3. Methods

Conceputal Model

Wildfire size depends primarily on five factors: 1) the stock of available biomass to burn (i.e., fuel availability), 2) the combustibility of that biomass (i.e., fuel flammability), 3) the ecology of the surrounding area (i.e., the topography of the surrounding area), and 4) how much effort is exerted to suppress the fire

Fuel flammability is primarily determined by temperature and precipitation in the month a fire occurred.

Therefore, a general function determining the size of wildfire can be expressed as

\[ Size = \text{fuel availability} \times \text{fuel flammability} \times \text{ecology} \times \text{effort} \]

Where \( Size \) is the size of the fire, \( \text{fuel availability} \) is the amount of fuel available, \( \text{fuel flammability} \) is the combustibility of that biomass, \( \text{ecology} \) is the ecology of the surrounding area, and \( \text{effort} \) is how much effort is exerted to suppress the fire.

Results for estimating the models using data from the Northern and Middle Rockies are provided in Table 3. As one can see, I still find that controlling for suppression expenditures results in significantly higher estimates for the impact of temperature on wildfire size. This suggests that studies that ignore suppression effort may suffer from significant omitted variable bias.

Estimated Models

To see whether controlling for suppression expenditures significantly alters my estimate of the impact of higher temperatures on wildfire size, I estimated the following two models:

Model #1

\[ \log(\text{Size}) = \alpha_0 + \alpha_1 \log(\text{Ti}) + \alpha_2 \log(P) + \alpha_3 \log(P_{6\text{mo}}) + \alpha_4 \log(\text{SuppExp}) + \epsilon \]

Model #2

\[ \log(\text{Size}) = \alpha_0 + \alpha_1 \log(\text{Ti}) + \alpha_2 \log(P) + \alpha_3 \log(P_{6\text{mo}}) + \alpha_4 \log(\text{SuppExp}) + \alpha_5 \log(\text{Year}) + \epsilon \]

I estimated the models above using data for 1,840 wildfires that occurred in the western United States. To see whether my results are robust to fuel-related unobservable variables, I also estimated these models for a subset of 565 wildfires that occur in the Northern and Middle Rockies ecosystems. Previous research has found that wildfires that occur in these ecosystems are typically not fuel-controlled, therefore, not having a good measure of fuel should have less of an impact on my results.

Estimator

Model #1 was estimated using Ordinary Least Squares (OLS). However, estimating Model #2 requires the use of an instrumental variables estimator, because including suppression effort as an independent variable likely introduces endogeneity bias. I used a two-stage least squares (2SLS) estimator with heteroskedasticity-robust standard errors. The instrumental variable that I used is the distance from a fire's point of origin to the nearest populated area.

Results for estimating Model #1 and Model #2 using data from the entire Western United States are provided in Table 2. As one can see, controlling for suppression expenditures results in significantly higher estimates for the impact of temperature on wildfire size. This suggests that previous studies that ignore suppression effort may suffer from significant omitted variable bias.

Results for estimating the models using data from the Northern and Middle Rockies are provided in Table 3. As one can see, I still find that controlling for suppression expenditures results in significantly higher estimates for the impact of temperature on wildfire size.