

Title: Anatomy of Flood Risk and Flood Insurance in the U.S.

Advisor: Dr. Makarand Hastak

The federally backed National Flood Insurance Program (NFIP), which is managed by the U.S. Federal Emergency Management Agency (FEMA), is presently under huge debt to the U.S. treasury. This debt is primarily a result of low flood insurance adoption rates, a limited willingness to pay for flood insurance, and substantial payouts after major disasters. Addressing this insolvency problem requires the NFIP to understand (1) the driving forces behind the demand for flood insurance in order to increase it, (2) how risk factors contribute to significant flood insurance payouts for effective risk reduction planning, and (3) how to forecast future flood insurance payouts for financial preparedness. This research has answered these three fundamental questions by developing empirical models based on historical data. To answer the first question, a propensity score-based causal model that analyzed one of the key components that influences the demand for flood insurance – the availability of post-disaster government assistance has been developed. It was found that the availability of post-disaster federal assistance in a county in a year increased the number of flood insurance policies by 5.2% and the total insured value of the policies by 4.6% in the following year. Next, this research has developed a Mixed Effects Regression model that quantified the causal relationships between the annual flood insurance payout in a county and flood related risk factors such as flood exposure, infrastructure vulnerability, social vulnerability, community resilience, and the number of mobile homes in the county. Based on the derived causal estimates, it was predicted that climate change, which is expected to increase flood exposure in coastal counties, will increase the annual NFIP payout in New Orleans, Louisiana by \$3.34 billion in the next 30 years. Lastly, to make the NFIP financially prepared for future payouts, a predictive model to predict the annual NFIP payout in a county with adequate predictive accuracy has been developed. The predictive model was used to predict the NFIP payout for 2021 and it was able to predict that with a 9.8% prediction error. The outcomes of this research create new knowledge to inform policy decisions and strategies aimed at fortifying the NFIP. This includes measures such as flood protection infrastructure planning, tailored disaster assistance, and other interventions that can bolster flood insurance uptake while mitigating the risk of substantial payouts. Ultimately, this research contributes to sustaining the NFIP's ability to provide vital flood insurance coverage to millions of Americans.