the risks, including the potential for negative market impacts.

The continued mischaracterization of rare climate events as one-time occurrences rather than part of a changing pattern may be a reason why climate risk remains abstract, hampering proactive behavior, policy change, and asset repricing. We believe that if markets had better access to climate probabilities, particularly the cumulative risk of occurrence over multiyear periods, they would better appreciate the severity and accurately reprice these risks.

Understanding probabilities over time requires appreciating the cumulative percentage risk of an event's likelihood for a given time period.

"Hundred-year" events do not mean "one and done"

A "hundred-year" event refers to one that has a 1-in-100 or 1% probability of occurring in a single year in a certain area. Some may incorrectly deduce that this means that a 1-in-100-year devastating hurricane, rainstorm, or flood will only occur once every 100 years. But probabilities aren't limited to one-time occurrences. Even rare events can happen more than once in a set time period, so the cumulative probability of events rises more than what our intuition would expect. Brazil has already experienced two "100-year" droughts since the start of the century, while Houston experienced three "500-year" floods in the last decade. Many places vulnerable to climate change will face the growing likelihood of repeat climate disasters.

Understanding probabilities over time requires appreciating the cumulative percentage risk of an event's likelihood for a given time period. The longer the period, the more likely a "rare" event is to occur, and the greater the impact minor increases in probability have. In many regions, data shows that 1-in-100 events are becoming 1-in-50 events — or worse. It often surprises people to realize that a 1-in-100 event has an 18.2% chance of occurring over a 20-year period, while a 1-in-50 event has a 33.2% chance of occurring over 20 years.

Here's how the math works:

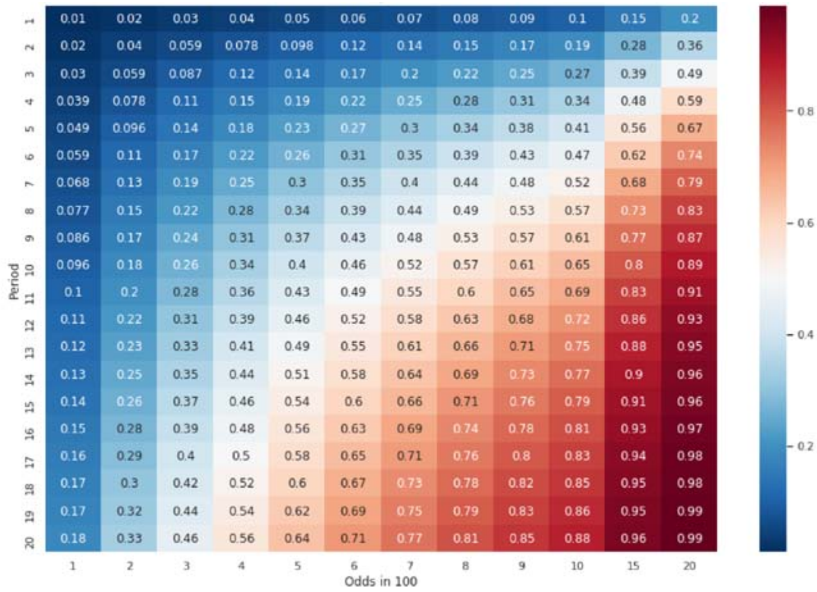
- In a given year, the probability that a 1% event will NOT occur is 99% or 0.99 (1 – 0.01).
- Over a 20-year period, the chance that a 1% event will not occur is 0.99^20, as we assume event occurrence to be independent year over year.
- So, the probability that a 1% event WILL occur at least once over a 20-year period is 1 – (0.99^20) = 18.2%.
- And the chance of a 2% event occurring at least once over 20 years is 1 – (0.98^20) = 33.2%.

Figure 1 illustrates how cumulative risk jumps with incremental changes in probability and time frame. Starting at the top left, as expected, a 1-in-100 event has a 1% chance of occurring in a one-year period. Go down two rows and across nine, for example, and the chances of a 9-in-100 event (9% chance in one year) occurring at least once in a three-year period are 25%. Jumping down to the bottom row, in a 20-year period, the chance of a 1% event occurring is 18%; a 2% event is 33%; and a 7% event has a staggering 77% likelihood of occurring at least once over that time frame.

FIGURE 1

Probability increases with time frame

Probability of at least one occurrence over various periods



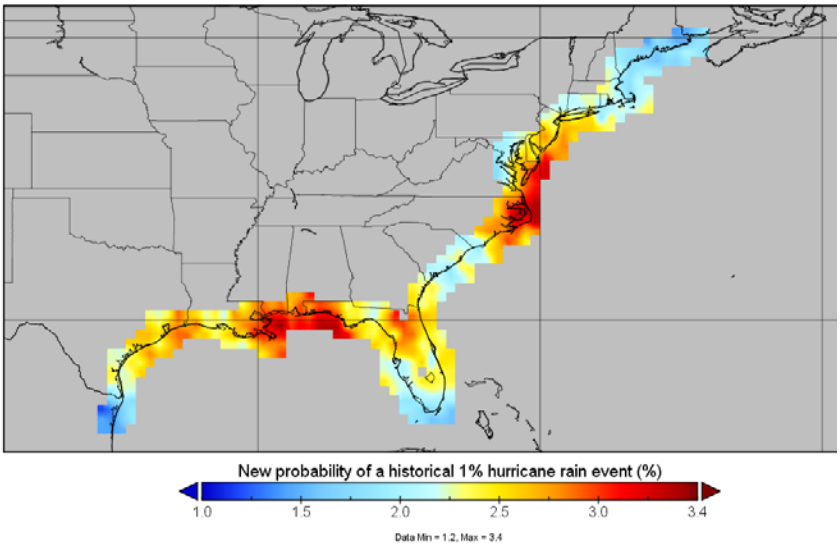
Source: Wellington Management

Physical manifestation of rising probabilities: Coastal US example

FIGURE 2 shows projections, based on climate data and scientific models from WHRC and MIT Professor of Atmospheric Science Kerry Emanuel, for extreme hurricanes along the US Eastern Seaboard and Gulf Coast. The legend colors show the change in probability of a 1% event from the 1981 – 2000 period to the 2031 – 2050 period. In some areas, 1% events will become 3% events. Referring to **FIGURE 1**, this means that some areas will face about a 45% chance of experiencing a devastating hurricane between 2031 and 2050.[1] No region on this map will see the risk of severe events decline over this period.

FIGURE 2

Change in probabilities for an extreme hurricane event for the period (2031 – 2050) from the period (1981 – 2000)



Sources: Woods Hole Research Center, Wellington Management

[1]Our hurricane data analysis is based on identifying points of interest (POI), such as metro areas or center points along a coastal grid cell, as were used to create the map in Figure 2. We then analyze projections for areas within a 300-kilometer radius, centered on each POI.

Considerations for investors and asset owners

For investors, the implications of these rising climate event probabilities are numerous. Here we focus on three considerations: holding periods, inventory, and valuations.

Holding periods

In portfolio construction, longer holding periods and lower turnover are typically seen as ways to minimize transaction costs and taxes. But for investments with climate-risk exposure, longer horizons may also increase embedded risk. An investor with low turnover of 25% has an average holding period of four years. As shown in **Figure 1**, the chance of a 2% climate-risk event occurring in a four-year period is nearly 8%. We believe that investors with allocations to climate-vulnerable assets, including coastal real estate, municipal bonds, infrastructure, energy, or transportation, should carefully evaluate holding periods vis-à-vis the increased odds of a negative climate event. At the same time, encouraging long-term climate-risk adaptation and mitigation through engagement with companies is becoming increasingly important for investors. Sharing specific climate-risk insights with managements may help companies make necessary incremental investments in their climate resiliency.

Inventory considerations

On a related note, a common heuristic around climate risk is to posit that capital-intensive companies or sectors, such as real estate developers and home builders, "only" carry, say, four or five years of inventory in a given region. But if that region — the southeastern United States, for example — is at risk of more frequent climate events, investors may want to rethink their inventory risk assumptions. Similarly, bondholders in large infrastructure or building projects may want to assess loan duration in at-risk areas.

Valuation calculations

With the help of Wellington's Investment Science (iSci) Team, the Climate Science Team has created a tool, called the Climate-Adjusted Yield Calculator, to help our portfolio managers see the impact of changing climate-event probability on the security-valuation process. We apply the probability and severity of an event into a model and use Monte Carlo simulations to understand the range of possible outcomes. This enables an investor to see the effect on expected returns from either a one-time event or a recurring disruption from multiple events. The investor can then evaluate the impact of these events between the current yield and the "climate-adjusted" yield. The tool is especially helpful when the impairment associated with an extreme climate event is evident, such as cases in which the value of the security depends upon a single asset.

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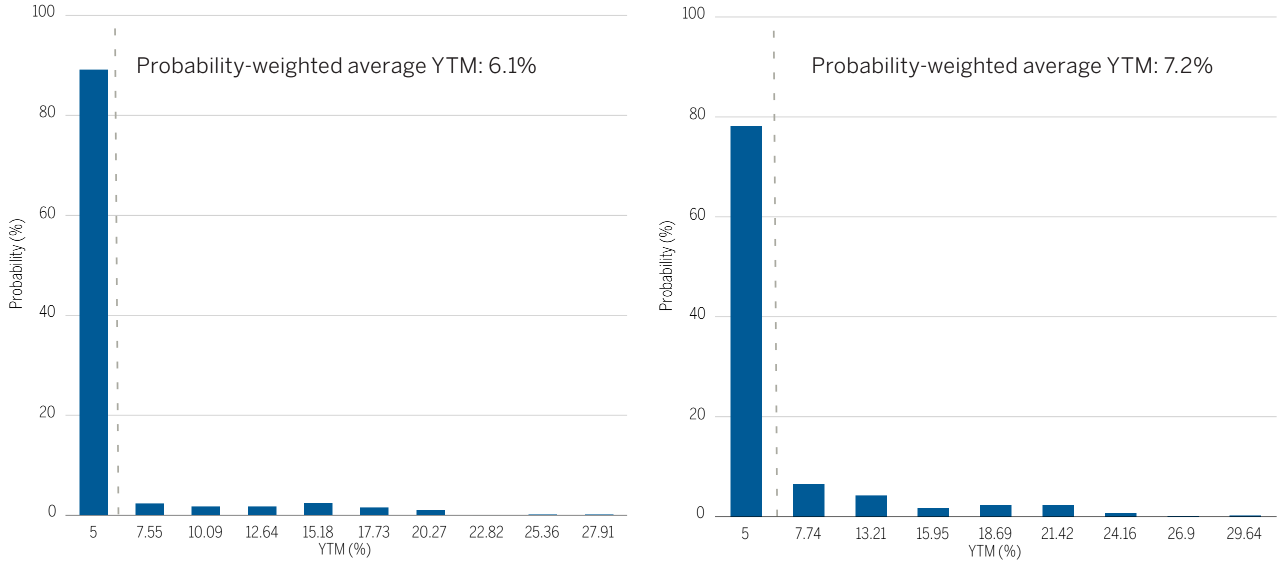
Designed to help investment teams stress-test climate-event probabilities on security returns, our Climate-Adjusted Yield Calculator can be useful in evaluating asset prices.

Designed to help investment teams stress-test climate-event probabilities on security returns, our Climate-Adjusted Yield Calculator can be useful in evaluating asset prices. For example, **Figure 3** shows the results of an analysis done on an infrastructure bond located in a hurricane zone. The bond offers a 5% yield with a 15-year maturity. When we apply the probabilities of hurricane-related impairments on the infrastructure, as well as a likely downgrade to the credit, it becomes apparent that the bond would have been fairly valued at a 6.1% yield, assuming a 1%-probability climate event, or at a 7.2% yield, assuming a 2%-probability climate event.

Figure 3

Probability distribution of climate-adjusted yield-to-maturity (YTM) outcomes

1%-probability climate event **2%-probability climate event**



Note: Yields plotted along the X axis are midpoints of their respective YTM-outcome ranges. | Source: Wellington Management

Conclusion

We believe the market has not yet appropriately repriced the increasing physical risks of climate change, partly because the cumulative probability of events over time is misunderstood. We are confident that repricing will occur, however, as these events can have significant economic impacts and therefore far-reaching effects on capital markets. The financial consequences of not repricing are great, and will show up in substantial lost value in the decades to come. In our view, properly repricing climate risk can also help companies and communities adapt to and mitigate the effects of climate change — and safeguard the environments in which they live.

To help mitigate and avoid these risks on our clients' behalf, we are challenging established rules of thumb and heuristics for assumptions like holding periods, cash-flow disruptions, inventory practices, and other behavior that may need to change in order to appropriately plan for and manage the climate-related "catastrophic norms" that Mr. Carney refers to. We will continue to develop tools like the Climate-Adjusted Yield Calculator that can help investors place more accurate values on securities that face some degree of climate risk.

Notes

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