

# Developing a model of disaster policies and the sovereign debt sustainability

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## Introduction / Objectives

This study develops a model for quantitatively analyzing the long-term disaster fiscal policy of a country in the Global South. Low-income countries with a high impact of climate change-induced disasters potentially face the danger of falling into a vicious cycle composed of economic stagnation, climate vulnerability, massive foreign procurement for disaster recovery, and debt crises, which could finally reach sovereign default. This study examines the integrated policies of disaster risk reduction (DRR) against such disaster vulnerability traps. We focus on the role of government insurance. It has been pointed out that governments need to be insured to prepare for potential large expenditures for disaster recovery. However, for countries that experience multiple disasters yearly, a disaster is not an event of uncertainty. Moreover, disaster insurance is a costly measure associated with high additional premiums and transaction costs. Considering them, the benefit of disaster insurance for such governments is not as obvious as it may seem. This study investigates the possibility that the government's insured status may contribute to lower interest rates on government debt and formulates a model to analyze the desirable combination of insurance policies and investment in disaster prevention and reconstruction.

## Methodology

We formulate a simple model of a small-open economy of two goods and money. Two sorts of physical stocks exist in the economy: production and DRR capital both exposed to natural hazards; the larger the ratio of DRR capital to the two stocks, the smaller the expected damage rate of the stocks.

A yearly increase in sovereign debt is given by a difference between expenditure and revenue, components of which include annual expenditure for disaster finance such as insurance premiums and receipts of funds at a disaster time to be used for prompt recovery and provision of relief goods. For the transition of the sovereign debt, the interest rate is assumed to be given as a function of the sovereign debt-GDP ratio and the size of the insurance contract in force at that time.

We assume that sovereign default occurs when the sovereign debt-GDP ratio exceeds a certain threshold. The government's problem is to maximize an objective function, which is the weighted sum of the expected GDP at the end of a planning period and its variance, subject to two constraints: (i) probability of the default during the planning period is less than a certain probability, and (ii) the expected value of the net external debt-GDP ratio for the country is less than a certain level.

## Findings / Significance of the work for policy and practice

Through numerical experiments, the qualitative behavior of the model was explored. As the first analysis, we simplified the model and set up a hypothetical model economy based on one developing country. Because there are many combinations of policy variables in this model, we limited them to three variables as follows: (i) the investment rate in DRR capital in terms of the GDP share, (ii) the ratio of prompt (i.e., within-the-disaster-year) reconstruction investment to the total destroyed physical capital, and (iii) the insurance coverage rate against the total stock damage and needs of relief goods. Numerical simulations were performed with a limited set of parameters. A basic case was set up with a certain combination of parameter values, and then the markup rate of disaster insurance, which was an exogenous variable in the model, was moved from 1 to 2.5 to examine the responses of the optimal values of the above three endogenous policy variables. As a result, the optimal insurance coverage rate decreased monotonically as the markup rate increased from 1 to larger. On the other hand, the optimal DRR investment rate and reconstruction coverage rate showed a single-peaked form. This is because, at first, the substitution effect of the insurance becoming more expensive dominates, and then the income effect of the increased premium expenditures dominates.

In other comparative statics on the basic case, it was shown that when the default threshold decreased, overall government spending contracted. However, the insurance coverage rates were found to increase or decrease in some cases, depending on the combination of other parameter values. Furthermore, when the expected damage rate of a disaster increased, the DRR investment rate increased, while the insurance coverage rate decreased due to higher premiums. A more detailed analysis will be reported at the time of the presentation. In summary, the endogenous variables in the model were found to move non-monotonically in response to changes in the economic environment. Therefore, policy analysis should be conducted on parameter values that replicate the specific real economy as much as possible. Designing a process of practice, which ultimately includes a feedback process between numerical simulation and policy scenario setting through discussion with practitioners, is also an important future task.