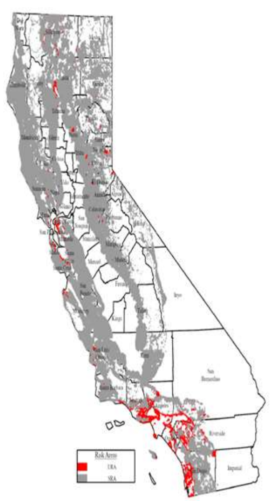
Wildfire Risk and Home Prices: The Case of California Building Codes

Edouard R. Mensah and Douglas H. Wrenn
Department of Agricultural Economics, Sociology, and Education, Pennsylvania State University

Background

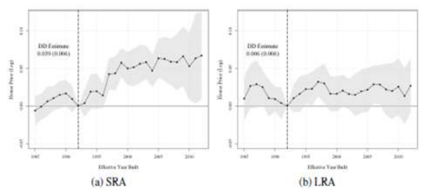
- Increasing wildfire damages in the U.S. over the past decade due to factors such as changing climate risks and fire suppression regimes and increased housing in wildland areas (Radeloff et al. 2018)
- Important to examine self-protection measures, especially in California where wildfire building code policies have been issued and evolving since 1980
  - most significant policy change occurring in 1992 with the passage of the Bates Bill (AB 337) and subsequent changes in 1994, 1995, 1997, 1999, and 2008 (Figure 1)
- Fire Hazard Severity Zone (FHSZ) maps subdivide the state into three broad areas based on the responsibility for wildfire suppression: federal (FRA), state (SRA), and local (LRA) (Figure A1)
- Previous research demonstrated the impact of wildfire-related regulations as it relates to structure vintages and damage during a wildfire event (Baylis and Boomhower, 2021)
- This paper assesses whether the increased safety afforded by homeowners for homes built after the most significant building codes were put into place has value and thus capitalizes into home prices

Figure A1: LRA and SRA Areas in the State of California



Notes: The gray regions show State Responsibility Areas (SRA). These are regions where Cal Fire is the primary agency in charge of wildfire suppression and prevention including implementing any legislative mandates regarding building codes established by the legislature. The red regions show Local Responsibility (LRA). These are regions, where local municipalities handle fire suppression and prevention. The boundaries in this figure are based on the 2007 boundaries drawn by Cal Fire, which were the most update-to-date maps during our study period.

Figure 4: DD-Event-Study Estimates of the Effect of Building Code Changes on House Prices



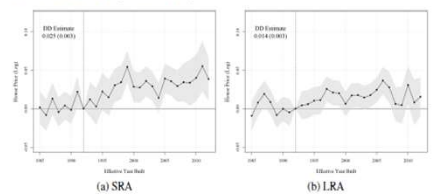
(a) SRA (b) LRA

Notes: The dependent variable is the natural log of house price. The treatment variable in each model is whether a house was built in an SRA (part a) or LRA (part b) fire zone. The treatment date is 1992, which is the year of the passage of Bates Bill formalizing changes to building codes in the SRA fire zones. The control group in both models is all houses built outside LRA and SRA areas. The models are estimated for house sales from 2013-2020. All LRA and SRA boundaries are defined based on maps drawn in 2007, the most recent update based on our study period. All models control for the quadratics in square footage, lot size, and bedrooms and bathrooms; an indicator for whether the house has a pool; and fixed effects for sale year-month and block group. The figures plot the estimated coefficients, and 95% confidence intervals, of interactions between vintage (year built) dummies and SRA or LRA dummies with the results normalized to 1992. Boxes in the upper-left corner show DD estimate from each model.

Figure 1: California Building Code History

- **1980:** Panorama fire in San Bernardino County leads to policy that initiates Cal Fire's development of Fire Hazard Severity Zone (FHSZ) maps.
- **1985:** First FHSZ maps released with three severity zones: Very High, High, and Moderate. The areas for the first maps was only defined for State Responsibility Areas (SRAs) - areas where Cal Fire is responsible for the wildfire response.
- **1991:** Oakland Hills Firestorm (Tunnel Fire) occurred, which initiated the process of developing state-wide wildfire building codes.
- **1992:** Bates Bill (AB 337) passed mandating stronger wildfire building codes and defensible space in SRAs and encouragement of their implementation in Very High FHSZs in Local Responsibility Areas (LRAs) - areas where local fire authorities are responsible for the wildfire response.
- **1994:** AB 3819 rated materials class A, B, C, and unrated
- **1995:** Law updated requiring class B roofs in SRA regulated areas and in LRA areas adopting regulations.
- **1997:** Law updated to increase requirement to class A roofs in high-hazard areas.
- **1999:** AB 423 passed to outlaw all unrated materials
- **2008:** Chapter 7A standards passed further strengthening codes and pushing for the expansion into remaining high-risk LRA areas.

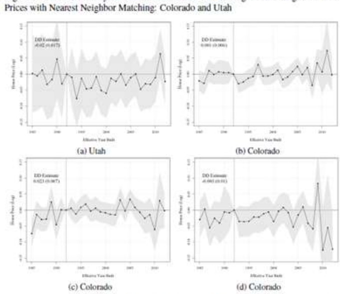
Figure 5: DD-Event-Study Estimates of the Effect of Building Code Changes on House Prices with Nearest Neighbor Matching



(a) SRA (b) LRA

Notes: This figure shows results for the same SRA model as Figure 4a and the same LRA model as Figure 4b with pre-processing of the data using a nearest neighbor matching technique. The matching model exact matches treatment houses with control houses from the same county, sale year, and vintage, and then uses a mahalanobis distance measure to find 1-to-1 treatment-control matches based on the acreage, square footage, bathrooms, bedrooms, and a pool indicator. The DD-event-study model is then estimated using the matched data with controls for housing characteristics and fixed effects for sale year-month and block group. The standard errors are clustered by matched pairs. The figure plots the estimated coefficients, and 95% confidence intervals, of interactions between vintage (year built) dummies and the SRA treatment variable with the results normalized to the year prior to treatment. The box in the upper-left corner shows the DD estimate (full results in Table 4).

Figure 6: DD-Event-Study Estimates of the Effect of Building Code Changes on House Prices with Nearest Neighbor Matching: Colorado and Utah



(a) Utah (b) Colorado (c) Colorado (d) Colorado

Notes: This figure shows results for the same matching model as Figure 5 using data on fire risk from other states: Colorado and Utah. For figures 5a and 5b risk is defined based on risk categories in the USDA Forest Service's 2018 Wildfire Hazard Potential (WHP) index pixel data. High-risk areas are defined based on classes Moderate, High, and Very High risk categories and all other areas are control areas. Figure 5c defines risk in Colorado based on the Colorado Forest Service's Wildfire Risk to Assets raster data, where high-risk is based on the Highest Risk, High Risk, and Moderate Risk categories and all other pixels are control areas, and defines risk based Colorado's Intensity index, where high-risk is based on the High Intensity category and all other pixels are control areas. The matching model exact matches treatment houses with control houses from the same county, sale year, and vintage, and then uses a mahalanobis distance measure to find 1-to-1 treatment-control matches based on the acreage, square footage, bathrooms, bedrooms, and a pool indicator. The DD-event-study model is then estimated using the matched data with controls for housing characteristics and fixed effects for sale year-month and block group. The standard errors are clustered by matched pairs. The figure plots the estimated coefficients, and 95% confidence intervals, of interactions between vintage (year built) dummies and the treatment variables with the results normalized to the year prior to treatment based on CA's Bates Bill (1992). The box in the upper-left corner shows the DD estimate.

Table 10: Benefits and Cost Estimates for Building Wildfire-Resistant Homes

	Baseline	Enhanced	Optimum
Cost Estimates			
Roof	$8,602	$8,602	$22,060
Under-Eave Area	$1,392	$1,392	$2,997
Exterior Wall	$14,431	$14,431	$16,886
Attached Deck	$4,826	$5,062	$10,974
Near-Home Landscaping	$808	$3,847	$3,847
Total Costs	$30,060	$33,335	$56,764
Capitalization			
SRA Homes		$17,798	
LRA Homes		$13,201	

Notes: This table provides estimates for construction costs for Baseline, Enhanced, and Optimum wildfire-resistant homes in California and capitalized benefits. The cost estimates are taken from a report by Headwaters Economics and Insurance Institute for Business and Home Safety (Barrett et al., 2022) (p. 39) averaging the estimates (in 2020 dollars) for Northern and Southern California. The capitalized benefits are estimates from our results using matching models in Table 4. The SRA benefit is 0.0249*$714,798 and the LRA benefit is 0.0141*$936,263. Capitalized benefits lower than total costs, *i.e.*, a benefit-cost ratio lower than one indicates wildfire-resistant home purchase is a better alternative to retrofit.

Table 4: DD Matching Model of the Effect of Building Code Changes on House Prices

	(1)	(2)
DD Estimate	0.0249***	0.0141***
	(0.0034)	(0.0029)
Acres	0.0929***	0.1686***
	(0.0023)	(0.0052)
AcresSqrd	-0.0077***	-0.0185***
	(0.0003)	(0.0009)
Sqft	0.0004***	0.0003***
	(4.62×10^{-6})	(4.49×10^{-6})
SqftSqrd	-2.29×10^{-8}***	-1.43×10^{-8}***
	(6.53×10^{-10})	(6.44×10^{-10})
Bedrooms	0.0949***	0.0553***
	(0.0071)	(0.0058)
BedroomsSqrd	-0.0140***	-0.0082***
	(0.0009)	(0.0007)
Bathrooms	0.0373***	-0.0106**
	(0.0055)	(0.0050)
BathroomsSqrd	-0.0017**	0.0035***
	(0.0008)	(0.0007)
HasPool	0.0846***	0.0698***
	(0.0020)	(0.0012)
Treated Mean ($)	714,798	936,263
N	128,804	116,888

Notes: The outcome variable is the natural log of the sale price. The data are for sales for the years 2013-2020. Column (1) shows results for the model with the SRA region as the treatment, and column (2) shows results for the model with the LRA region as treatment. The pre-treatment period is for houses built between 1985 and 1991. In addition to the variables shown, both models include fixed effects for sale year-month, vintage, and census block group. The standard errors are clustered on the matched pair level.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Data

- Home sales dataset for single-family homes in the treatment state (CA) and two placebo states (CO and UT), obtained via a licensing agreement with CoreLogic
- Sale years 2013-2020 and restriction to homes not destroyed by fire: vintage (effective year built) ranging from 1985-2012.
- Boundaries of SRA, LRA, and FHSZ risk locations developed by Cal Fire in CA; boundaries of wildfire risk locations developed by USDA Forest Service (2018) in CA, CO, and UT

Results

- Homes with the same vintage but located in the SRA sell for 2.5% premium and those in the LRA sell for a 1.4% premium relative to control homes in California (Figure 5 and Table 4)
- Evidence of no such effects in Colorado and Utah
- Translating these effects into changes in home values shows that the SRA home premium is $18K and the LRA premium is $13K, which are lower than the cost estimates of a retrofit (Table 10)

Conclusion

- Our results provide evidence that homeowners recognize and are willing to pay for the various self-protection measures mandated by CA's wildfire building codes.

Methods

- In CA: treated home if home effectively built in the post-Bates Bill era (1993-2013) and is in the SRA or the Very High FHSZ area of LRA; control home otherwise
- Vintage-based quasi-experimental design: event-study difference-in-differences (DD)
  - regressing the natural log of real home prices on sale year-month and census block-group fixed effects, housing characteristics, vintage fixed effects and the latter interacted with the SRA and LRA treatment variables
  - using the full data sample and a matched sample based on nearest-neighbor matching to improve balance between treated and control homes.
- Identifying assumption: homes in the same sale year-month, block group, and vintage, but outside treated areas serve as good controls (Levinson, 2016). Placebo tests using CO and UT samples

References:
Barrett, K., Quarles, S. L., and Gorham, D. J. (2022). Construction costs for a wildfire-resistant home, California edition. Technical report, Headwaters Economics and Insurance Institute for Business and Home Safety.
Baylis, P. and J. Boomhower. 2021. "Mandated vs. Voluntary Adaptation to Natural Disasters: The Case of U.S. Wildfires." *NBER Working paper 29621*.
Levinson, A. 2016. "How Much Energy Do Building Energy Codes Save? Evidence from California Homes." *American Economic Review*. 106(10): 2867-2894.
Radeloff, V. C., D. P. Helmers et al. 2018. "Rapid Growth of the U.S. Wildland-Urban Interface Raise Wildfire Risk." *Proceedings of the National Academy of Sciences*. 115: 3314-3319.
Walls, M., T. Gerarden, K. Palmer, X. F. Bak. 2017. "Is Energy Efficiency Capitalized into Home Prices? Evidence from Three Cities." *Journal of Environmental Economics and Management*. 82(2017): 104-124.

Contact:
Douglas H. Wrenn, Associate Professor
Agricultural Economics, Sociology, and Education
Pennsylvania State University
115 Ferguson Building, University Park, PA 16802 Email: dhw121@psu.edu

PCHES
Program on Coupled Human and Earth Systems

pches.psu.edu