Revisiting the stratified cost index

5 (+5) slide deck

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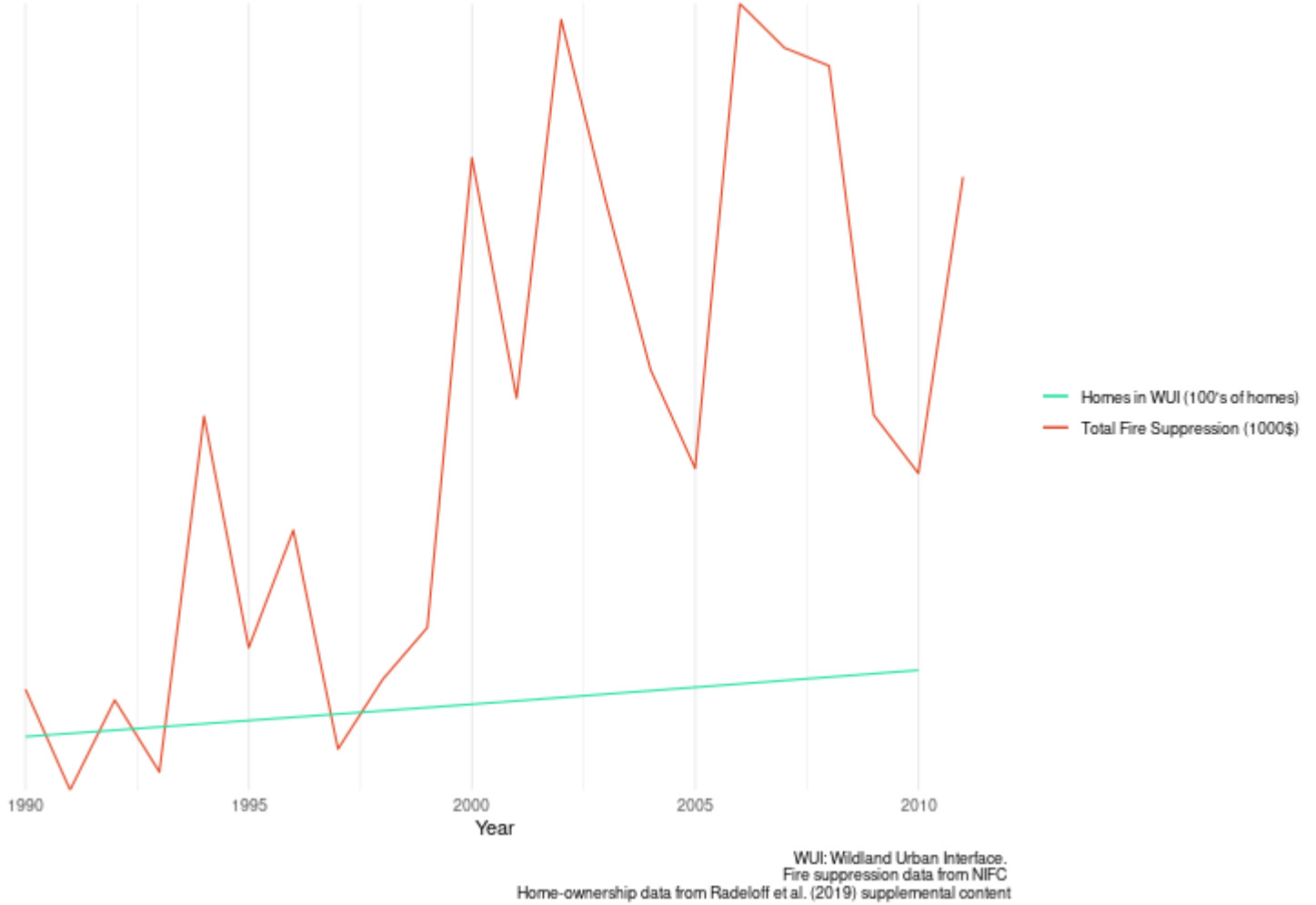
Fall 2021

Speed-trial

Over the last ten years, the US has spent **21.4** billion 2010 dollars on fire suppression

Is this the correct amount? How would we know?

McCash fire, threatening California Seqouia: Inciweb, September 16, 2021



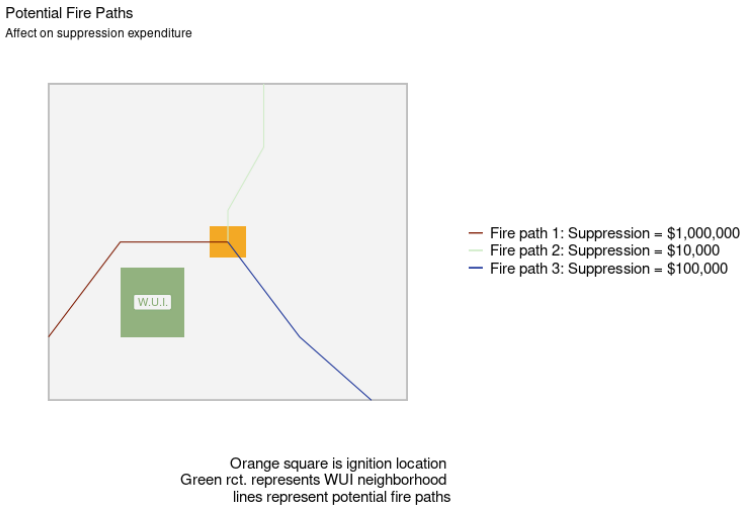
Fires are getting more expensive to fight as time goes on

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

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

Big concern of public policy is an observed link between **property values** and expense of fires

Understanding of mechanisms behind variation in **cross-sectional** suppression expenditures (eg, fuel, elevation, water) crucial.



Also a dynamic time component. Which paths a fire could take impact expected costs. Suppression decisions impact actual paths AND costs, and expected paths affect suppression decisions, homes at risk and costs. **Simultaneity** problem

[2] Government & Suppression

Policy failure

"Wildland fires constitute a major crisis in American environmental policy, a crisis created by a longstanding policy failure." - Busenburg, 2004 RPR

[2] Government & Suppression

Some evidence in existing literature that this money disproportionately benefits the wealthy. *

Expensive private homes in WUI are prone to fire risk.

- Expensive homes are owned by wealthier individuals
- Those at-risk homes benefit more from suppression dollars than cheaper, less-at-risk homes

This is **extremely regressive!**

Fire suppression is essentially a multi-billion dollar home-insurance underwriting program for wealthy individuals.

*: See Wibbenmeyer, WP or Boomhower & Baylis, 2020

[3] Outline

Research goal: decompose the fire manager's problem.

Q_1 Do fire managers **actually** preferentially assign resources to fires near more expensive properties?

Q_2 Or... just correlation between fire suppression and property values due to physical attributes common to expensive properties and higher suppression costs.

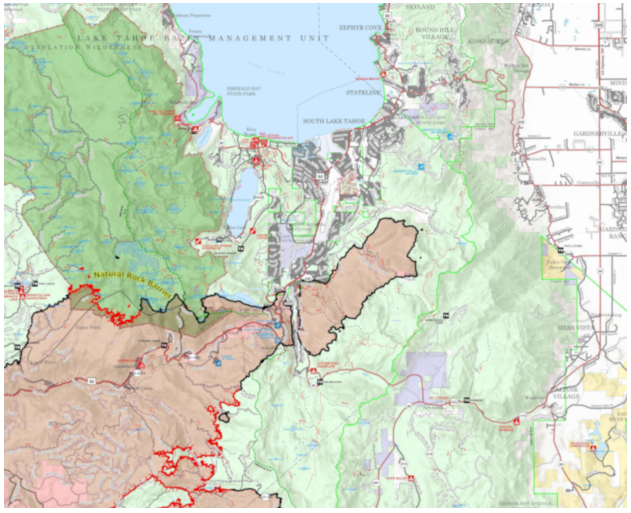
Methods: Double/Debiased Machine Learning

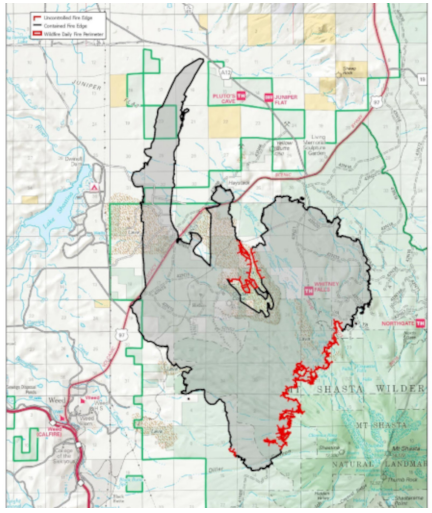
- Uses **CCT** to model nuisance functions $\eta = \{g(x), f(x)\}$
- Produces causal estimates of property value on fire suppression costs, conditional on machine learned fire risk attributes

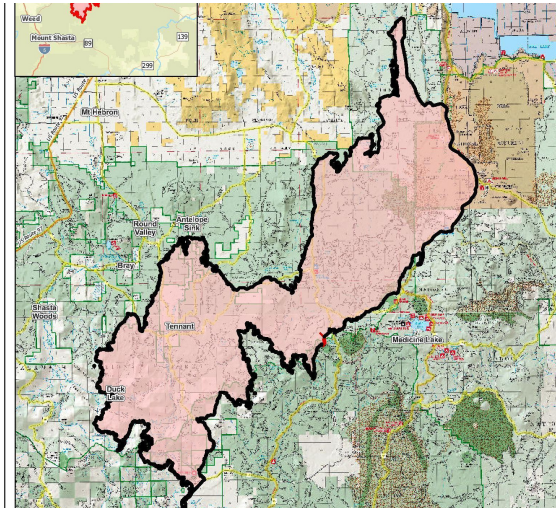
[3] Example: Lake Tahoe

Q: Does Fire 1 get more resources than fire 2 or 3?

Fire 1 **Fire 2** **Fire 3**







Follow up Q: Is it because Lake Tahoe has more expensive homes?

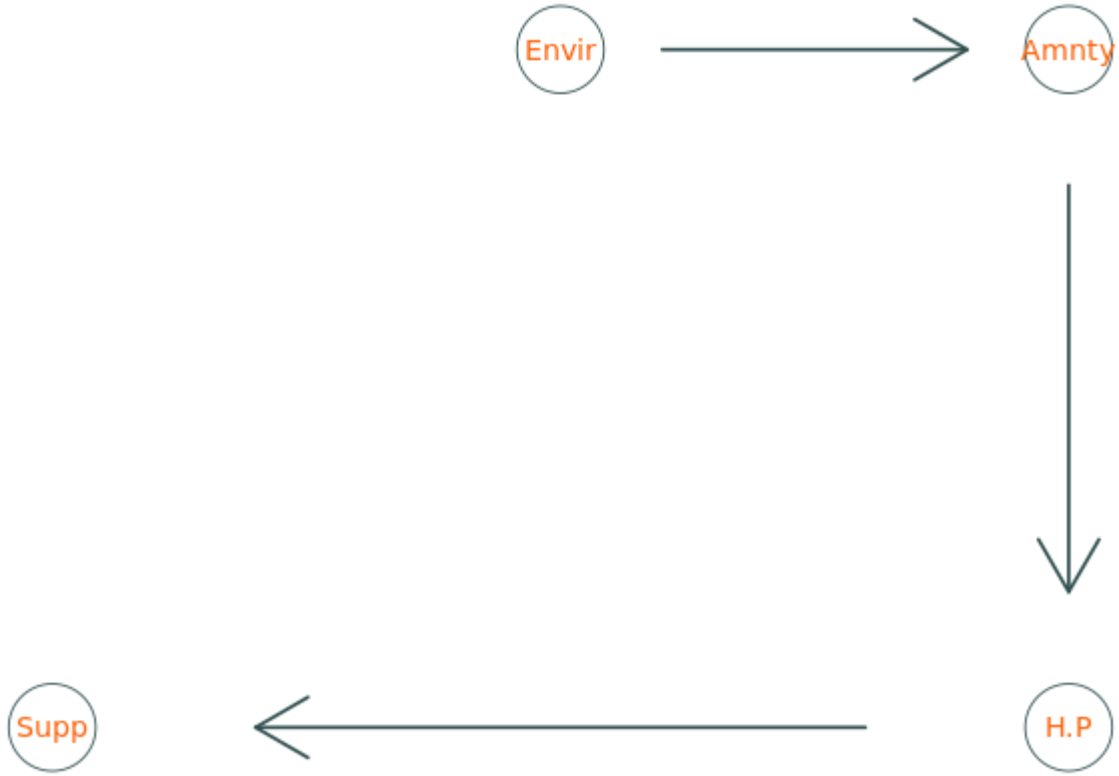
All: Near lakes and Threaten some homes

[4] Research Question

Do higher property values cause higher supp. costs?

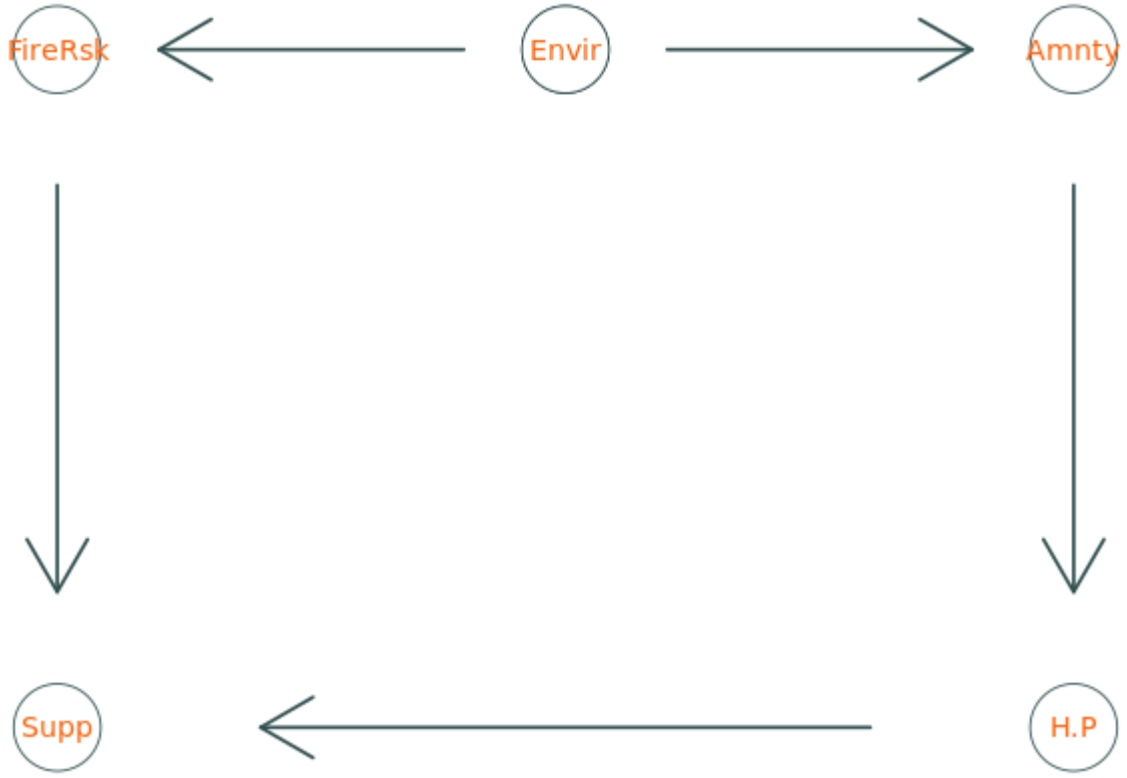
[4] Basic Hedonics

We know environment plays role in housing prices



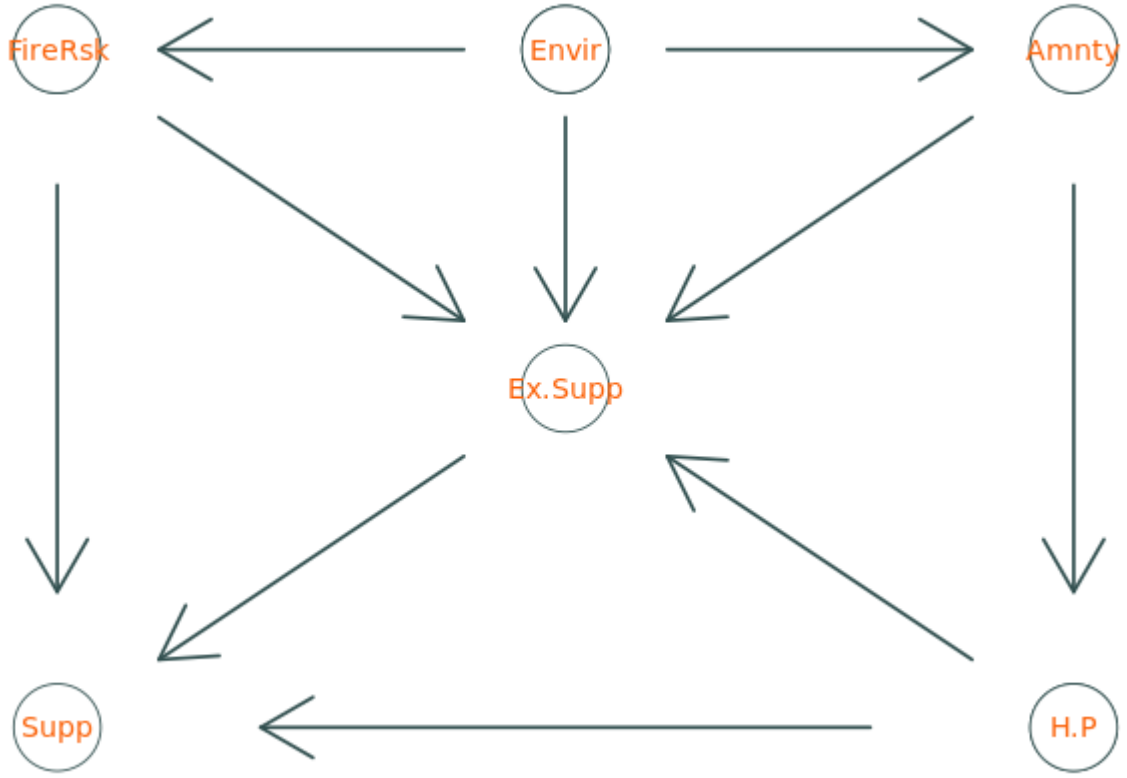
[4] Basic Physics

Well known environment plays role in fire risk



[4] Fire Manager Info Set

Fire Manager Pre-plans actions



Q: What do we need to identify how much of **home 1 or 2's** prices comes from risk-correlated amenities?

☑ **GOAL:** Disentangle the physical components of expected fire suppression costs from the human/bias-driven tendency to protect expensive property.

A: We'd need an algorithm that can simultaneously combine short and long-distance dependencies of amenity sets on... elevation, fuels, water-features, telephone, etc. **Enter ViT** (Really **CCT**)

[5] Basics of D/DML

Can't just use ML OR OLS in a causal pipeline without thought (particularly one with simultaneity bias). Based on SCM, need to control for all variables

But those variables represent millions of pixels per fire, at a minimum. Need to learn the data **manifold**

D/DML allows us to use out of sample estimates from a ML algorithm to estimate a causal effect property val. on suppression, controlling for lower-dimensional functions of X.

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

$$Supp = \theta H.P + g(X) + \varepsilon_1$$

$$H.P = f(X) + \varepsilon_2$$

$$\eta_0 = \{\hat{f}\,(X), \hat{g}(X)\}$$

[5] My methods

Collect raster data on fuels, historic fires, elevation, summed home values (block level), weather, communication towers, accessibility level... etc (31 different raster inputs!)

Use double-debiased ml with a **vision transformer** on 1750 fires over the 2020 and 2021 fire seasons

- estimate the causal effect of 20km radius property values on suppression costs. (so far)

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Repeating original procedure on my fire data - **[estimate = .1606, SE = .0322]**

[6] Work to do

Presentations - need to work on this. Plan to present at economic micro group and metrics group

Drafts - an early draft done by mid october. 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.

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Others?