

Non-negligible indirect risks of sea level rise: Evidence from Japan

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Abstract:

Sea level rise (SLR) is one of the most visible and alarming consequences of global climate change, which endangers social and economic impacts, particularly in low-lying areas and small island states at vulnerability. The potential risks of SLR have been widely evaluated in the scientific community, however, most studies have focused on the direct impacts on coastal areas while overlooking the potential propagation effect along the value chain. This paper aims to answer the research question: How and to what extent is the indirect risk of sea level rise affect the value chain, by carrying out an empirical analysis for a representative island country Japan. To this end, millions of financial transaction records between 302,845 firms across Japan are collected, which details the information of the firms including location, industry category, capital, transaction items, estimated transaction amounts, etc.

The assessment focuses on the spatial and industrial characteristics of the SLR risks. Based on an input-output model, the economic losses of various industries and regions across Japan caused by the disasters are estimated, which is specifically characterized as the impact on firms. The year 2019 before the COVID-19 pandemic is considered for analysis to eliminate distractions. The intermediate scenario of RCP4.5 defined by IPCC and the median global sea-level projections are considered here as which is recognized as closely aligned with the current global emissions and situation. To explore the spread extent of the effects of the hazard across industries and regions, the Gini index are adopted for quantitative analysis. The two indexes are originally used to measure the equality of income distribution across a population, in this paper, they are used to represent the wideness of the hazard spread. The more equal the industries and regions get affected by the hazard, the wider the impacts spread.

Results show that the indirect risks of SLR intensify the impacts on the entire value chain in Japan. From the national level, the direct risk leads to 0.97% economic losses, while the indirect risk doubles the number and reaches 1.9% of the total asset, which further results in an effect of 2.87% in total. In terms of industry classification, manufacturing, transportation and communication, construction, and agriculture are among the four industries that endeavor the largest effects with total economic losses above 3%, while the least affected industries (<1%) are electricity, gas and water, finance and insurance, and public affairs. Besides, it is found that indirect effects widen the spread of the value chain risks across industries as well as regions, visualized by a flatter Lorenz curve that is closer to the line of perfect equality (i.e., lower Gini index) for the indirect risk compared to that of direct risk.

Overall, our study provides important insights to understand the potential economic impacts of SLR and highlights the non-negligibility of the indirect risks of SLR through empirical analysis in Japan. SLR or to a larger extent climate change put everyone at risk directly and/or indirectly, thus there is a strong need to call for responsibility from all, instead of only the coastal area.

Keywords: Sea level rise; Indirect risks; Economic losses; Value chain; Japan