

The Equilibrium Effects of Wildfires: Evidence from the California Housing Market

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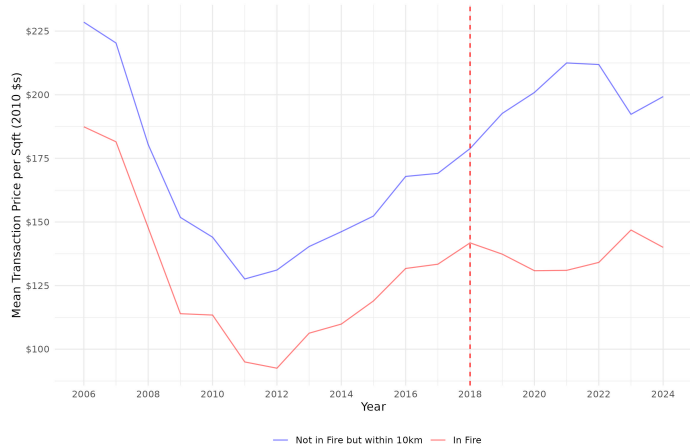
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Economic impacts of wildfires

- 15 of CA's 20 most destructive fires have happened since 2015 ([CAL Fire 2025](#))
 ⇒ Massive economic losses
- Change in composition of neighborhoods and housing markets ([Hennighausen and James 2024](#))
 - 2018 Camp Fire - Paradise, CA
 - 50,000 people displaced
 - short run changes in housing prices in burn areas and nearby neighborhoods

Camp Fire Mean Yearly Transaction Price/Sqft



What does this paper do?

What are the equilibrium effects of wildfires?

Methods:

- Estimate the equilibrium effect of wildfire exposure to shed light on supply vs demand effects in the housing market
 - 20 years of California housing transaction and wildfire data
 - Event study in a hedonic framework

Findings:

- Properties within the fire perimeter see a sharp decline in prices, but prices recover about 3 years after the fire
- Price declines are comprised of direct and indirect effects
- Building permit issuances spike immediately after the fire

This paper considers supply and demand effects in a hedonic framework

Previous work:

- Existing hedonic work evaluates environmental goods that don't directly affect the housing stock ([Banzhaf 2021](#), [Haninger et al. 2017](#), [Muehlenbachs et al. 2015](#))
- Work on property values and wildfire exposure focuses on recovery ([He et al. 2026](#), [Issler et al. 2026](#), [Malliaris et al. 2026](#))

This paper:

- Supply decreases with fire occurrence → large price decline
- Supply increases with rebuilding activity → prices begin to recover

⇒ **As supply changes, prices move in a way consistent with demand changes**

What happens to the price of property i in the fire perimeter?

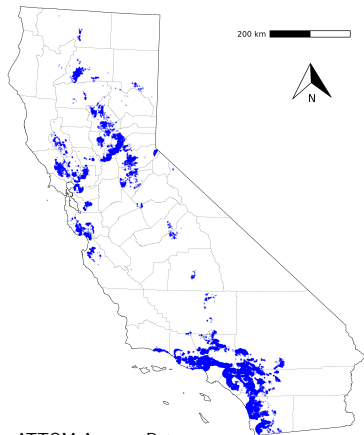
① Damaged:

- direct: structure damage because of the fire $\rightarrow p_i \downarrow$
- indirect (demand): fire damages local amenities $\rightarrow p_i \downarrow$
- indirect (supply): fire decreases local housing stock $\rightarrow p_i \uparrow$
- $\Delta p_i = \text{direct effect} + \text{indirect effects}$

② Not damaged:

- direct: not damaged $\rightarrow$ no effect on p_i
- indirect (demand): fire damages local amenities $\rightarrow p_i \downarrow$
- indirect (supply): fire decreases local housing stock $\rightarrow p_i \uparrow$
- $\Delta p_i = \text{indirect effects}$

Housing Data



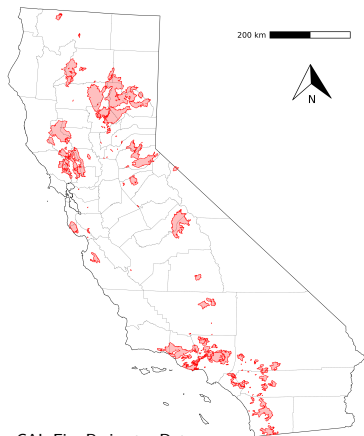
Source: ATTOM Assessor Data

ATTOM

- Recorder data: APN, sale price, sale date
- Assessor data: property characteristics, location, assessed value
- Keep residential owner occupied properties that sold at least twice between 2004 and 2024 and are within 10km of a wildfire
- Drop multi-treated properties ($< 1\%$) and housing characteristic outliers
- 400,000 properties with 2 million transactions

Summary Stats

Wildfire Data: Perimeters



Source: CAL Fire Perimeter Data

CAL Fire

- Fire perimeters data: record fires of a certain size or if there is any structure damage or loss of life
- Wildfire name, start date, end date, perimeter
- Keep fires ≥ 300 acres from 2004 to 2024 that have at least one property in the perimeter
- 159 fires

Fire Size Distribution

Fire Trends

Supplemental Data

1. **Property Damage Status**

Actual damage data (CAL Fire (DINS), Baylis and Boomhower (2026)):

- APN, address, lat/lon, fire, fire start date, structure type, damage level
- Properties within fire perimeters from 2003-present

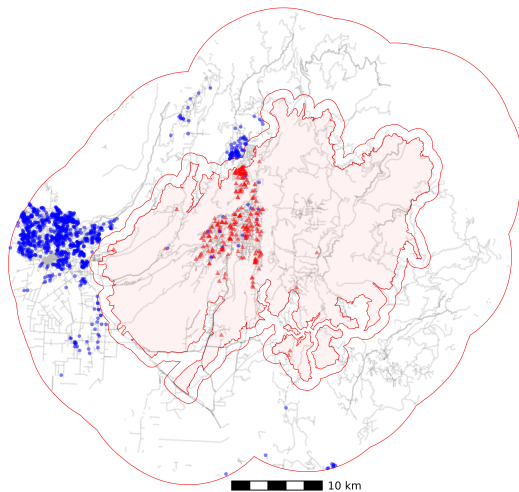
Predicted damage data (ATTOM Assessor Data):

- Lasso using changes in assessed value and property characteristics
- 87.4% predicted correctly
- Correlation between actual and predicted damage: 73.2%

2. **Building Permits (Builty)**

- address, file date, permit issuance date, final date, permit description
- 4.6 million residential permits for 2.5 million properties

Defining treatment and control: Camp Fire Sales 2017-2019



Treatment Status ● Control ▲ Treated

[Treated vs control summary stats](#)

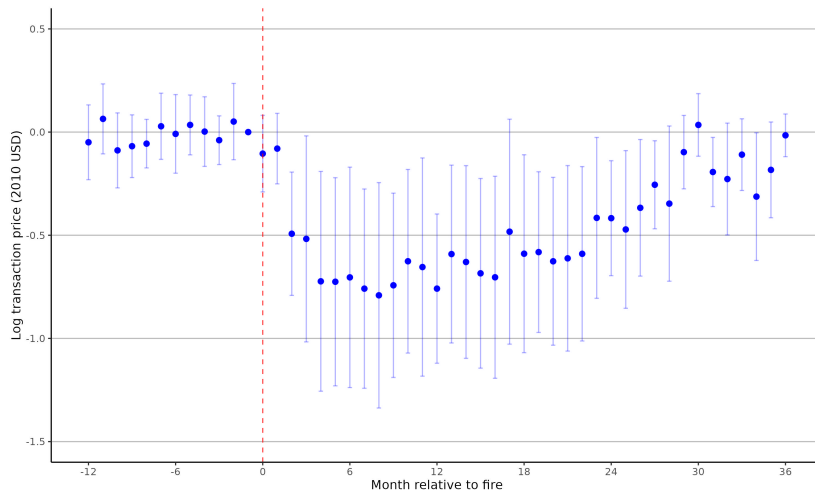
Stacked Event Study (Wing, Freedman, Hollingsworth (2024))

$$\ln(p_{itycf}) = \sum_{\substack{\tau=k \\ \tau \neq -1}}^K \beta_{\tau} \text{Fire}_{if} * ET_{ft}^{\tau} + \gamma X_{ity} + \alpha_{if} + \delta_{tf} + \eta_{cyf} + \varepsilon_{itycf}$$

- p : transaction price of property i in month t in census tract c and year y
- Fire : indicator if property i is in the fire
- ET : indicator for being τ months from the fire month
- X : property characteristics (bathrooms, bedrooms, age, age², property type)
- property (α), sale month (δ), census tract-sale year (η) fixed effects are all interacted with a fire
- Standard errors are clustered at the fire level

Wildfires lead to a large, temporary decline in housing prices

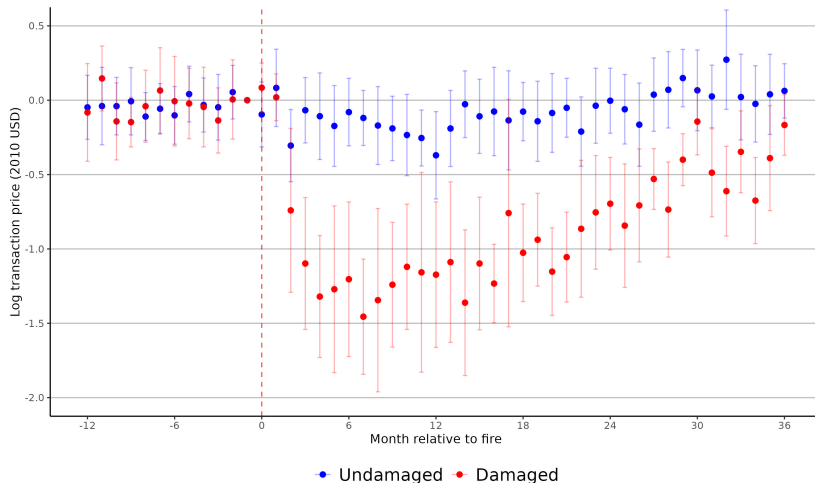
$$\ln(p_{itycf}) = \sum_{\tau=-12}^{36} \beta_{\tau} \text{Fire}_{it} * ET_{ft}^{\tau} + \gamma X_{ity} + \alpha_{if} + \delta_{tf} + \eta_{cyf} + \varepsilon_{itycf}$$



Heterogeneity

Undamaged property prices fall by as much as 37%

$$\ln(p_{itycf}) = \sum_{\tau=-12}^{36} \beta_{\tau} \text{Fire}_{if} * ET_{ft}^{\tau} * \text{Dam}_i + \gamma X_{ity} + \alpha_{if} + \delta_{tf} + \eta_{cyf} + \varepsilon_{itycf}$$



Residential direct and indirect Camp Fire (2018) costs

Mean transaction price in year before the fire:

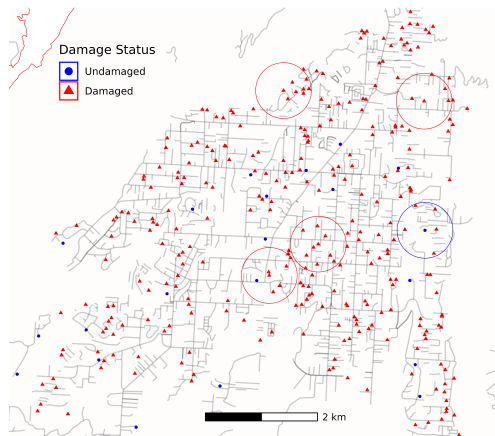
- Undamaged properties: \$265,716 → average loss of \$98,315
- Damaged properties: \$217,192

Total losses:

- Undamaged properties (3061): \$301 million
- Damaged properties (14,499): \$3.1 billion
- Reported total losses: \$16.5 billion ([LA Times, 2019](#))

Does local damage contribute to the indirect effect?

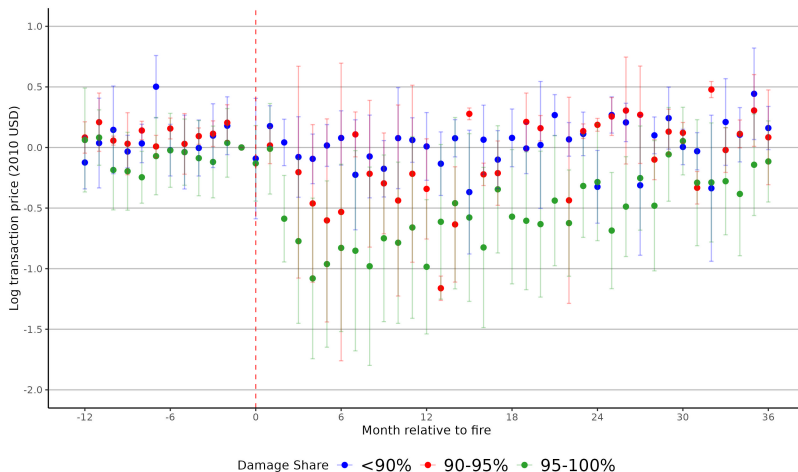
- For each property within each fire, draw a 500m circle around the property
- Calculate share of damaged properties within 500m
- Stacked event study: control for damage status and include variable for share of damaged properties



Paradise, CA (Camp Fire 2018)
Source: ATTOM and Cal Fire data

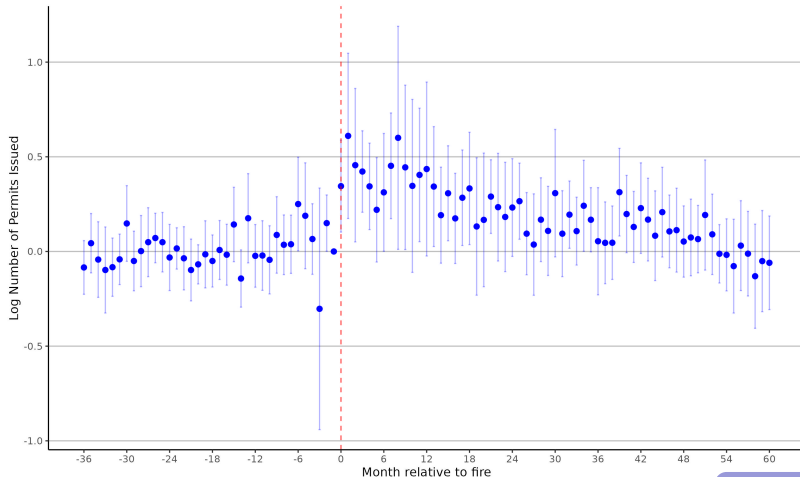
Substantial nearby damage leads to declining prices

$$\ln(p_{itcyf}) = \sum_{\tau=-12}^{36} \beta_{\tau} \text{Fire}_{if} * ET_{ft}^{\tau} * \text{Share}_{if} + \gamma X_{ity} + \text{dam}_{if} + \alpha_{if} + \delta_{tf} + \eta_{cyf} + \varepsilon_{itycf}$$



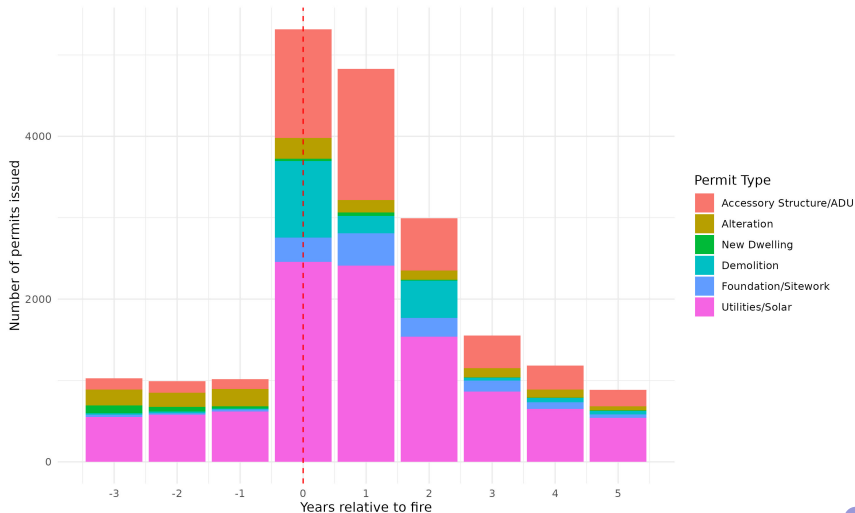
Residential building permits spike 1 month after the fire at 61%

$$permits_{iyf} = \exp(\sum_{\tau=-36}^{60} \beta_{\tau} Fire_{if} * ET_{ft} + \alpha_{if} + \delta_{yf} + \varepsilon_{iyf})$$



Sold properties are newer & bigger

Demolition, utility, and accessory structure permits drive the increase



Conclusion

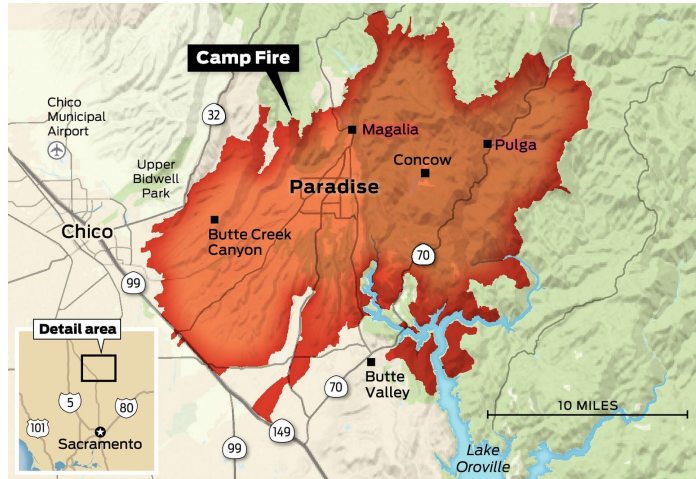
This paper finds:

- Wildfire exposure is associated with large declines in housing prices that recover after 3 years
- Undamaged properties in the fire perimeter also face a decline in prices
 - \$301 million of indirect costs in Camp Fire
 - indirect costs driven by local damage
- Rebuilding activity helps prices to recover
 - demolition, utility, and accessory structure permits
- Wildfires affect housing market prices through demand changes

Appendix

Case Study: Camp Fire 2018

- November 8, 2018 in Butte County, CA
- High winds, lack of rain, failed utility infrastructure
- California's deadliest and most destructive wildfire
 - resulted in 85 deaths
 - burned over 150,000 acres
 - destroyed 18,804 structures
 - \$16.5 billion in damages



Sources: Cal Fire, Nextzen, OpenStreetMap

Todd Trumbull / The Chronicle

Camp Fire (2018): Recovery

5 years after the fire:

- $\frac{1}{3}$ of the pre-fire population
- about 2500 homes rebuilt (about 32% of the homes pre-fire)
- removed dead trees, put powerlines underground
- still high fire risk

Sources: Bliss 2023, Chabria and Garrison 2023, and Siegler 2023



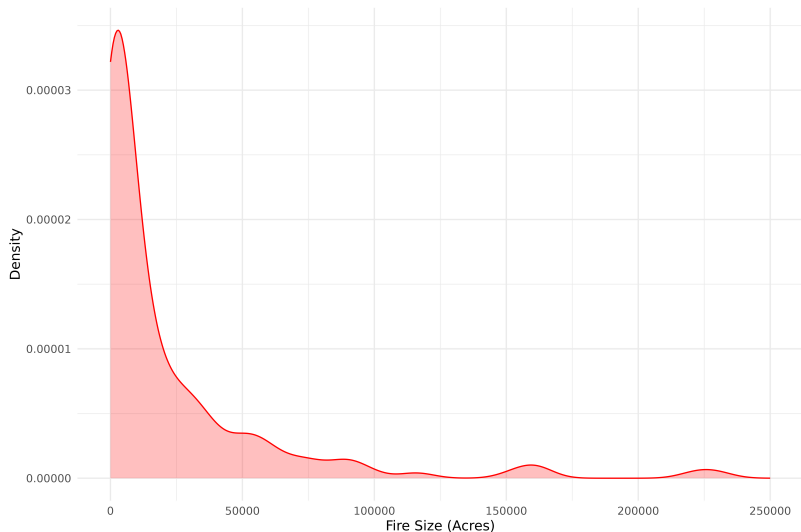
A home under construction in Paradise, Calif., which was devastated by the Camp fire in 2018. (Tomas Ovalle / For The Times)

Housing Summary Statistics

Variable	Mean	St. Dev.	Min	Max
In Fire	0.01	0.08	0.00	1.00
Sale Price	458,795.50	297,571.80	34,460.20	3,823,794.00
Log Sale Price	12.87	0.58	10.45	15.16
Bath Count	2.34	0.77	0.01	5.00
Bedroom Count	3.16	0.92	1.00	6.00
Age	33.90	20.88	0.00	124.00
Year Built	1980.66	20.34	1900	2,023
Number of Sales	2.43	0.69	2.00	8.00
Single Family	0.77	0.42	0.00	1.00
Multifamily	0.003	0.06	0.00	1.00
Condo/Townhome	0.21	0.41	0.00	1.00
Other Housing	0.02	0.12	0.00	1.00
Number of properties	399,789			
Number of transactions	2,020,059			

Table 1: Summary statistics for main analysis data. This table provides the summary statistics for the data used in the main analysis of this paper. It comprises housing transactions from 2004 to 2024. Transaction prices have been normalized to 2010 dollars. In Fire is a dummy indicating if a property is within a fire perimeter or not. Single Family, Multifamily, Condo/Townhouse, and Other Housing are dummy variables indicating the type of property. The multifamily category consists of buildings like apartments, duplexes, triplex, etc. The Other Housing category consists of buildings like mobile homes and manufactured homes. The 0.01 seen in Bath Count minimum doesn't mean there was 1% of a bath. Decimals are used to indicate partial baths (e.g. just a toilet and sink and no bathtub).

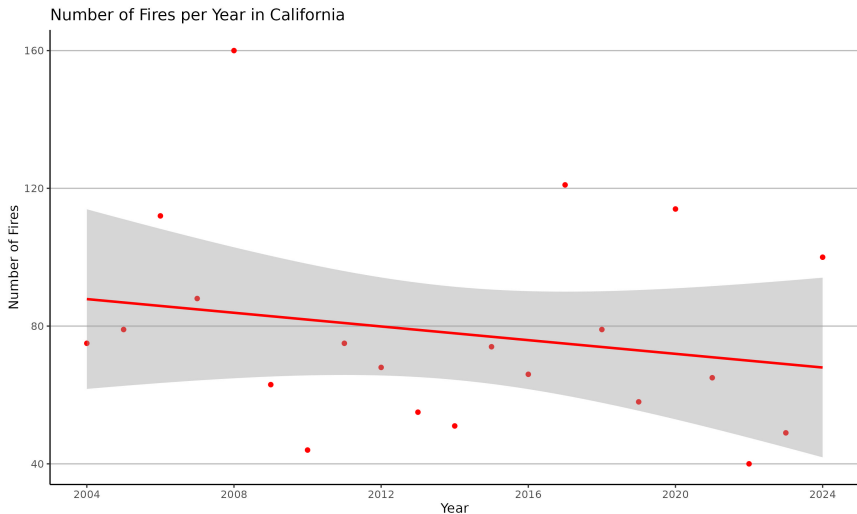
Sample Fire Size Distribution



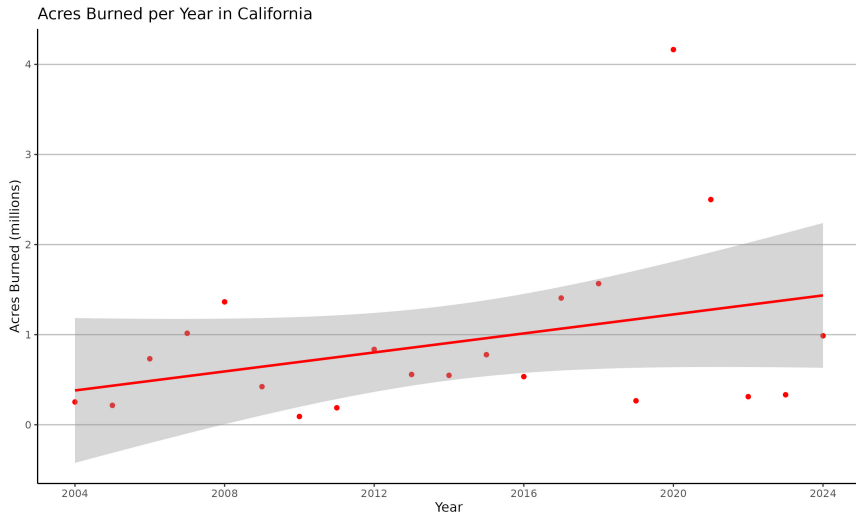
- Min: 309
- Max: 963,405
- Mean: 40,604
- Median: 6997
- St. Dev: 104,873

Fire Perimeter Data

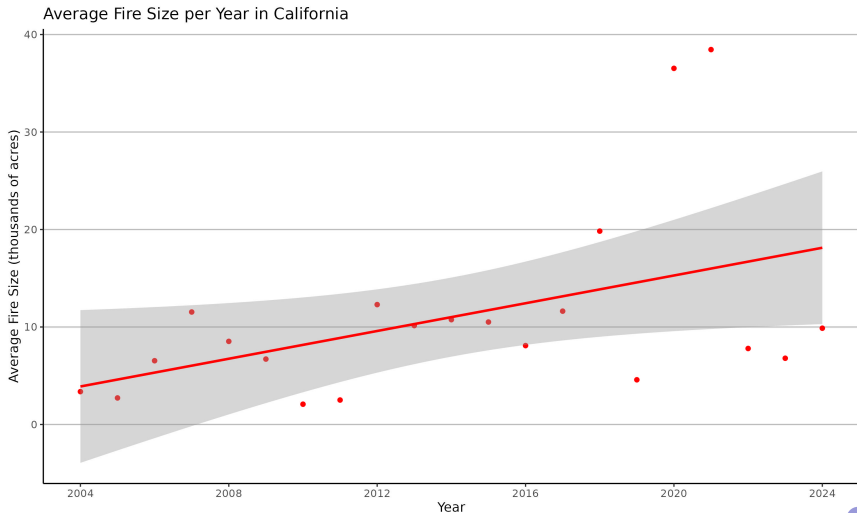
Fires per year are declining



More acres burned per year

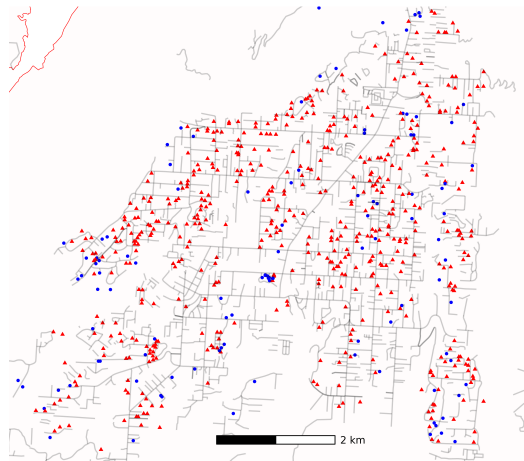
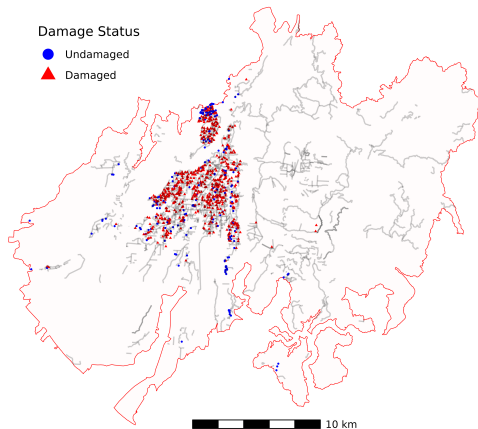


Fires are getting bigger



Fire Perimeter Data

Damage Inspection Data: Camp Fire (2018)



Source: CALFIRE DINS data

DINS Data

Defining treatment and control

- Merge property and fire if the property is within 10km of the wildfire perimeter
- **Treated:** properties in fire perimeter
- **Control:** properties 1 to 10km from the perimeter
- 5256 properties are treated during this time
- **Reference group:** properties outside the fire perimeter and in-fire properties in the period right before the fire
- Post-fire transaction prices of in-fire properties are compared to transaction prices outside the perimeter and sales that occurred right before the fire

Treated vs Control Summary Statistics

	In Fire		Out of Fire	
	Mean	St. Dev.	Mean	St. Dev.
Sale Price	474,458.88	381,444.79	454,239.47	301,789.03
Log Sale Price	12.81	0.73	12.85	0.59
Bath Count	2.43	0.81	2.30	0.75
Bedroom Count	3.07	0.87	3.11	0.92
Age	30.06	18.32	32.82	21.07
Year Built	1982.28	17.75	1978.73	20.70
Number of Sales	1.85	0.68	1.95	0.75
Single Family	0.82	0.39	0.76	0.42
Multifamily	0.00	0.06	0.00	0.06
Condo/Townhome	0.10	0.30	0.22	0.41
Other Housing	0.08	0.27	0.02	0.12
Number of Properties	3116		266,010	
Number of Transactions	4977		804,872	

Table A1: Summary statistics for pre-fire transactions split between in the fire perimeter and out of the fire perimeter. This table provides summary statistics of transactions within vs outside of the fire from 2004 to 2024. These are statistics of the pre-fire data to see how similar the two groups are before treatment. Transaction prices have been normalized to 2010 dollars. In Fire is a dummy indicating if a property is within a fire perimeter or not. Single Family, Multifamily, Condo/Townhouse, and Other Housing are dummy variables indicating the type of property. The multifamily category consists of buildings like apartments, duplexes, triplex, etc. The Other Housing category consists of buildings like mobile homes and manufactured homes.

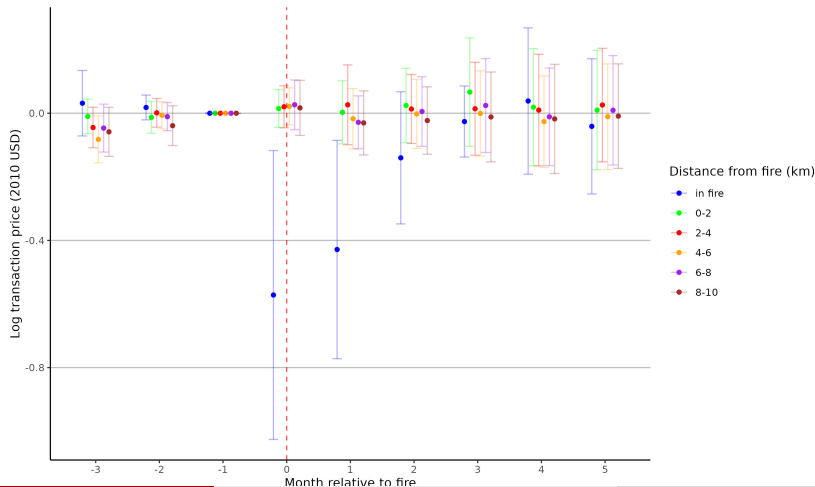
How do effects vary over space?

$$\ln(p_{itycf}) = \sum_{b=0}^B \sum_{\substack{\tau=k \\ \tau \neq -1}}^K \beta_{\tau}^b \text{Fire}_{if} * ET_{ft}^{\tau} * D_b + \gamma X_{ity} + \alpha_{if} + \delta_{tf} + \eta_{cyf} + \varepsilon_{itycf}$$

- Same variables as main specification plus interaction with distance bins, D
- Long bins: 1km out to 10km
- Short bins: 100m out to 1km

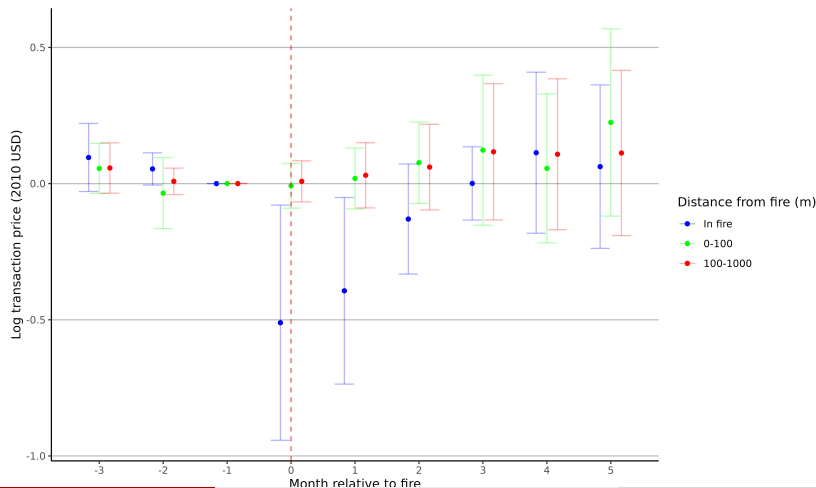
Housing price effects only within the fire boundary

$$\ln(p_{itycf}) = \sum_{b=0}^5 \sum_{\substack{\tau=-3 \\ \tau \neq -1}}^5 \beta_{\tau}^b \text{Fire}_{it} * ET_{ft}^{\tau} * D_b + \gamma X_{it} + \alpha_{it} + \delta_{tf} + \eta_{cyf} + \varepsilon_{itycf}$$



Housing price effects only within the fire boundary

$$\ln(p_{itycf}) = \sum_{b=0}^2 \sum_{\substack{\tau=-3 \\ \tau \neq -1}}^5 \beta_{\tau}^b \text{Fire}_{if} * ET_{ft}^{\tau} * D_b + \gamma X_{ity} + \alpha_{if} + \delta_{tf} + \eta_{cyf} + \varepsilon_{itycf}$$

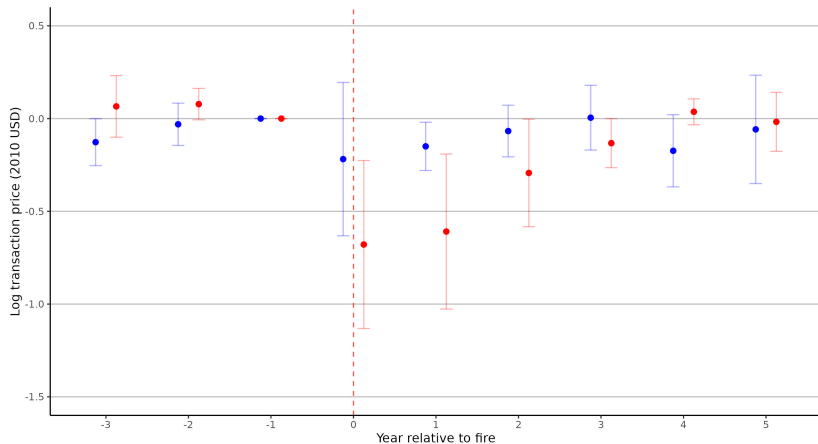


How do effects vary by fire and property characteristics?

$$\ln(p_{iyf}) = \sum_{b=0}^B \sum_{\substack{\tau=-3 \\ \tau \neq -1}}^5 \beta_{\tau}^b \text{Fire}_{if} * ET_{fy}^{\tau} * D_b + \gamma X_{iy} + \alpha_{if} + \delta_{yf} + \eta_{cyf} + \varepsilon_{iyf}$$

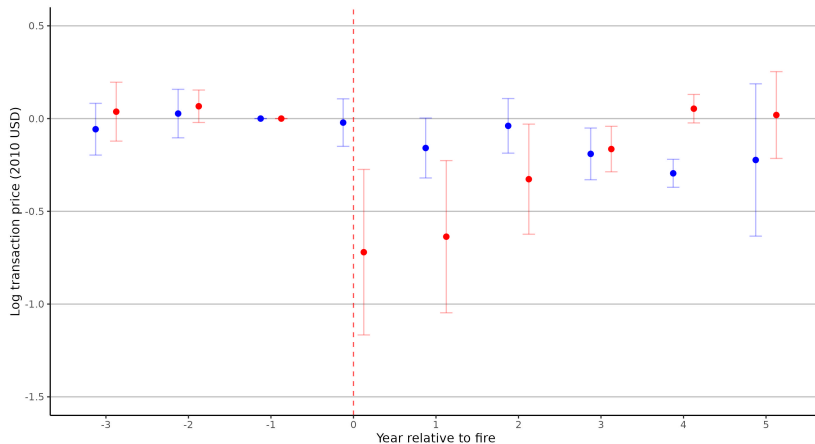
- Same variables as main specification plus interaction with characteristic of interest
- Fire characteristics: size (acres), building destroyed
- Property characteristics: property type, urban, census tract income

Fire size



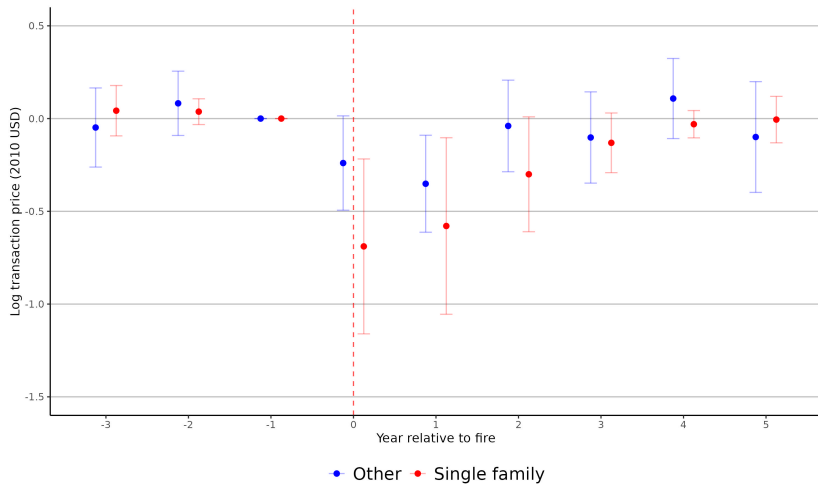
Fire size (median = 6997 acres) • Below median • Above median

Buildings damaged in the fire

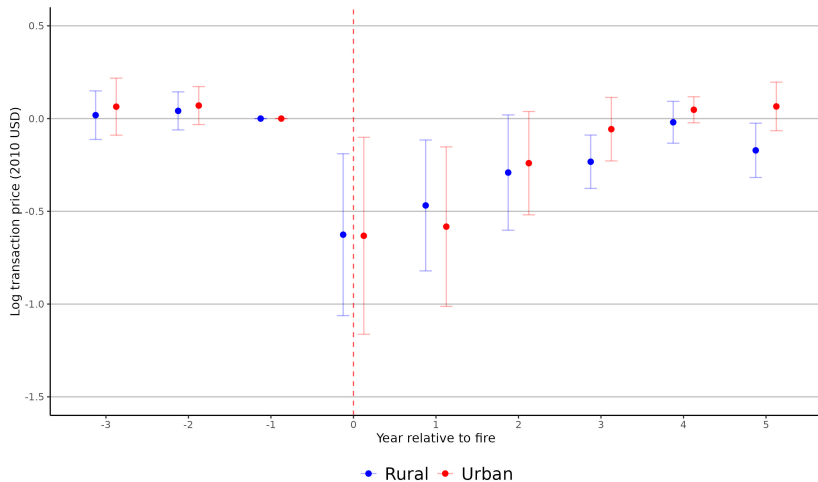


Destroyed buildings (median = 108 properties) • Below median • Above median

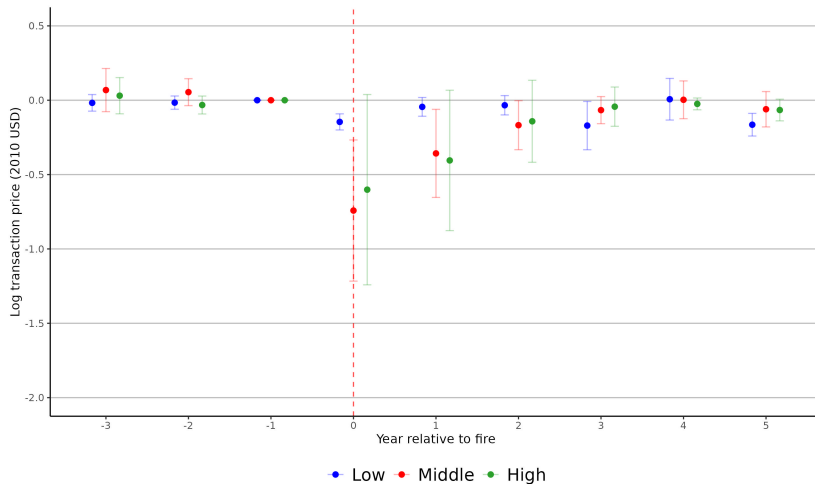
Property type



Urban property



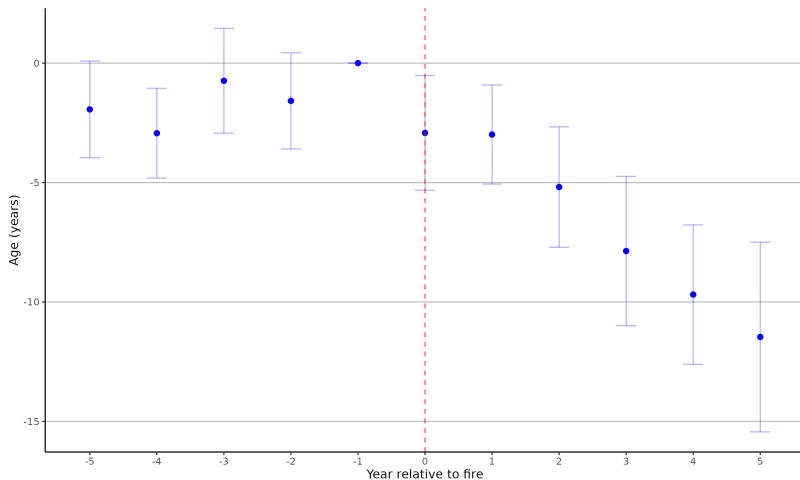
Census tract income



Main Specification

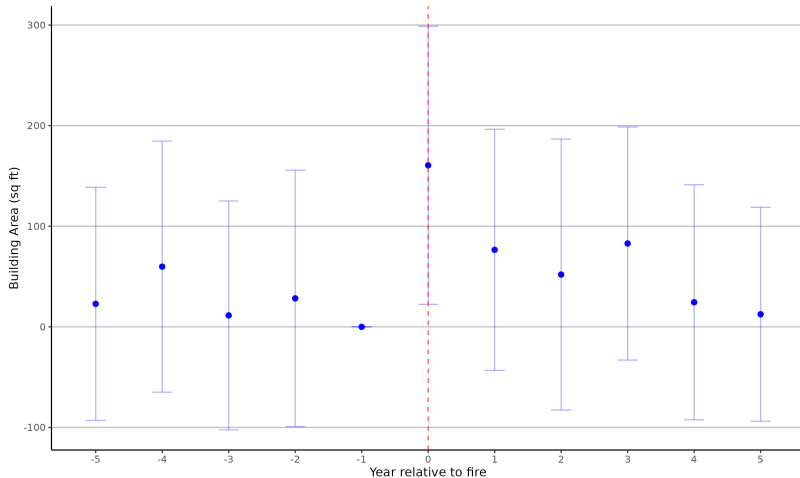
Transacted properties are newer after the fire

$$age_{iyct} = \sum_{\tau=-5}^5 \beta_{\tau} Fire_{it} * ET_{ft}^{\tau} + \alpha_{ct} + \delta_{yt} + \varepsilon_{iyct}$$



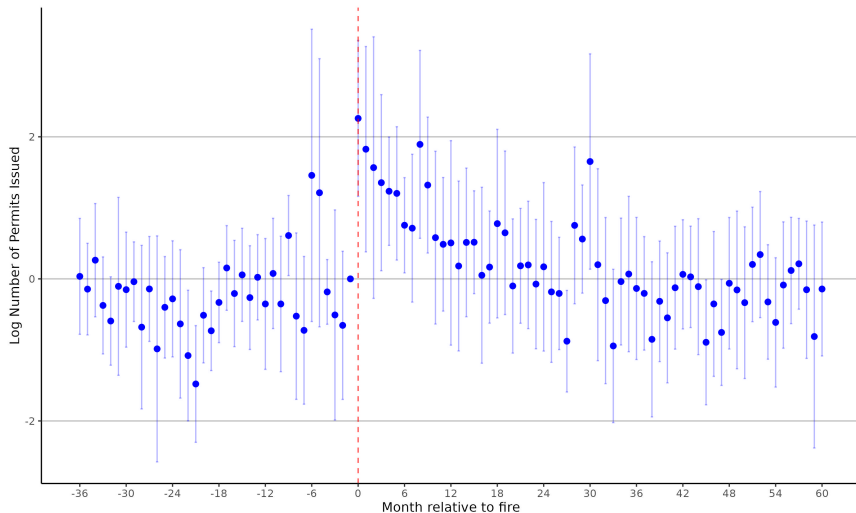
Transacted properties are bigger after the fire

$$sqft_{iyct} = \sum_{\tau=-5}^5 \beta_{\tau} Fire_{if} * ET_{ft}^{\tau} + \alpha_{ct} + \delta_{yct} + \varepsilon_{iyct}$$

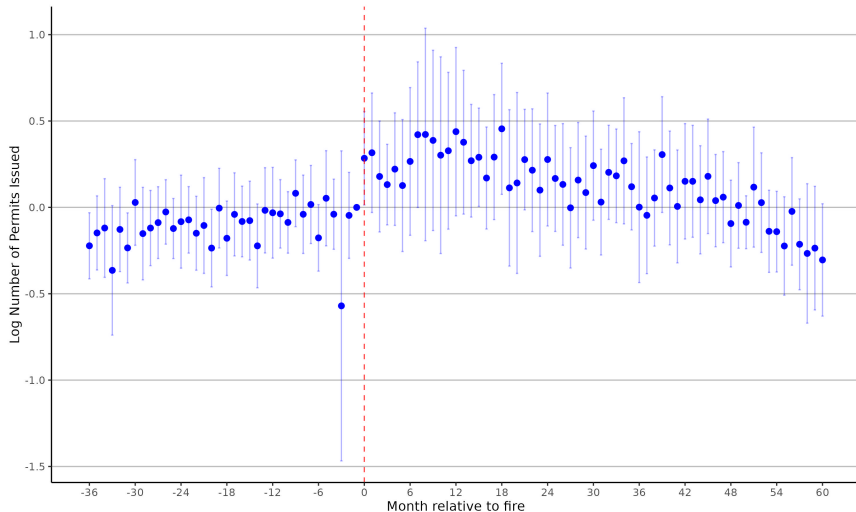


Permit results

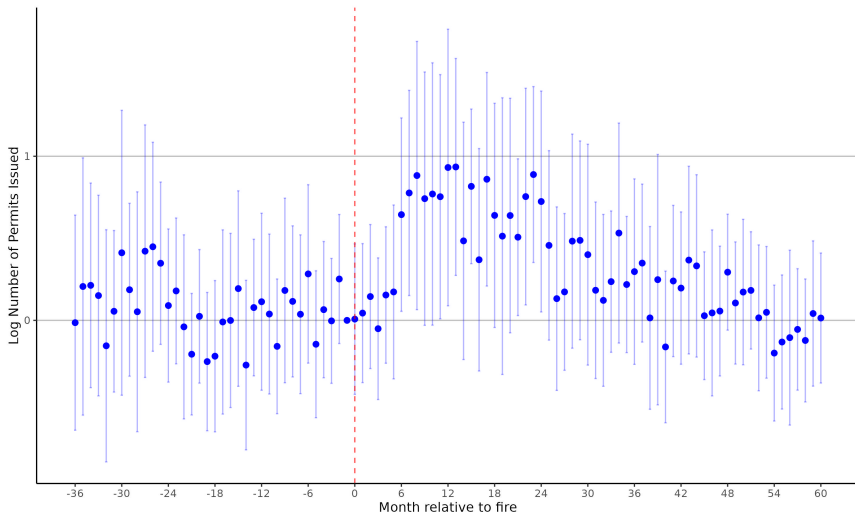
Demolition permits increase by 226%



Utility permits increase by 45%



Accessory structure permits increase by 93%



Permit distribution