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Macroeconomic Effects of Natural Disasters: A Large Scale Agent Based Modelling Approach using Copulas

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We introduce a copula approach to model dependencies between risks and show how this could be used to avoid underestimation of extreme events in large-scale risk assessments. We apply the approach within an extensive agent based model to determine the macroeconomic consequences due to catastrophic events. The agent based approach is capable of modelling an entire national economy with all sectors, including households, firms and banks. It is based on an input-output model with 64 industries where all goods and services are produced endogenously. We show that without a copula approach only average annual losses on the country level would be available which limits analysis on long term effects. However, with the copula approach, which includes the estimation of basin scale loss distribution through catastrophe modelling, exposure estimation through Corine land cover mapping, assessment of appropriate copulas and parameter estimation, including an algorithm to couple coupled basins as well as an upscaling procedure to the country level, the whole risk spectrum can be estimated. The direct loss estimates from the copula approach, separated into different risk bearers, are used to build a damage scenario generator which gives the input for the agent based model. The agent based model in turn assesses the additional indirect losses due to the event which can be much larger than the direct losses alone. The agent based model is calibrated to the case auf Austria at a scale 1: 10, e.g. with hundreds of thousands of agents and the agents are calibrated according to micro data, including business information, balance-sheets, and income statements. We show that there can be severe effects due to large scale natural disaster events through different transmission channels, even leading to systemic risks. This detailed information should be useful for determining risk management options on various scales.