Improving the market penetration of flood insurance by considering positive externality: A global scale assessment

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Key points

- ◆Flood insurance can accelerate post-disaster recovery and reduce indirect losses caused by floods. However, past flood insurance models have mainly focused on micro-level individuals, ignoring its macro-level positive externality. This paper establishes a macroeconomic assessment model that considers the positive externality of flood insurance.
- ◆In this macro-level flood insurance model, considering the positive externality can significantly improve the economic feasibility of flood insurance. This includes the positive impact of flood insurance on the national economy and the maximum risk premium that flood insurance companies can charge. The research finds that more countries should implement flood insurance.
- ◆The economic feasibility of flood insurance is mainly influenced by the flood risk characteristics of the insured countries, especially the variability of annual flood losses. The variability of annual flood losses has a negative effect on promoting flood insurance, as the higher its value, the higher the risk premium that needs to be paid.
- ◆According to the economic theory, positive externality problems typically require government intervention. We suggest that the government should take the lead in facilitating a co-insurance agreement.

Results

We calculate the maximum risk premium attachment coefficient under different senarios. The higher the coefficient, the higher the variability of implementing flood insurance.

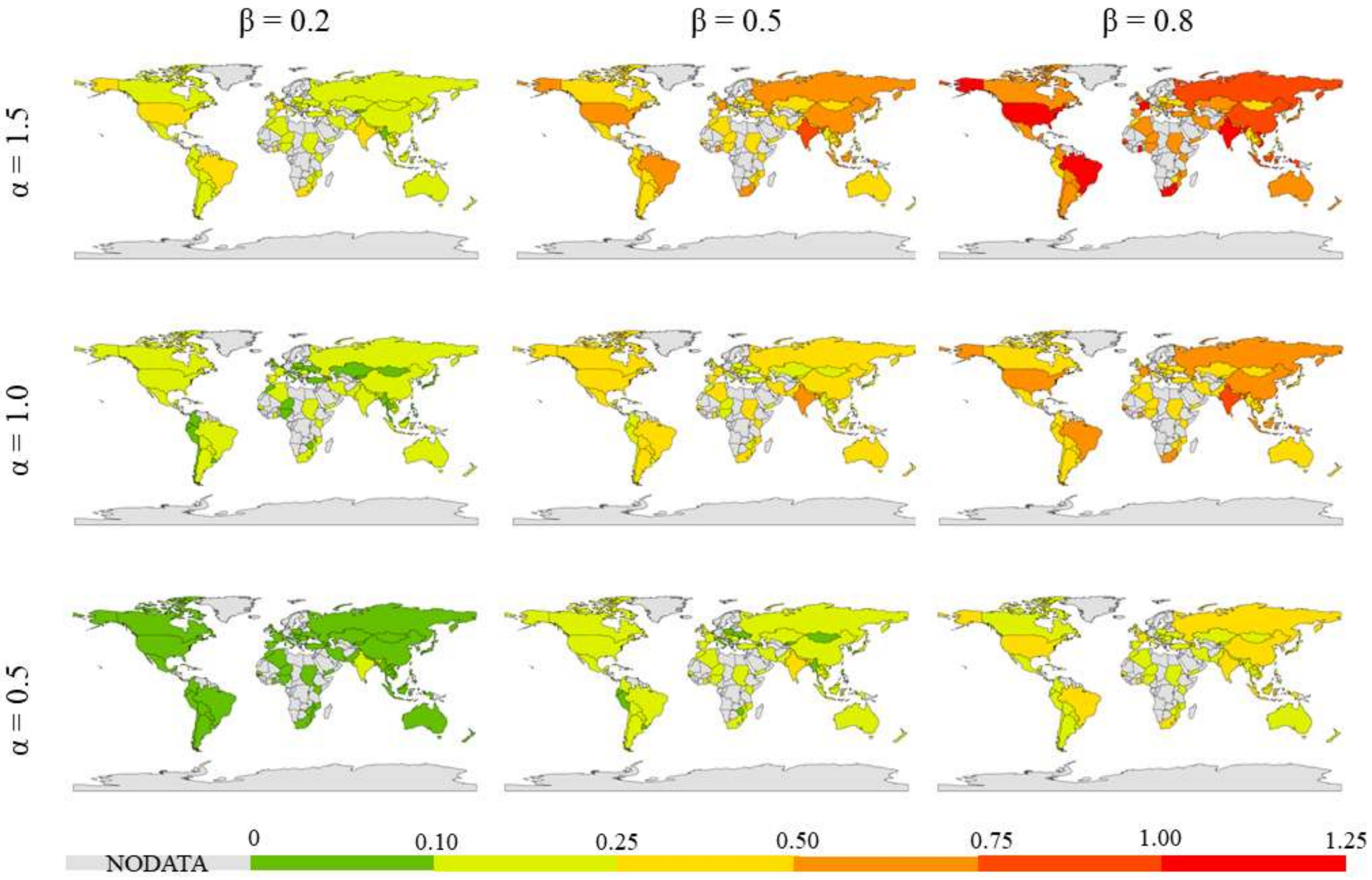

Figure 2. The maximum risk premium attachment coefficient λ of flood insurance in various countries. Grey districts indicate no data or unreliable data.

Methods

Global flood economic losses data were obtained from the International Disaster Database (EM-DAT). The GDP and CPI data for each country are obtained from the World Bank.

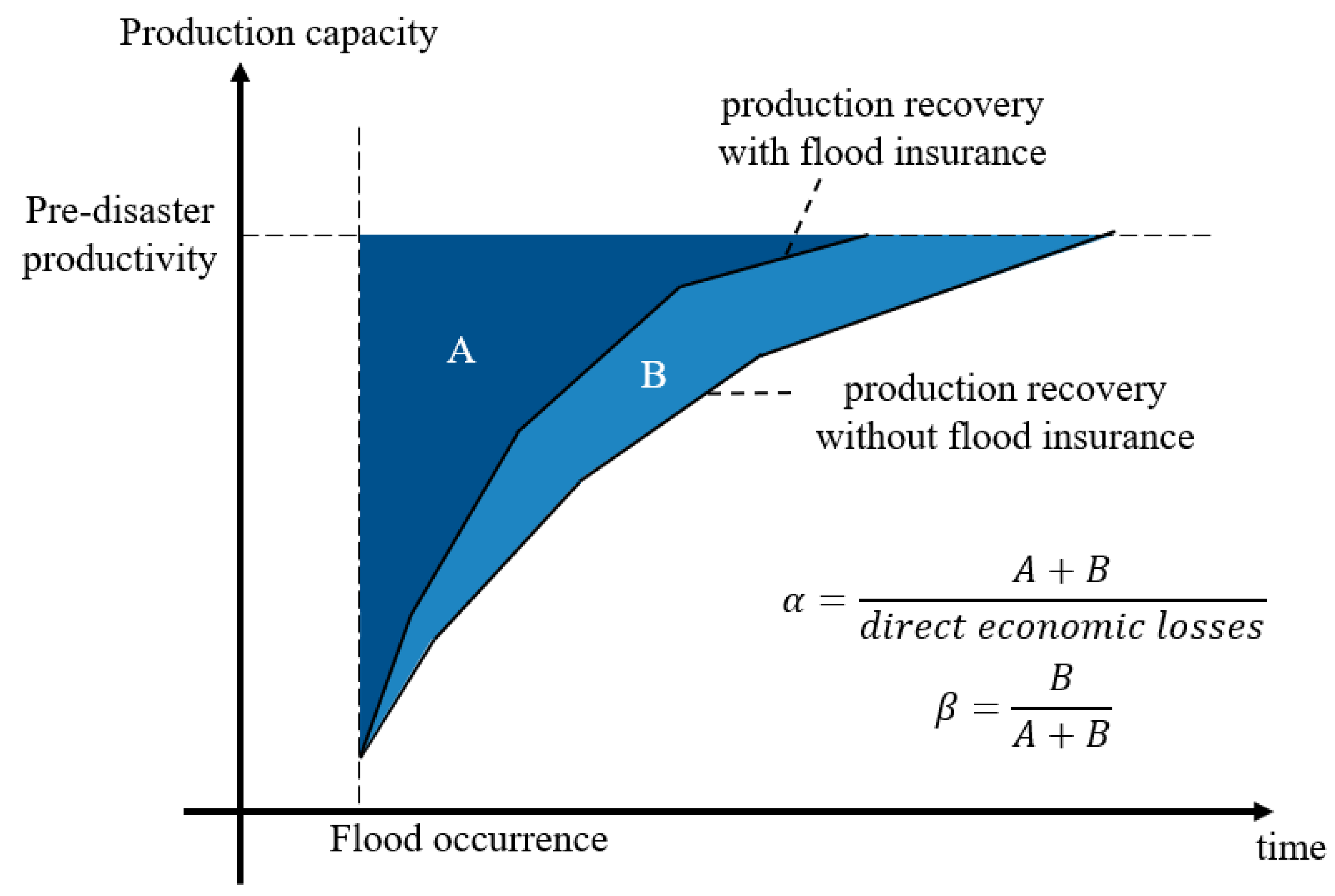

Figure 1. The square of A+B represents the total indirect economic losses when no flood insurance is purchased, while the square of A represents the indirect economic losses when flood insurance is purchased and B represents the reduction in indirect economic losses due to the purchase of flood insurance.

$$p(L_R) = \begin{cases} 1-p_0 & if \quad L_R = 0 \\ p_0 \times \dfrac{e^{-(\ln L_R - EL_R)^2/(2\times CV^2 \times EL_R^2)}}{L_R \times EL_R \times \sqrt{2\times\pi}} & if \quad L_R \neq 0 \end{cases}$$

$$L_R = \frac{L}{W_{base}^{GDP}} \qquad EL_R^{real} = \int_0^{L_{R\,max}} (p(L_R)\times L_R)dL_R$$

$$SDL_R^{real} = \sqrt{(1-p_0)\times(EL_R^{real})^2 + \int_{0+}^{L_{R\,max}} (p(L_R)\times(L_R - EL_R^{real})^2)dL_R}$$

$$pm_R = EL_R^{real} + \lambda \times CV^{real} \qquad U(W) = \frac{W^{1-\sigma}}{1-\sigma}$$

$$EU_N(W) = (1-p_0)\times U(W^{pergdp}) + \int_{0+}^{L_{max}^R} p(L^R)\times U(W_N)dL^R$$

$$EU_Y(W) = (1-p_0)\times U(W^{pergdp}\times(1-pm_R)) + \int_{0+}^{L_{max}^R} p(L^R)\times U(W_Y)dL^R$$

- ◆There are four main input variables of each country: annual mean direct losses rate, coefficient of variation of annual direct losses, probability of flooding and per capita GDP.
- ◆When $EU_Y(W)$ is equal to $EU_N(W)$, calculate the maximum value of the risk premium attachment coefficient λ.
- ◆L_{max}^R is equal to the 10,000-year flood direct losses rate.