The National Flood Insurance Program Underwater: Censored Regressions on Flood Insurance Claims

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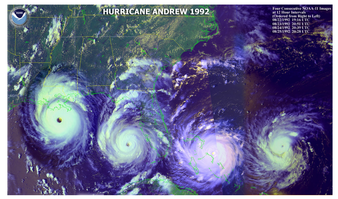

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Objectives

- Estimate the probability of at least one flood insurance claim being filed per month for each county in Florida.
- Estimate the expected count of flood insurance claims filed per month for each county in Florida.
- Determine whether significant changes have occur over time in the number of flood insurance claims filed.

FIGURE 1: Florida Counties

Introduction

- In 1968 Congress passed the National Flood Insurance Act, creating the National Flood Insurance Program (NFIP) (Government Accountability Office, 2011).
- The market for flood insurance has long been deemed unprofitable by private insurers because of the systemic risk.
- After Hurricane Katrina and more recently Hurricane Sandy, the NFIP is indebted to the Treasury for approximately $17 billion not including the losses for Hurricane Sandy, which is believed to be an additional several billion dollars (Kousky and Michel-Kerjan, 2012).
- Our analysis examines the number of flood insurance claims filed.

Data

- There are more than 2 million of flood insurance policies in Florida, which is 40% of the nation's total number of flood insurance policies .
- The dataset contains observations for each of the 67 counties of Florida. The number of flood claims, the variable of interest, is aggregated monthly for the months June 1992 to June 2012. 16147 observations are utilized in the estimation.
- Almost 90% of the county-month observations have zero flood insurance claims filed with the NFIP. To reduce bias, we choose to include the zero observations and utilize zero-inflated models.

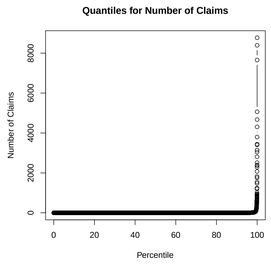

FIGURE 2: Percentiles for Number of Claims for the Entire Dataset

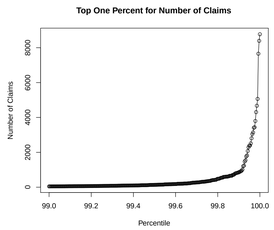

FIGURE 3: Top 1% Percentile for Number of Claims for the Entire Datasets

Method

Using Bayesian hierarchical modeling, we model the data with a Zero-Inflated Poisson (ZIP) distribution with spatial random effects, such that

$$Pr(C_{it} = k) = \begin{cases} P_{it} + (1 - P_{it})e^{-\lambda_{it}} & \text{if } k = 0 \\ (1 - P_{it})\dfrac{e^{-\lambda_{it}}\lambda_{it}^{k}}{k!} & \text{if } k = 1, 2, 3, \ldots, \end{cases} \quad (1)$$

where C_{it} denotes the random variable of the count of flood insurance claims, for county $i = 1, \ldots, N$ and for month $t = 1, \ldots, T$. The probability parameter P_{it} is modeled using the logit link:

$$\text{logit}(P_{it}) = \alpha_{i,0} + \alpha \text{NumPolicy}_{it}, \quad (2)$$

NumPolicy is the number of flood insurance policies in forced for each county. The Poisson parameter λ_{it}, the expected number of flood claims given atleast claim has been filed, is modeled using the log link:

$$\log(\lambda_{it}) = \beta_{i,0} + \beta \text{NumPolicy}_{it}. \quad (3)$$

The random effects $\alpha_{i,0}$ and $\beta_{i,0}$ are modeled with the spatial Conditional Autoregressive (CAR) model.

Results

Below are the estimates for the probability parameter, P, and λ for five counties in Florida. As can be seen in Figure 1, these counties are located in different regions of Florida.

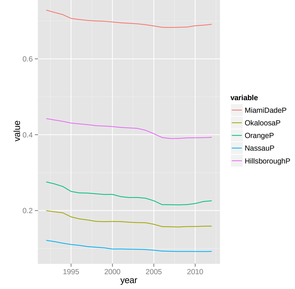

FIGURE 4: Probability Parameter P for the ZIP Distribution

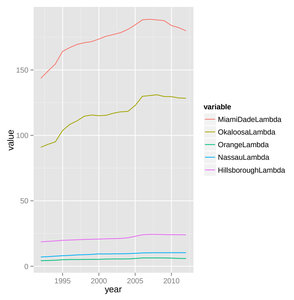

FIGURE 5: Probability Parameter λ for the ZIP Distribution

Conclusions

- As would be expected, there is a large range in the probability of a given county experiencing at least one flood claim being filed in a month.
- As seen in Figure 4, there is approximately a 70% probability that there will be atleast one flood claim filed in Miami-Dade County. This sharply contrast with other counties, such as Nassau County, which has approximately a 10% probability of atleast one flood insurance claim being filed.
- Overall there is a gradual decrease over time in the probability of at least one flood claim being filed, yet the expected number of flood claims being filed given a flood event occurred has increased over time.
- Although some counties, such as Miami-Dade County, have a high probability of at least one flood claim being filed and a high expected number of flood claims given a flood has occurred, other counties, such as Okaloosa, have a relatively low probability of at least one flood claim being filed, yet a high number of expected flood claims given a flood has occurred.

Future Research

- The Zero-Inflated Negative Binomial distribution is also considered to allow for greater dispersion.
- Other covariates relating to weather patterns and topography will be included in modeling the parameters.
- The indemnity payments for the flood claims are modeled with spatially varying coefficients.
- Monte Carlo simulation will be run in order to determine the premium and coverage totals for each county.

References

Government Accountability Office. FEMA : Action Needed to Improve Administration of the National Flood Insurance Program. Rep. no. 11-297.:2011.

Kousky, C. and Michel-Kerjan, E. "Hurricane Sandy, Storm Surge, and the National Flood Insurance Program: A Primer on New York and New Jersey." : Resources for the Future, 2012.