

Distortion-Based Tail Risk Assessment: Linking Extreme Climate Events to Economic Losses

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Abstract

Traditional climate-risk stress tests apply historical, sector-level shocks to current balance-sheets, capturing the bulk of the loss distribution but scarcely touching tails. Such an approach usually overlooks the potential for large losses driven by extreme weather events, which are sparsely represented in empirical records and difficult to translate into severity. To address these limitations, climate science often turns to extreme value theory, while finance employs tail-sensitive risk measures. The link between hazard intensity and financial loss is usually established via damage functions fitted to past data.

Monte-Carlo experiments show that, if the underlying hazard exhibits even moderate tail fatness, conventional VaR and ES can strongly underestimate tail events, and this might lead to a severe underestimation of the economic impact. The problem is exacerbated by the lack of data, which typically affects extreme events.

We propose a probabilistically sound alternative inspired by distortion measures, linking the distributions of the events to the distribution of the economic losses, while still in line with traditional approaches based on vulnerabilities.

The approach is based on three main points: first, a distortion function is used to map the probability of exceedance in the event space to a probability in the loss space; second, this probability is linked to the economic impact by using quantile functions (either known, or derived from information about vulnerabilities); third, since the distortion function can be parametrised, our approach naturally supports scenario analysis on technology uptake or mitigation policy.

We provide analytical justifications and statistical results, to support our claims.

Keywords— climate risk, economic impact, tail risk, damage function, distortion function

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