

[Skip to content](#)



- [Solutions](#)
- [Insights](#)
- [Events](#)
- [About](#)
 - [Our Story](#)
 - [Team](#)
 - [Careers](#)
 - [In the News](#)
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Scenario Analysis for Physical Climate Risk: Equity Markets

Posted on [June 18, 2019](#) [June 18, 2019](#) by [Natalie Ambrosio](#)

In this second installment of our blog series of scenario analysis, we focus on **how investors can start exploring impacts on portfolios of listed equities/fixed income with existing climate risk analytics**. The series provides our current reflections on how corporations and financial institutions can integrate physical climate risk into scenario analysis. The first installment, on [foundations](#), focuses on important characteristics of climate science that affect how climate data can be used to inform scenario analysis for economic and financial risk. A forthcoming post will discuss scenario analysis at the asset level for real asset investments and corporate facilities.

Scenario Analysis Serves Different Purposes

Scenario analysis serves different purposes for real asset investors and for equity or fixed income investors. When looking at a single real asset, scenario analysis can be used to inform very concrete decisions regarding the asset, working directly with the asset operator: whether and what flood protections to put in place, insurance requirements, anticipated impacts on operational costs from water and energy consumption, etc.

In contrast, for an equity or fixed income portfolio, investors' influence on the resilience of the underlying asset (e.g. a corporation or a sovereign entity) is much more limited. In a previous publication we discussed the [importance of shareholder engagement](#) with corporations as a key channel for investors to help raise awareness of rising risks from climate change, and encourage companies to invest in responsible corporate adaptation measures. **Investors, however, would be hard pressed to run scenario analysis on individual portfolio companies themselves, and disclosures from corporations on scenario analysis remain weak and fragmented.**

Meanwhile, prudential authorities in Europe have been signalling expectations that insurers and banks perform scenario analysis on their portfolio to examine potential impacts of climate change, to understand how different climate-driven outcomes might prevent the insurers and lenders from meeting their financial obligations. Most recently, in April, the Bank of England Prudential Regulatory Authority (PRA) released a proposed set of [specifications for scenario analysis](#) that includes some simplified assumptions on climate impacts on financial portfolios.

In this piece we examine how available climate risk analytics can be leveraged to inform early attempts at developing stress test assumptions and simulate potential outcomes on investment portfolios aligned with the relative exposure of corporations by sectors and by regions.

Climate Risk Analytics for Equities/Fixed Income

We leverage our data on corporate physical risk exposure to determine what assumptions can be made in this type of early stress test. In this piece, we analyze the climate risk scores for 1730 of the largest companies in MSCI All Country World Index (ACWI). This physical risk assessment is based on the exposure of the underlying database of about a million facilities globally.

We score each company on three components of physical climate risk: Operations Risk, Supply Chain Risk and Market Risk.

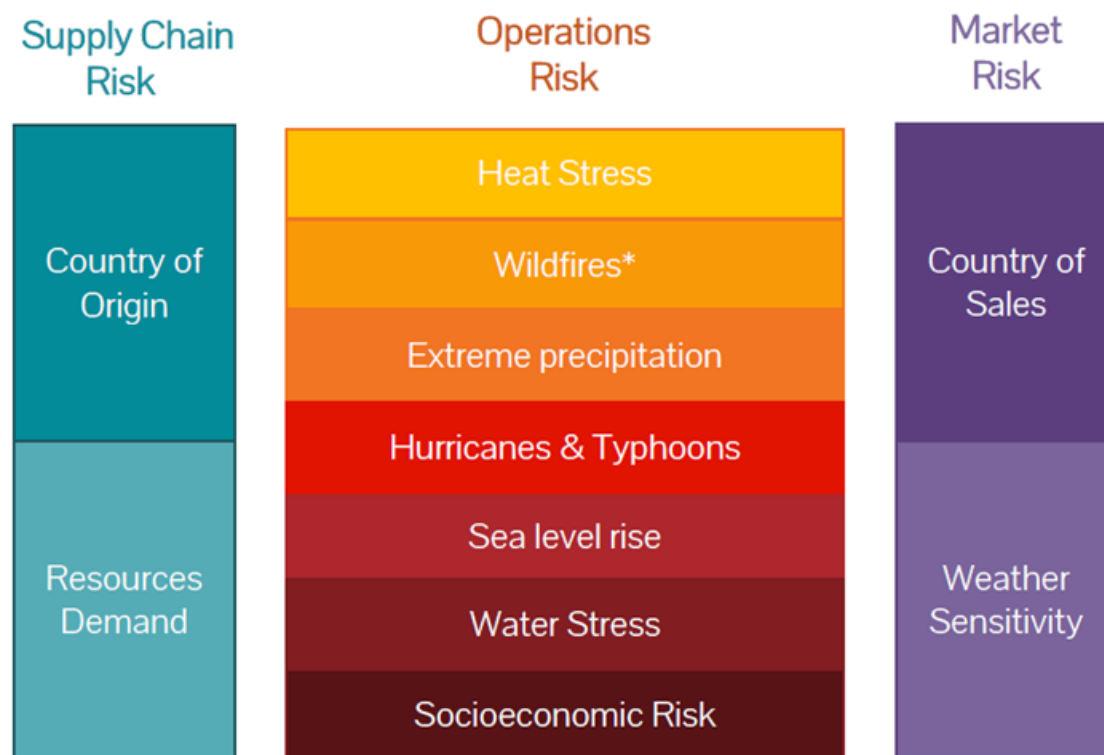


Figure 1. 427 indicators for physical climate risk exposure in corporations (equities/fixed income)

- A company's Operations Risk is based on its facility-level exposure to hurricanes & typhoons, sea level rise, floods, extreme heat and water stress. The analysis also considers the sensitivity of different types of facilities. For example, manufacturing plants with their high energy demands are more sensitive to extreme heat than offices.
- Supply Chain Risk is based on the risk in countries that export commodities that the company depends on and a company's reliance on climate-sensitive resources such as water, land and energy, based on its industry.
- Market Risk is based on where a company's sales are generated and how its industry has historically been impacted by weather variability.

Scores are normalized, with 0 being the least exposed and 100 being the most exposed. (For more details, please refer to our previous report [Physical Climate Risk in Equity Portfolios](#) as well as our [Solutions](#) page)

In line with considerations of relevant time horizons and of impacts being locked in over the climatic short term (detailed in [Part 1](#)), our standard equity risk score data considers projected climate impacts in the 2030-2040 time period under a single RCP scenario, RCP 8.5 (the worst case scenario, also known as business as usual), but leverages several climate models.

From Climate Hazard Exposure to Financial Impacts

Studies of how physical climate hazards translate into financial impacts at the company level are scarce. While a [growing body of research](#) explores the complex relationships between climate hazards and economic impacts, which vary by sector and by region, **academic research on the relationship between climate events and corporate/stock performance, at scale, is still limited. Our approach focuses on leveraging what can be estimated in a robust, data-driven way: relative exposure of companies to climate hazards.**

Our analysis of global corporations shows the relative exposure of industries to climate related risks across all three dimensions: operations risk, market risk and supply chain risk (Table 1). This table shows the sectors with the highest exposure, including manufacturing, infrastructure (utility, energy, transportation), and industries with high dependency on natural resources (food, apparel).

Table 1. Industries most exposed to physical climate risks . Source: Four Twenty Seven.

| GICS Sector | GICS Industry Group | 427 data-derived estimates of exposure to select climate hazards | | | |
|------------------------|--|--|-----------------------|-------------------|-------------------------|
| | | Average score | Operations Risk Score | Market Risk Score | Supply Chain Risk Score |
| Information Technology | Semiconductors & Semiconductor Equipment | 56 | 43 | 70 | 62 |
| Information Technology | Technology Hardware & Equipment | 54 | 44 | 64 | 57 |
| Utilities | Utilities | 53 | 46 | 37 | 70 |
| Health Care | Pharmaceuticals, Biotechnology & Life Sciences | 52 | 42 | 63 | 57 |
| Consumer Staples | Household & Personal Products | 50 | 40 | 65 | 57 |
| Materials | Materials | 50 | 42 | 60 | 51 |
| Industrials | Transportation | 50 | 43 | 41 | 63 |
| Consumer Staples | Food & Staples Retailing | 48 | 41 | 57 | 52 |
| Consumer Discretionary | Automobiles & Components | 48 | 42 | 66 | 34 |
| Industrials | Capital Goods | 47 | 42 | 57 | 40 |
| Consumer Discretionary | Consumer Durables & Apparel | 46 | 40 | 54 | 46 |
| Energy | Energy | 45 | 39 | 48 | 51 |

Services, not shown in the table, are not only less exposed, they're also far less sensitive to changes in climatic conditions, with the exception of the financial sector, which holds the risk of all the other sectors in its investment, lending or insurance portfolios. Note that real estate is not included in this analysis, but data on regional exposure in that sector can be found in our [white paper on climate risk in real estate](#).

These differentiated impacts by sectors can lay the foundations for a stress test, as industry risk levels can be used to set initial assumptions on sector-wide impacts. Following the example set out by the Bank of England's PRA, for example, investors could assume that sectors with high exposure might see a 10% or 20% drop in value, whereas sectors with medium exposure would see half of that impact. These assumptions are not intended to substitute for financial impact modeling, but provide a shortcut to test how a portfolio might perform under climate-driven duress.

Drivers of Exposure to Physical Climate Risk

While some sectors overlap with those examined in scenario analysis exercises for transition risk, such as utilities and energy, other sectors with high exposure are not typically included in scenario analysis, like tech manufacturing or pharmaceuticals. Understanding the nuances of the risk pathways in each sector and their relative exposure to different hazards is critical to refining assumptions and developing models that can quantify value-at-risk by sector with some accuracy.

Manufacturing companies in the tech sector rely on complex value chains that [can be interrupted by extreme weather events](#), particularly in Asia, which is a region highly exposed to typhoons and extreme precipitation. They also often produce expensive and water sensitive products using costly machinery and can incur costs and damages from extreme events on site. Pharmaceuticals are particularly exposed because of the prevalence of their manufacturing in water-stressed regions (India, California) and regions highly exposed to hurricanes & typhoons. For example, damaged manufacturing sites in Puerto Rico had rippling impacts on pharmaceutical operations globally [during Hurricane Maria](#) in 2017. Pharmaceuticals is also one of the groups with the most weight in the MSCI ACWI, making this exposure particularly significant (Fig 2).

MSCI ACWI - Average Company Score by Industry Group

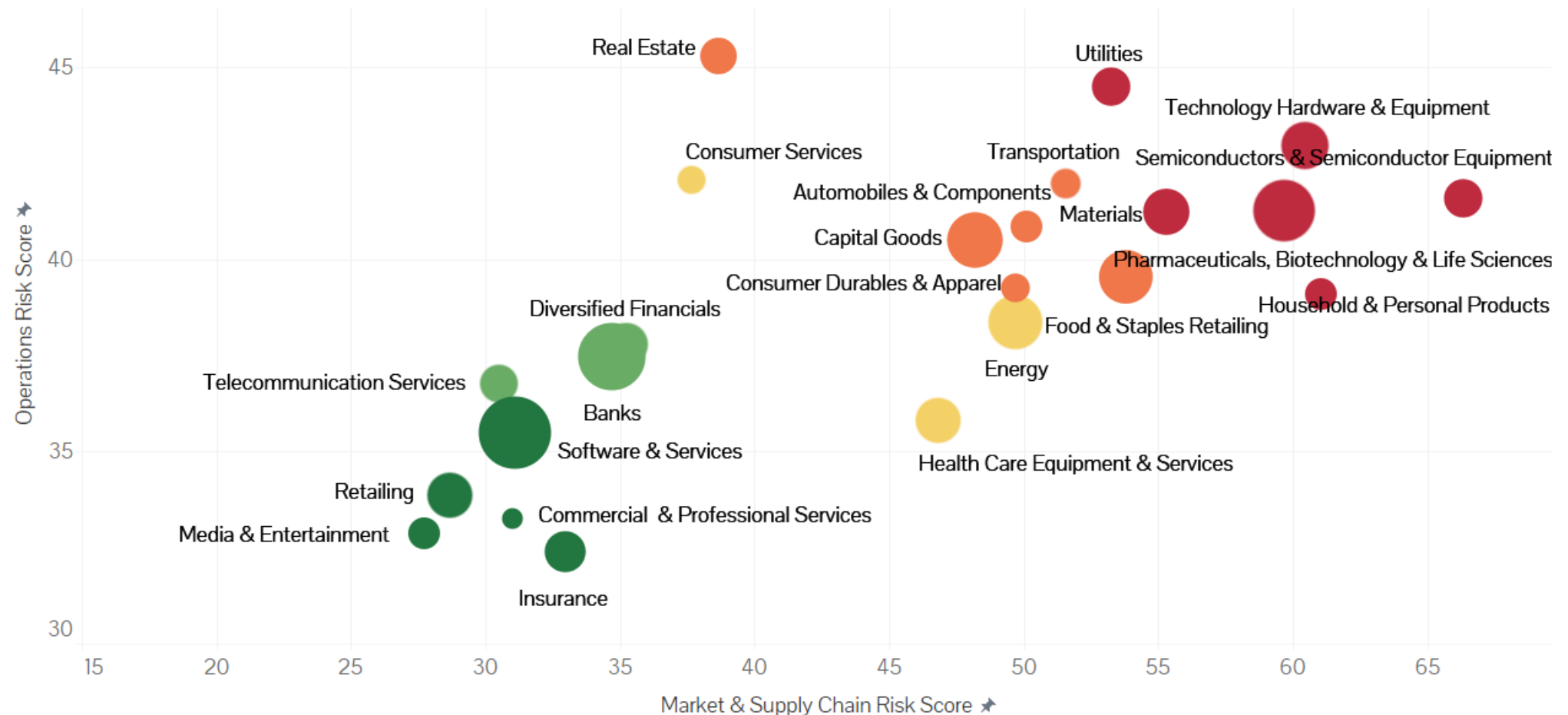


Figure 2. The average company risk score by GICS Industry Group, with Operations Risk on the y-axis and Market & Supply Chain Risk on the x-axis. Red represents those industries with the highest exposure, green represents those with the lowest exposure and the size of the bubble signifies an industry's weight in the MSCI ACWI. Source: Four Twenty Seven.

In the utility sector, the nature of the exposure is very different from that observed in transition risk analysis: carbon neutral power generation can be as exposed as thermal generation – for example due to water stress or floods for hydro facilities. In addition, utilities rely on expensive equipment, such as cables, poles, fuel storage and pipes that are often exposed to severe weather and sensitive to extreme conditions. Their operations are also resource-intensive, relying heavily on energy and water for cooling. They can experience operations disruptions during peak energy demands or due to equipment damage during storms.

The exposure of the automobiles & components sector has been illustrated by recent flooding in Japan. Automobile companies rely on manufacturing processes and machinery that can be interrupted due to flooding or hurricane damage, but their reliance on employee labor also makes these companies vulnerable to the wider regional impacts of extreme events. For example, during Japan's extreme flooding in July 2018, Mazda was forced to halt operations at some of its facilities that were not physically damaged themselves, [because its employees could not travel safely to work](#).

Conclusion

Climate change calls for a better understanding of impacts of physical hazards on financial markets, which remains a topic largely unexplored. Yet **as regulators push insurers and banks towards the integration of climate scenarios into stress testing, robust, data-driven views on the relative exposure of sectors or regions provide a helpful foundation from which to explore the potential impacts on equity and fixed income portfolios.**

Over time, better data will become available as academic and industry providers develop models that capture the nuances of climate impacts on different industries and geographies, but also as companies make a concerted effort to disclose better data on their past and anticipated financial exposure to extreme weather and climate-related events.

Four Twenty Seven's [data products and portfolio analytics](#) support risk reporting and enable investors and businesses to understand their exposure to physical climate risks across asset classes.

Post navigation

[Scenario Analysis for Physical Climate Risk: Foundations](#)

[Newsletter: Bank of England Publishes First Stress Test for Climate Risks](#)

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