Do higher property values increase fire suppression costs?

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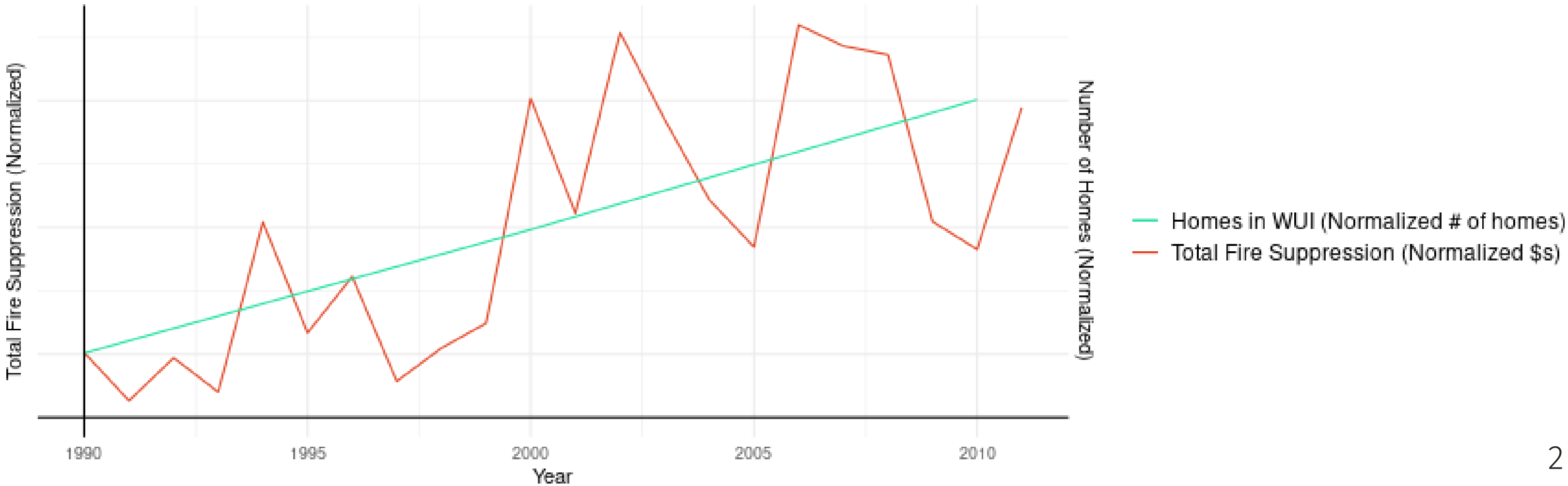
Over the last ten years, the US spent **$21.4** billion on fire suppression

Most recent data (1990-2010) shows rising numbers of **WUI** homes

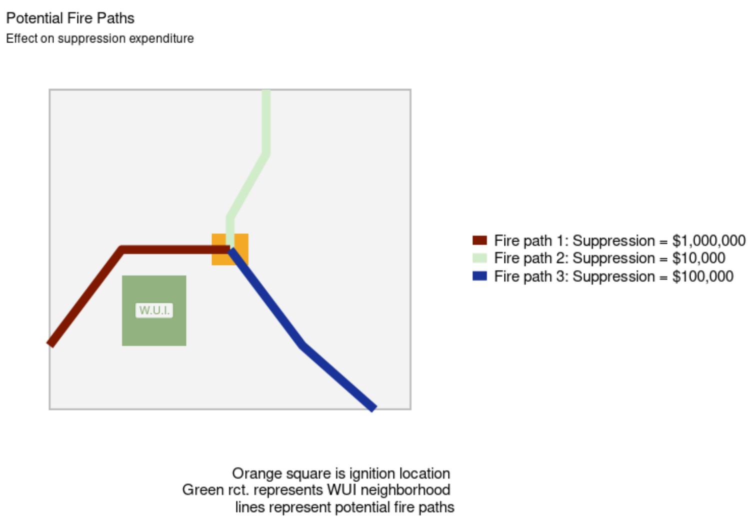


[2] What is **causing** these higher costs?

What causes fires to be **more** or **less** expensive to suppress in the first place?

Major policy concern: association between **property values** and **expense of fire suppression** (observed by existing literature) $\rightarrow$ **regressive!**

Is this association due to a bias towards protecting wealth directly or due to expensive homes being built in places that are expensive to fight fires?



Complication: Dynamic expectations. Which paths a fire could take impact expected costs. Suppression decisions impact actual paths AND costs. Expected paths affect suppression decisions, homes at risk, and costs. **Simultaneity** problem arises if statistically analyzed ex-post, but disappears if examined using ex-ante data.

[3] Outline

Research goal: Decompose the fire manager's problem to identify:

H_1 Do fire managers preferentially assign more resources to fires near expensive properties?

H_2 How much of this correlation between fire suppression and property values is due to physical attributes common to expensive properties and higher suppression costs?

Note: Could be both!

Methods: Double/Debiased Machine Learning

- Uses **C**ompact **C**onvolution **T**ransformer (**CCT**), to model nonlinear confounders in a regression model (e.g., Slope, Fuels, Canopy Cover, Accessibility ...)
- Produces causal estimates of property value on fire suppression costs, controlling for machine-learned fire risk attributes

[4] Causal System

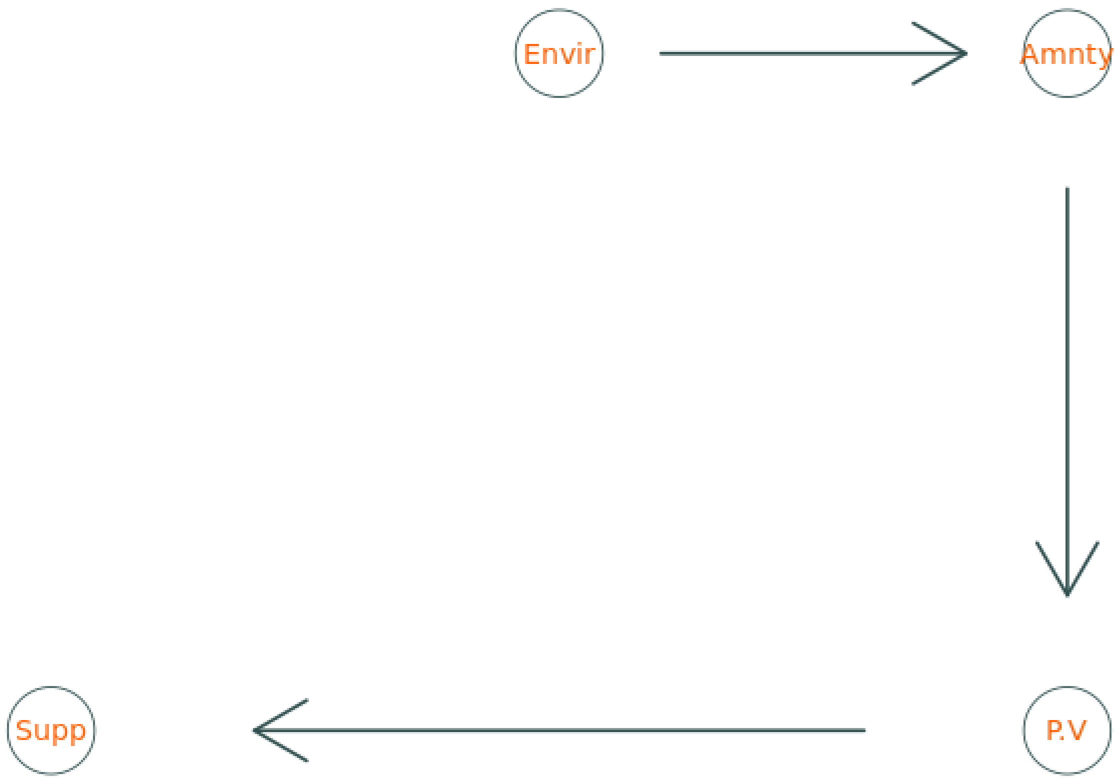
Research Question

P.V: Property Values| **Supp**: Suppression Costs

[4] Causal System

Basic Hedonics

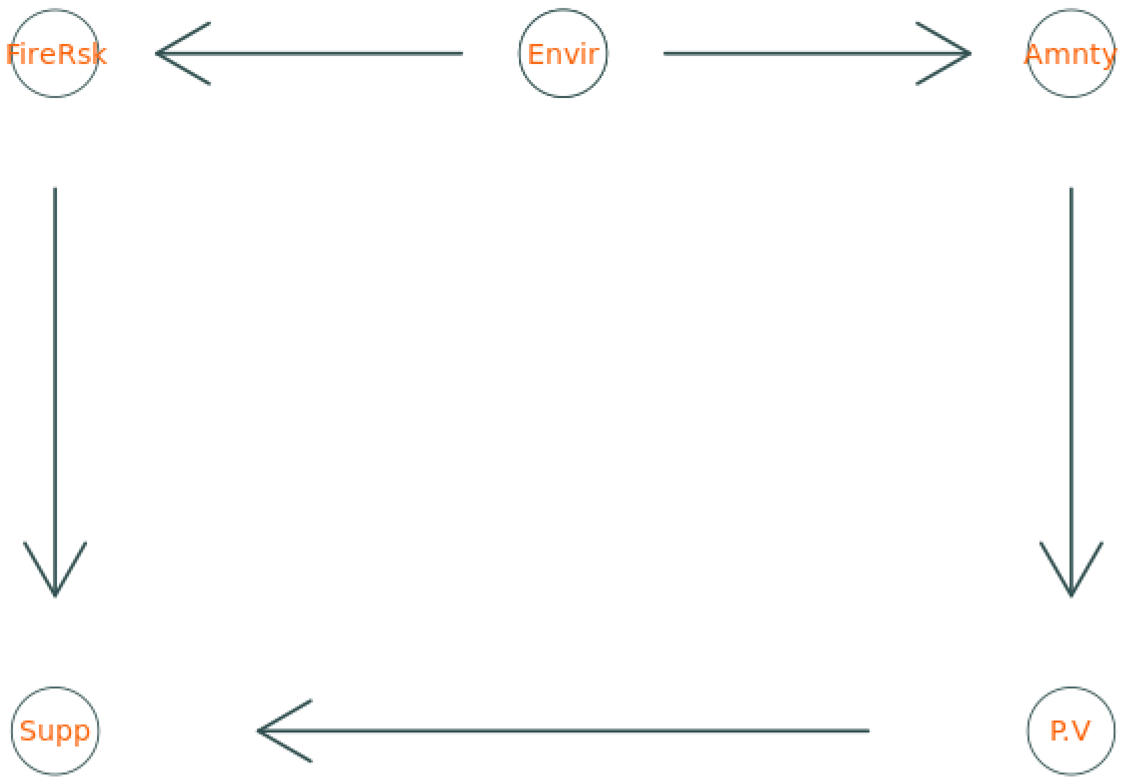
P.V: Property Values| **Supp**: Suppression Costs| **Envir**: Environment| **Amnty**: Amenities| **FireRsk** : Fire Risk|**Ex.Supp**: Expected Suppression Costs



[4] Causal System

Basic Physics

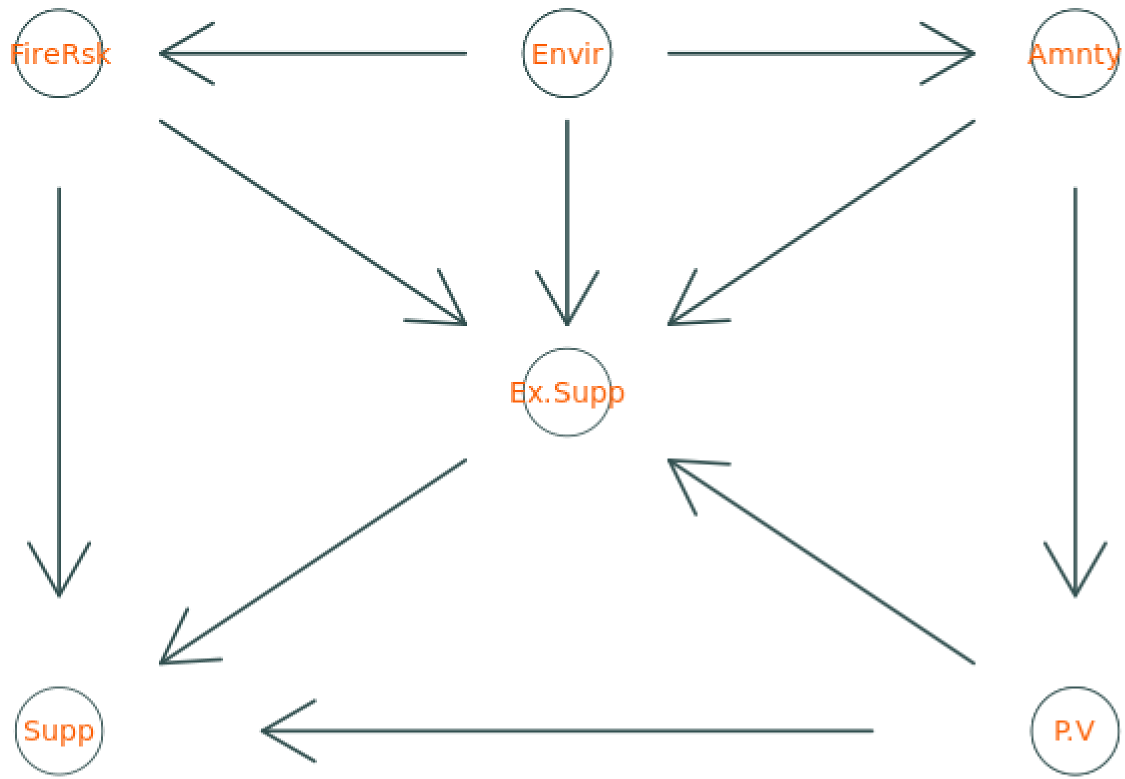
P.V: Property Values| **Supp**: Suppression Costs| **Envir**: Environment| **Amnty**: Amenities| **FireRsk** : Fire Risk|**Ex.Supp**: Expected Suppression Costs



[4] Causal System

Fire Manager's Expectation/Information

P.V: Property Values| **Supp**: Suppression Costs| **Envir**: Environment| **Amnty**: Amenities| **FireRsk** : Fire Risk|**Ex.Supp**: Expected Suppression Costs



☑ **GOAL:** To disentangle physical components of expected fire suppression costs from a tendency to protect expensive property. Use models of fire spread and values at risk to identify control variables - elevation, fuels, water-features, telephone, etc.

D/DML uses out-of-sample estimates from **CCT** to estimate the causal effect of property value on suppression, controlling for flexible associations between fire-level per-acre Suppression Expenditure and Environment, Amenities and Fire Risk across two control functions f & g. **Assume** u, v exist & are additively separable from $g,\ f$.

$$\theta \equiv param\ of\ interest,\ X \equiv \{Rsk, Envr, Amn, Ex.\,Supp\}$$

$$log(Suppression\ Costs_i) = \theta log(PropVal_i) + g(X_i) + u_i \quad (1)$$

$$log(PropVal_i) = f(X_i) + v_i \quad (2)$$

Estimating θ with functionally rigid modeling tools like OLS can generate bias in this system of equations due to f in equation (2).

My estimates indicate a smaller effect from property values on suppression costs than existing literature: for a **1% increase in property values**, costs **increase by .038%**, which compares to **reported .11%** increase in Gebert et al.

[6] Work to do

Presentations - need to work on this. In particular, would like to work on getting a tight 10 minute talk as well as a 20 minute version. Plan to present at economic micro group and metrics group

Drafts - an early draft done by mid November. I hope to circulate this draft to my committee, and have offers to get feedback from Matthew Wibbenmeyer and Margaret Walls. Depending on feedback, third draft, followed by final draft.

Defended April 1st, 2022.

Need to run full model on all 10 folds* (as of now, only applied to one fold, but results have small confidence band, and more iterations should reduce the size of this band)

Potentially repeat procedure for building-assigned income by tract? If of interest.

Likely useful to do some degree of ablation tests for my version of CCT. Others?

*:X Folds: Dataset split into fractions of 1/X, use X-1/X to train, 1/X to predict out of sample