# The Effects of Extreme Wildfire and Smoke Events on Household Financial Outcomes

Discussion by Ding Du (OCC)

# Motivation

- Wildfire activity has become both more extreme and more destructive.
- There is an emerging literature on effects of wildfires.
  - Migration: Sharygin (2021), Winkler and Rouleau (2021)
  - Mortgage: Issler et al. (2020)
  - Migration and household finance: McConnell et al. (2021)
    - Fires that have caused at least one building to be destroyed from 1999 to 2018
    - Heightened out-migration probability among tracts that experienced the most destructive wildfires
    - Significant drop in homeownership among those treated by major fires, concentrated in people over the age of 60.
    - Measures of credit distress, including delinquencies, bankruptcies, and foreclosures, improve rather than deteriorate after the fire, but the changes are not statistically significant.

# Motivation

- Adverse effects of extreme wildfires extend beyond the perimeter of the fire owing to the broad diffusion of fire related **smoke** and particulate **pollution**.
- These air quality effects are typically not accounted for in assessments of wildfire economic effects.
- This paper studies the impact of **extreme** US wildfires and related **smoke** and **air pollution** events on household mobility, housing and financial outcomes.

# Sample

- Four **extreme wildfires**, defined as those that damage or destroy 1,000 or more structures.
- Focus on Camp

**Table 1.** List of Extreme Wildfires in the U.S. Between 2016-2020

| Fire Name | Destroyed Structures | Date | State |
|---|---|---|---|
| Camp | 17,764 | 11/8/2018 | CA |
| Central LNU Complex | 6,862 | 10/9/2017 | CA |
| Glendale | 3,000 | 1/29/2016 | OK |
| North Complex | 2,288 | 8/17/2020 | CA |
| Chimney Tops | 2,018 | 11/23/2016 | TN |
| Carr | 1,610 | 7/23/2018 | CA |
| LNU Lightning Complex | 1,469 | 8/17/2020 | CA |
| CZU AUG Lightning | 1,329 | 8/16/2020 | CA |
| Beachie Creek | 1,292 | 8/16/2020 | OR |
| Glass | 1,198 | 9/27/2020 | CA |
| Thomas | 1,053 | 12/4/2017 | CA |

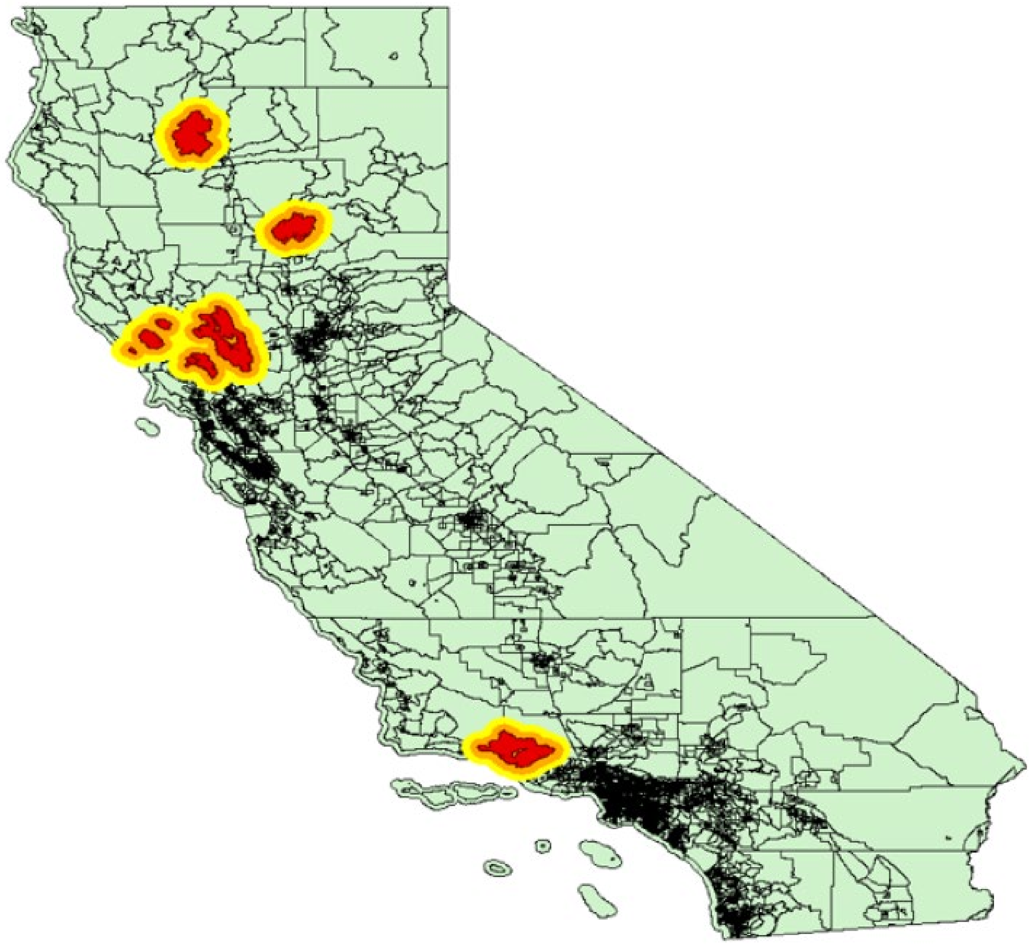


**Figure 1.** Extreme Wildfires in CA between 2016-2020 and the 1-, 5-, and 10- mile Peripheral Rings

# Paper Strategy: Wildfires

- Diff-in-diff
  - Treatment: fire zones
  - Control: 1- and 5-mile rings beyond the fire zone
  - Tract: Migration & HPI
  - Consumer: Financial outcomes

$$Y_{i,t} = \beta * Fire_{i,t} * Post_{i,t} + \tau_t + \zeta_i + \varepsilon_{it},$$

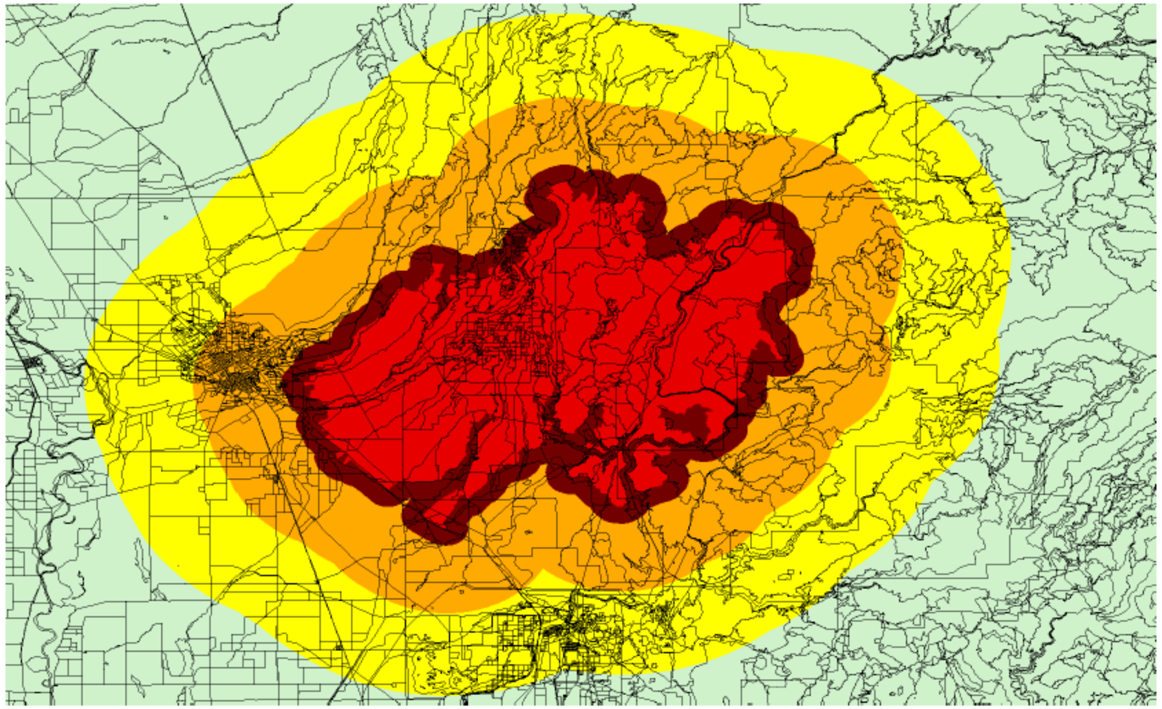


**Figure 2.** Treatment and Control Areas in the Camp Fire Analyses
*Notes*: This figure shows the treatment and control areas in the Camp fire analyses. The red area is the fire footprint, which is the treatment area; the brown area is a 1-mile peripheral ring, which we carve out in our analysis; the orange area is a 1- to 5-mile peripheral ring, which is the control area; and the yellow area is a 5- to 10-mile peripheral ring, which is an alternative control area. The border lines are census blocks in California.

# Comments: Camp Fire

- Tract: HPI & Migration
  - Pre-trends in HPI (Repeated Sales Median)
  - ATE for Migration ↓ with ↑ in the control group
- Robustness tests
  - Ccovariate balance
  - Longer pre-window
  - Different trends associated with local characteristics: $X'_{c,2018q3}\tau_t$ , where $X'_{c,2018q3}$ is vector of tract-level characteristics as of 2018q3
  - Alternative control groups (e.g., PSM)
- Heterogeneity tests

**Figure A.4.** The Effect of 2018 Camp Fire on Housing Prices

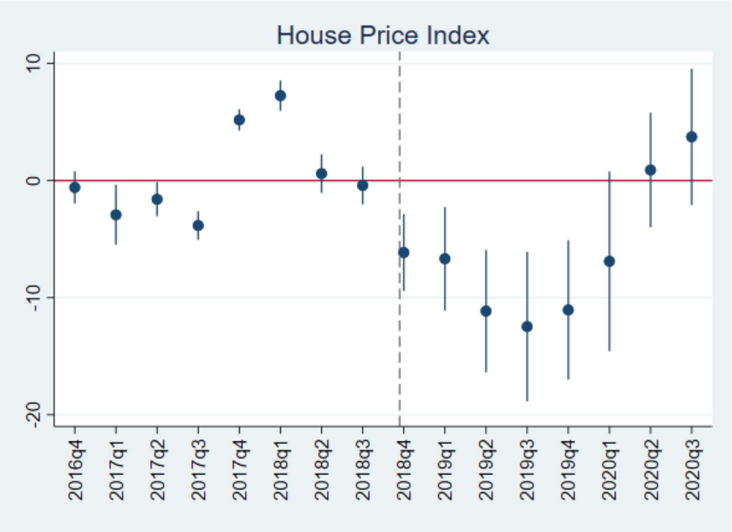



**Table 2.** Effects of Camp Fire on Net Migration

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| | Move-in | Move-out | | Net migration | |
| *Treated* × *Post* 0 vs 5 miles | 1.97 | 19.2*** | 17.7*** | | |
| | (2.87) | (1.92) | (5.27) | | |
| *Treated*×*Post* 0 vs 10 miles | | | | 9.28*** | |
| | | | | (2.23) | |
| *Treated*×*Post* 0 vs 20 miles | | | | | 3.2*** |
| | | | | | (1.29) |
| Census tract FE | + | + | + | + | + |
| Year-qtr FE | + | + | + | + | + |
| Observations | 470 | 470 | 470 | 674 | 1,023 |
| R-squared | 0.49 | 0.47 | 0.15 | 0.11 | 0.10 |
| Dependent variable mean | 36.02 | 33.18 | 6.96 | 2.31 | 2.67 |

# Comments: Camp Fire

- Consumer: Balance & Delinquency
  - The total # of observations for the balance regressions is much smaller than that for the delinquency regressions.
  - Balance in level could have outliers.
- Robustness tests
  - log(Balance) or log(1+Balance)
  - Poisson pseudo-likelihood regressions
  - Count-based delinquency (e.g., intensive vs. extensive margins)
  - Triple and quadruple DID
  - A different FICO threshold (e.g., 620 as in Billings, Gallagher, and Ricketts (2022))
- Interpretation
  - Homeowners/renters: insurance or ability to repay?
  - McConnell et al. (2021): credit distress ↓

**Table 6.** Heterogeneous Effects of Camp Fire on Credit Card Balance and Delinquency

| | Homeowners | | Renters | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| **Panel A: Credit Balance** | Credit Score $\leq$ 720 | Credit Score > 720 | Credit Score $\leq$ 720 | Credit Score > 720 |
| *Treated* $\times$ *Post* | -3,195.09 | -1,404.54* | -866.16 | 108.21 |
| | (3,797.26) | (745.91) | (995.98) | (436.06) |
| Time-varying borrower attributes | ✓ | ✓ | ✓ | ✓ |
| Census tract FE | + | + | + | + |
| Year-qtr FE | + | + | + | + |
| Observations | 691 | 4,505 | 6,282 | 6,282 |
| R-squared | 0.37 | 0.37 | 0.22 | 0.15 |
| Dependent variable mean | 7,382.2 | 3,674.5 | 3,125.1 | 2,114.1 |
| **Panel B: Delinquency** | Credit Score $\leq$ 720 | Credit Score > 720 | Credit Score $\leq$ 720 | Credit Score > 720 |
| *Treated* $\times$ *Post* | 0.00 | 0.00 | 0.06*** | 0.00 |
| | (0.01) | (0.00) | (0.02) | (0.00) |
| Time-varying borrower attributes | ✓ | ✓ | ✓ | ✓ |
| Census tract FE | + | + | + | + |
| Year-qtr FE | + | + | + | + |
| Observations | 3,376 | 17,319 | 28,297 | 22,964 |
| R-squared | 0.14 | 0.04 | 0.14 | 0.04 |
| Dependent variable mean | 0.01 | 0.00 | 0.11 | 0.00 |

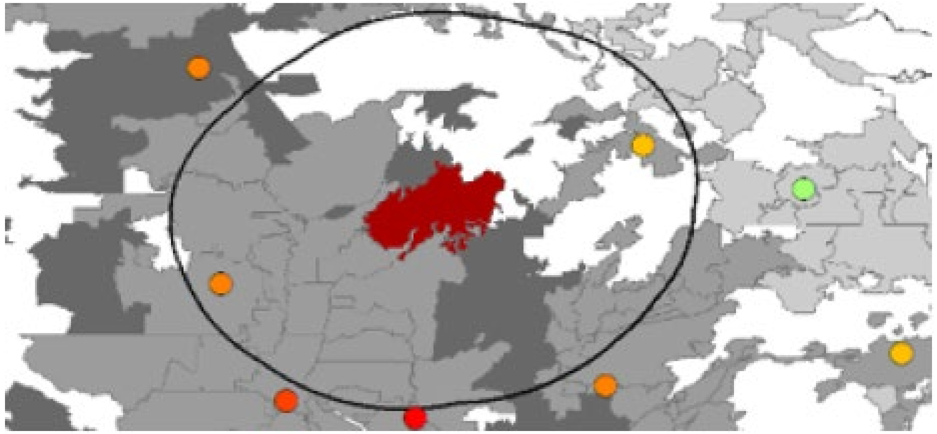
# Paper Strategy: Pollution

- ZIP codes **outside** of the wildfire burn area but within **30 miles** from the fire perimeter.
- Rank order zip codes based on the level of **pollution** in the four weeks immediately following the onset of the fire
- Define the **top quartile** as **Treatment** and the **bottom quartile** as **Control** and drop remaining zip codes.
- Diff-in-diff
    - Consumer: Financial outcomes

$$Y_{i,t} = \gamma * \Delta PM2.5_z * Afterfire_{z,t} + X_{i,t}\vec{B} + \tau_t + \zeta_i + \varepsilon_{i,t}.$$

$$Y_{i,t} = \gamma * \widehat{PM2.5_z} * Afterfire_{z,t} + X_{i,t}\vec{B} + \tau_t + \zeta_i + \varepsilon_{i,t}.$$

**Month of the Fire:**



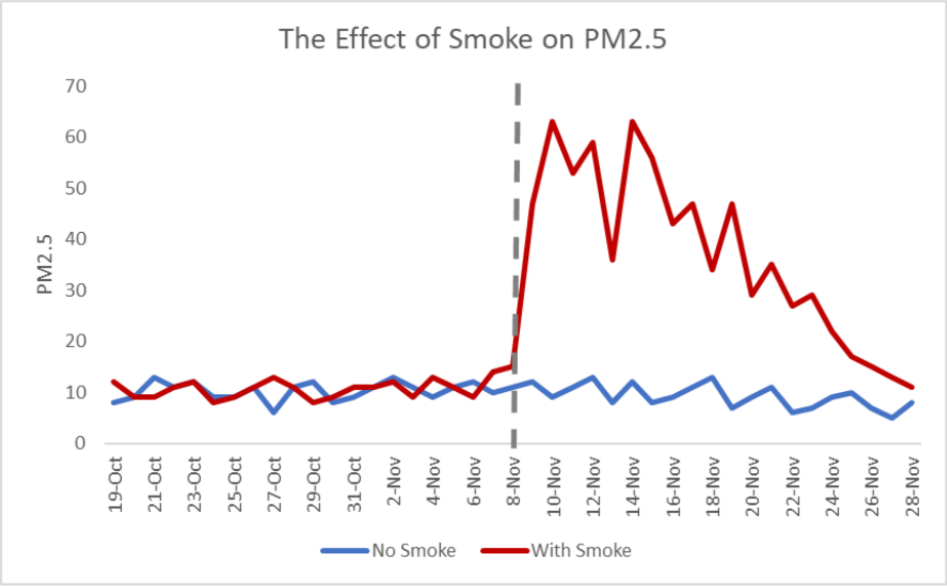



**Figure A.3.** Wildfire Smoke Elevated PM2.5 After the Camp Fire

# Comments: Pollution

- Robustness tests
  - Ccovariate balance
  - Parallel trends for delinquency
  - Longer pre-window
  - Different trends associated with local characteristics: $X'_{z,2018q3}\tau_t$ , where $X'_{z,2018q3}$, vector of zip-level characteristics as of 2018q3
  - Delinquency based on count
  - Triple DID for heterogeneity tests
  - Alternative FICO thresholds
  - **Alternative control groups (e.g., 50 miles from fire, zips outside the 30-mile ring)**

**Table 9.** Heterogeneous Effects of Wildfire-Induced Pollution on Credit Card Spending and Payment: Different Credit Score Segments

| | 1 | 2 |
|---|---|---|
| **Panel A: Δ Spending** | Credit Score ≤ 720 | Credit Score > 720 |
| *Treated* × *Post* | 140.061 | 535.442*** |
| | (107.843) | (88.154) |
| Time-varying borrower attributes | ✓ | ✓ |
| Account FE | + | + |
| Year-month FE | + | + |
| Observations | 249,317 | 449,846 |
| R-squared | 0.131 | 0.076 |
| Dependent variable mean | -1,048.704 | -36.189 |
| **Panel B: Δ Payment** | Credit Score ≤ 720 | Credit Score > 720 |
| *Treated* × *Post* | -445.491*** | -26.773 |
| | (89.364) | (70.242) |
| Time-varying borrower attributes | ✓ | ✓ |
| Account FE | + | + |
| Year-Month FE | + | + |
| Observations | 249,317 | 449,846 |
| R-squared | 0.093 | 0.052 |
| Dependent variable mean | 489.834 | 394.592 |

# Comments: Pollution

- Treatment measures
  - ΔPM2.5 - Difference between fire month PM2.5 and the same month PM2.5 in the prior year.
  - $\widehat{PM2.5}$ - Smoke-driven pollutants based on a machine learning model

- Alternative measures and tests
  - Both smoke and pollution could be caused by events other than wildfires. Could there be more direct measures (e.g., based on wind information)?
  - Placebo tests?

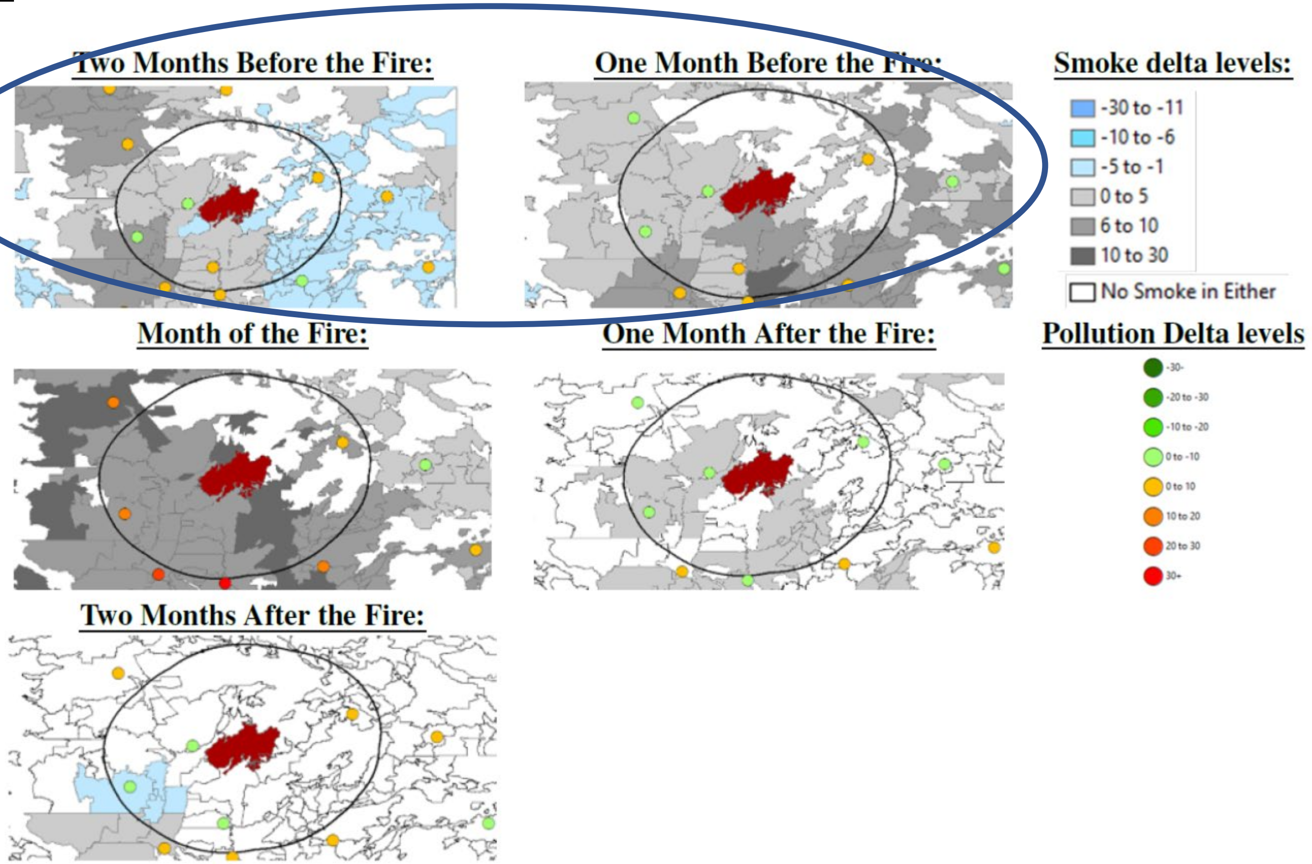



**Figure 5.** Delta Smoke and Pollution – Camp Fire

*Notes*: This figure shows the variation in changes in smoke and pollution (relative to the same months in 2015) two months before and after the Camp Fire. The red area is the fire footprint. The black circle is a radius of 30 miles from the fire. The border lines are ZIP Codes. Each ZIP Code is colored in gray or blue according to the change in the number of smoke days in the current month relative to the same month in 2015 (the base year). The dots represent the pollution monitors, where shades of green represent a decline in pollution levels compared with the same month in 2015 (the base year). The orange-red color of the pollution monitors means an increase in pollution levels compared with the same month in 2015.

# Comments: Pollution

- Pollution vs. wildfires.
  - Pollution has similar impact as wildfires.
- Interpretation
  - Why?

**Table 4.** Effects of the Camp Fire on Consumer Financial Distress

| | 1<br>Mortgage Delinquency | 2<br>Credit Card Delinquency | 3<br>Personal Loan Delinquency | 4<br>Retail/Store Card Delinquency |
|---|---|---|---|---|
| *Treated×Post* | 0.02* | 0.02*** | 0.05* | 0.02 |
| | (0.01) | (0.01) | (0.03) | (0.02) |
| Consumer FE | + | + | + | + |
| Year-qtr FE | + | + | + | + |
| Observations | 20,686 | 71,964 | 11,544 | 17,282 |
| R-squared | 0.54 | 0.77 | 0.74 | 0.73 |
| Dependent variable mean | 0.01 | 0.04 | 0.08 | 0.12 |

**Table 7.** Effects of Camp Fire-Induced Pollution on Credit Outcomes

| **Panel A** | 1<br>Mortgage Delinquency | 2<br>Credit Card Delinquency | 3<br>Personal Loan Delinquency | 4<br>Retail/Store Card Delinquency |
|---|---|---|---|---|
| *Treated × Post* | 0.01*** | 0.02*** | 0.05** | 0.02*** |
| | (0.00) | (0.00) | (0.00) | (0.00) |
| Time-varying borrower attributes | ✓ | ✓ | ✓ | ✓ |
| Borrower FE | + | + | + | + |
| Year-qtr FE | + | + | + | + |
| Observations | 5,846 | 20,730 | 3,023 | 5,007 |
| R-squared | 0.31 | 0.78 | 0.76 | 0.79 |
| Dependent variable | 0.01 | 0.04 | 0.13 | 0.10 |

# Conclusions

- My take
  - Nice motivation
  - Interesting data (e.g., smoke, pollution)
  - Intriguing and detailed results

- My comments
  - Wildfires - Robustness checks
  - Pollution - Alternative treatment measures, placebo tests
  - Interpretation (e.g., why does pollution have similar impact as wildfires?)