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# A Multi-Layer Network Model of Climate Reinsurance: Company Benefits vs. Climate Resilience?

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Decreased insurability has been observed in selected locations related to increased climate risks. Decreased insurability could contribute to limits to adaptation to climate change, posing major challenges to the economy across world regions [1].

One of the visible features of the current (re)insurance global market is its limited capacity to absorb risk [2]. Furthermore, the capacity of this market might be decreasing in areas with increasing climate risks. In addition, just 4 companies dominate the market with assumed reinsured premiums above \$20B, which indicates that a certain degree of oligopoly might be limiting the capacity of the global reinsurance market to absorb climate risks.

Traditional economic models of (re)insurance markets fail to capture the influence of market structures, which we capture in a multilayer reflecting the activities of public and private entities with insurance cover, primary insurers, and re-insurers. These are represented as nodes forming multiple layers in a network model. The main attributes of the nodes relate to their insurance-related activities, and those of the links to their fees, coverage and claims.

Aiming to understand the impact of higher levels of risk related to a changing climate, we explore the role of the structure of the network, and in particular we investigate the risk transfer and the claim activation conditions across nodes, and the number of nodes per layer.

A first version of this multilayer model was built on the basis of the functioning of the (re)insurance market and the dynamics of its actors represented as nodes and their transactions represented as a network linking them; this was coded in NetLogo. One of the limitations of studying the economics of insurance is that it is often not possible to obtain data from the insurance industry due to the competitive advantage that such information could provide to other businesses. In this context, our model stands out as a stylized model capturing the most important features of the market at hand. With this model, we investigate a number of market structures and reproduce the dynamics of the nodes under different levels of climate risk, representing policy scenarios leading to higher levels of resilience due to a larger number of different node types (e.g. reinsurers) spreading risk in the network.

The results show that market structures populated with different numbers of reinsurers have an influence in the resilience of the network under higher levels of risk. Fig. 1 shows how a network with a larger number of reinsurer nodes (see X axis, variable 'n-re-insurer-nodes') is able to cope with larger climate impacts (see variable 'impacted-people-netneighbours' in the Y axis, it is the size of a connected component representing the size of the simulated climate impact).

These results indicate that that some current (re)insurance market properties — particularly the existing limited number of sizeable reinsurers in the market— call for policy incentives to increase the number of reinsurance providers, which is a challenge for the somehow oligopolistic nature of this market, and which will increase the insurability and climate resilience of the overall system.

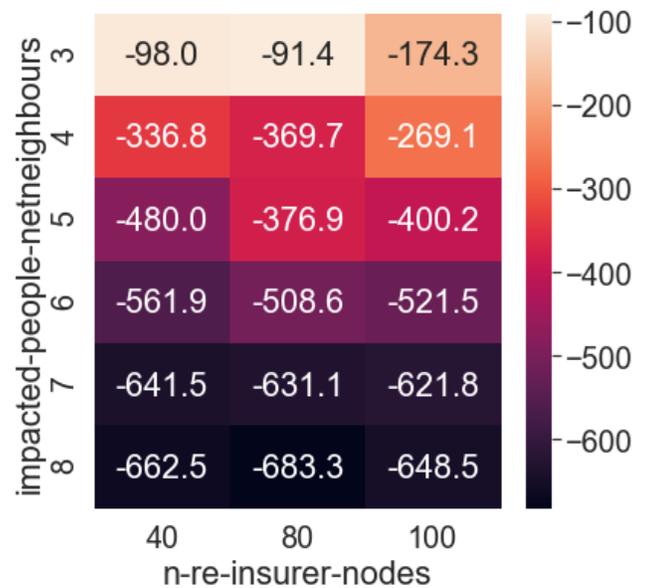


Fig. 1: The heatmap shows the aggregated annual balance of re-insurance companies in the market without accounting for the revenue from the reinvestment of insurance premiums, thus solely analyzing the influence of stylized climate shocks and market structure comparing different assumptions on policy interventions to promote climate resilience. The size of simulated climate impacts, involving a larger impact on neighboring communities is represented in the Y axis (variable 'impacted-people-netneighbours' is the size of the impacted connected component), while the X axis (variable 'n-re-insurer-nodes') represents the number of re-insurers available in the market.

[1] Cremades, R., Surminski, S., Máñez Costa, M., Hudson, P., Shrivastava, P. and Gascoigne, J. Using the adaptive cycle in climate-risk insurance to design resilient futures. *Nature Climate Change* 8 (2018).

[2] Wynes, S., Garard, J., Fajardo, P., Aoyagi, M., Burkins, M., Chaudhari, K., ... & Matthews, D. (2022). Climate action failure highlighted as leading global risk by both scientists and business leaders. *Earth's Future*, 10(10).