

# The market value of seismic retrofit, or Natural hazard mitigation pays

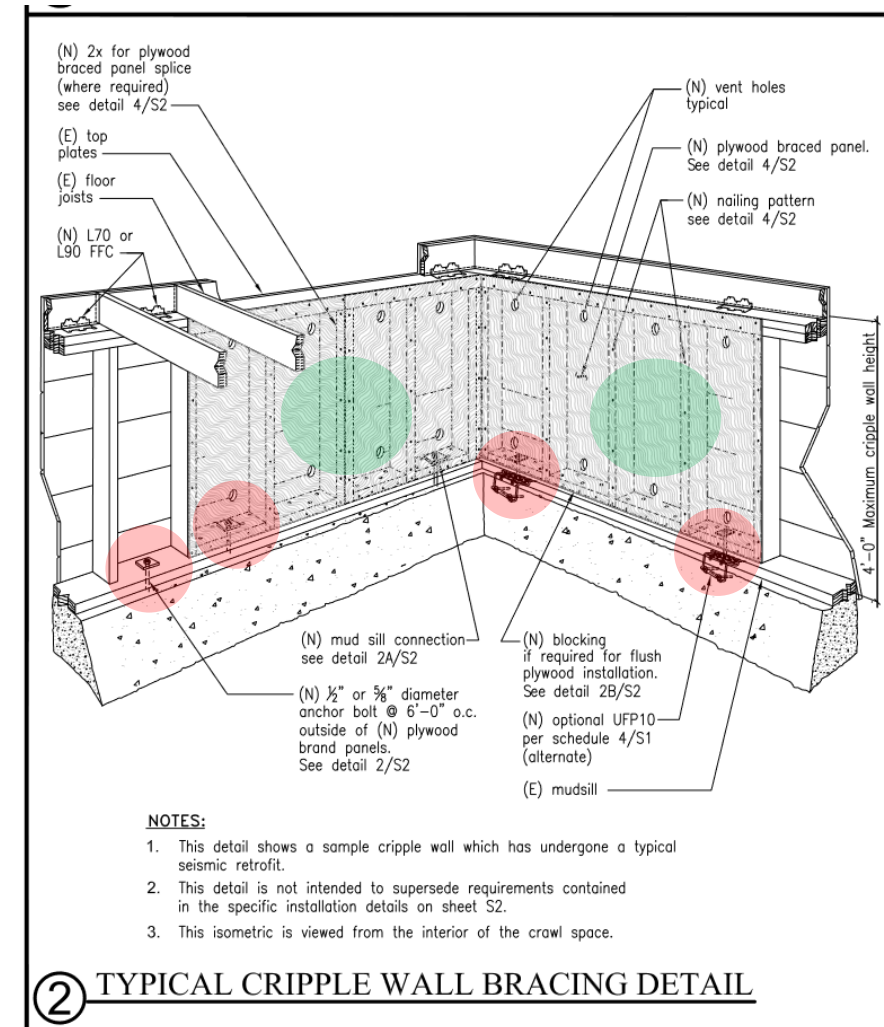
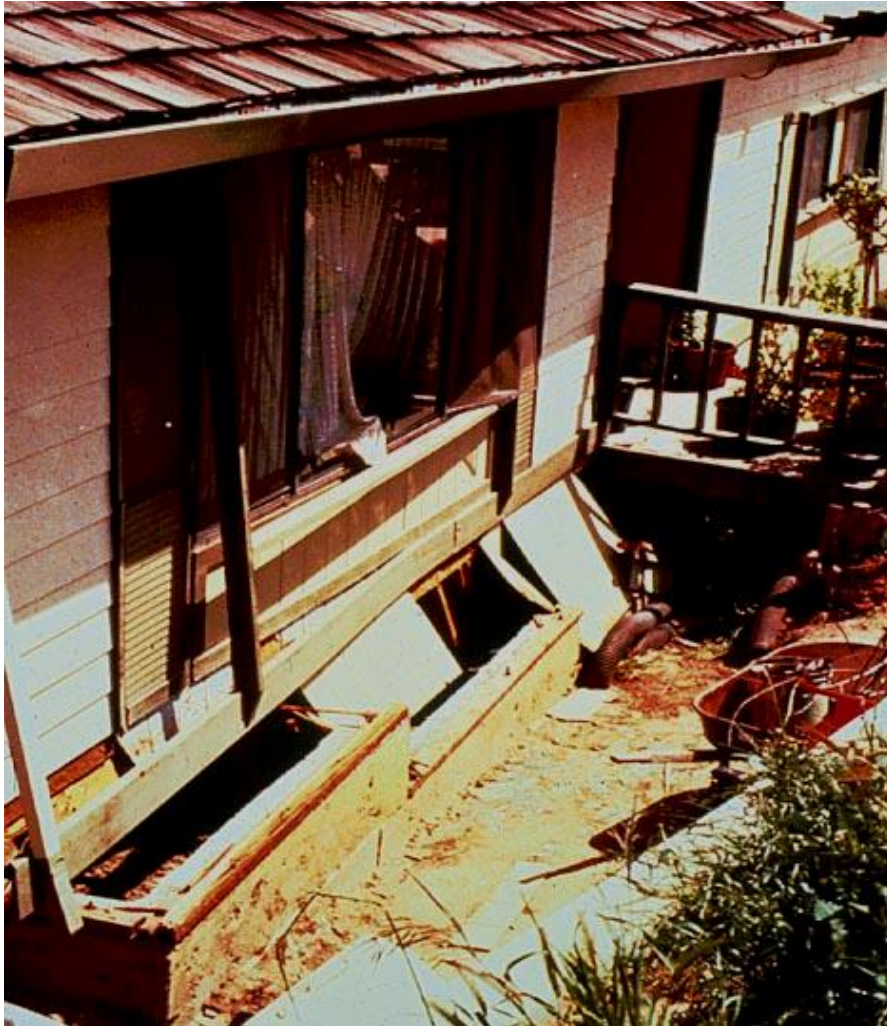
Keith Porter, chief engineer



May 30, 2023



# Earthquake resilience problems with older wood houses & how to fix them

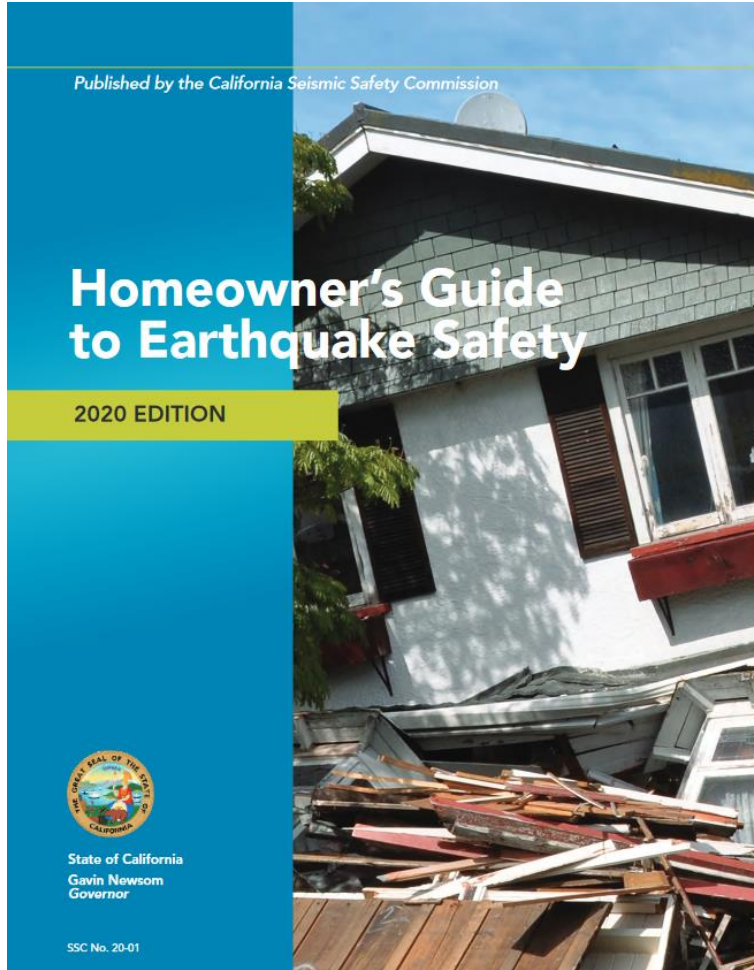


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# Why spend \$10,000 to strengthen your house? Retrofit pros and cons

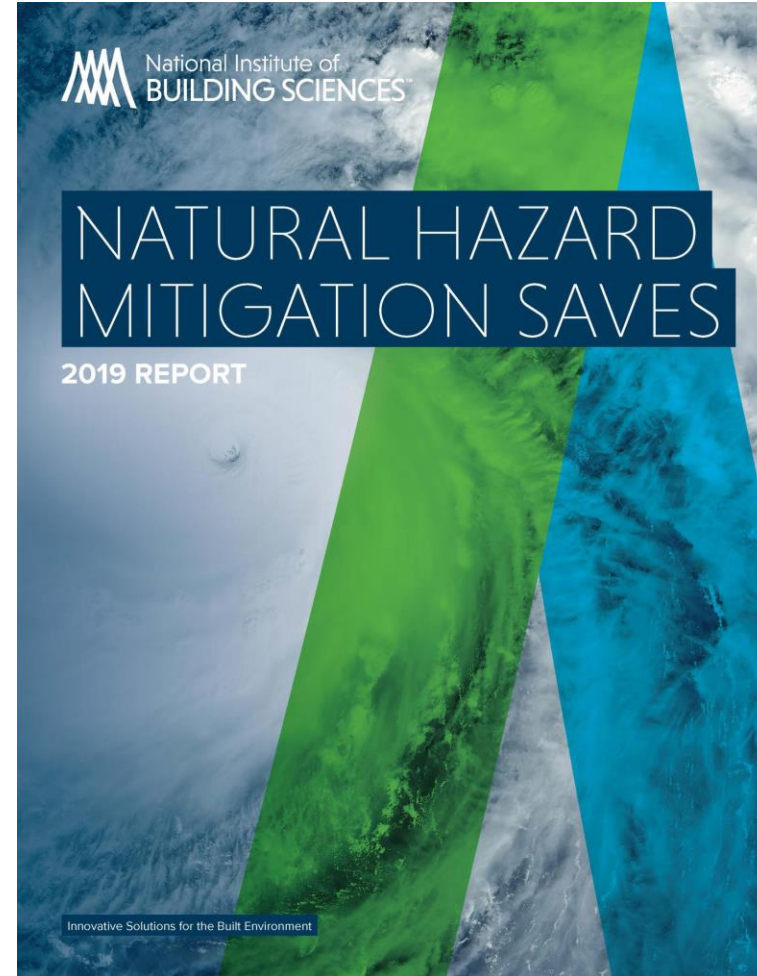


# Pro



**Prevent injuries & property damage**

May 30, 2023

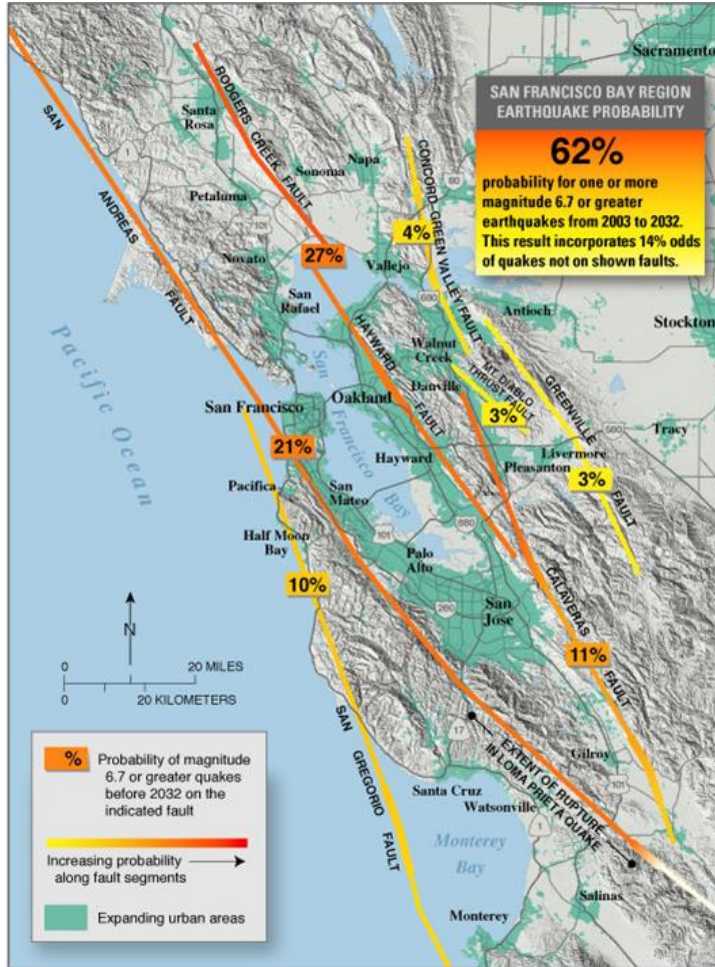


**Save more than you spend**

Market value of seismic retrofit

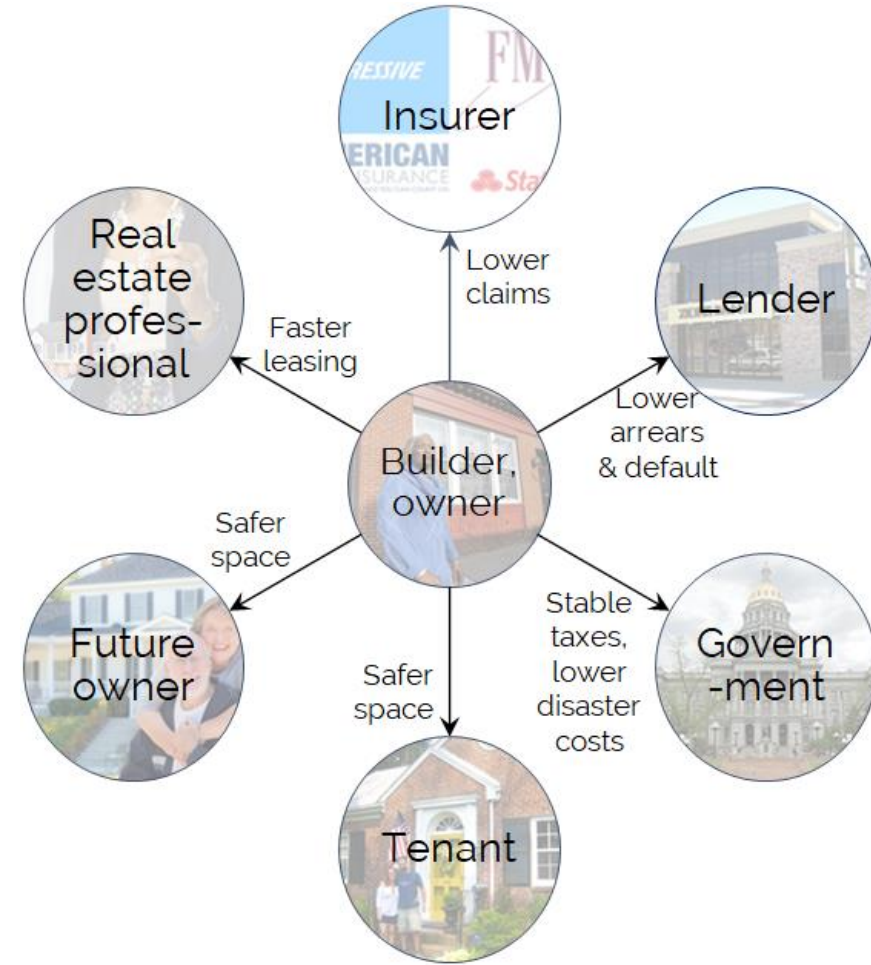


Con



**83% chance of no earthquake in 8 years**

**A lot of co-benefits go to others**



# A moral dilemma

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“Protect your family  
and property”



“Make money!”



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What if both angels told you to  
do the same thing?



# Wind mitigation protects your house *and* makes money

## Simmons & Kruse (2000)

Market Value of Mitigation and Perceived Risk:  
Empirical Results

Kevin M. Simmons and Jamie Brown Kruse<sup>1</sup>

**ABSTRACT.** This paper explores the value of windstorm mitigation in a Gulf Coast city. Policymakers have long assumed that agents will not voluntarily mitigate for a natural disaster. Consequently, policy has focused on coercive measures. Data for the study contains detailed information on the inclusion of storm-blinds, a specific hurricane mitigation feature. Results indicate that homes with storm-blinds command a premium compared to homes without this feature, thereby questioning the assumption held by policymakers. This result, however, is limited to homes located on the island portion of the community indicating that agents differentiate the risk from one area to another. (D8)

**I. Introduction**

A common assumption among professionals in disaster planning and response has been that voluntary mitigation for low probability high consequence events has little perceived value to residents in high-risk areas. This assumption is based largely on a comparison of the costs to install mitigation and the expected value of the benefits of the mitigation

ie in this model was highly significant  
t storm blinds add about 16% to the value of th  
f the coefficient is large, several issues must t

without such experience, more need is given to a possible disaster.  
(Kunreuther, 1978)

**II. Theory**

Traditional expected utility theory would suggest that with full insurance, agents will not mitigate. Dixit (1990) outlines this dilemma as follows:

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## Awondo et al. (2019)

Estimating Effects of Wind Loss Mitigation on Home Value

Sebastain Awondo\*, Harris Hollans\*\*, Lawrence Powell\*, Chip Wade\*\*\*

**Abstract**

We employ a novel spatial regression model to estimate effects of windstorm loss mitigation features on the value of coastal homes. Specifically, we consider joint effects of the Insurance Institute for Business and Home Safety's (IBHS) *FORTIFIED HOME*<sup>TM</sup> designation (henceforth Fortified) and distance from the coast on the prices paid for houses. We find that on average homebuyers pay a seven-percent premium for Fortified homes, which exceeds the typical cost of building or retrofitting homes to the Fortified standard. In addition, we find that Fortified construction and distance from the coast are substitutes. The premium is highest for homes nearest the coast.

al value of *Fortified* is substantial (at least 15 percent)

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# How to find out if seismic resilience does too



# Get data on bedrooms, baths, area, sale price, etc. of retrofitted houses

3 bd | 2 ba | 1,723 sqft

remodel includes whole house earthquake retrofitting. Ideally

**Zillow** Save Share More

3 bd | 2 ba | 1,723 sqft

2015 Orange Ave, Costa Mesa, CA 92627

**Sold: \$1,435,000** | Sold on 09/03/20 | Zestimate®: **\$1,996,800**

Est. refi payment: \$8,252/mo **Refinance your loan**

Home value Owner tools Home details Neighborhood details

### Overview

This quintessential Southern California abode exudes Spanish charm of the 1920's and is located on a sunny street in Eastside Costa Mesa. Completely rebuilt during year long, extensive down to the studs renovation in 2006 and spanning approximately 1,723 square feet of living space, the single-story residence features classic Mediterranean-style architecture, complete with arched doorways and windows, as well as gleaming walnut floors throughout. A custom stain grade knotty alder front door opens to a Walker Zanger trimmed foyer and the residence beyond. Airy spaces include a living room with picture window, fireplace and built-ins, separate dining room, and upgraded kitchen. Three bedrooms include a master suite with backyard access, en suite bathroom, glass-enclosed shower and separate Jacuzzi soaking tub, and walk-in closet by California Closets. Rounding out the residence are gorgeous grounds wrapping around the home, where multiple entertaining areas include a full built-in outdoor kitchen with tap, sparkling Pebble Tec saltwater pool and spa with waterfall feature, and a secluded grassy area surrounded by gorgeous trees and gardens. For the most discerning buyer, a complete and extensive remodel includes whole house audio, surround sound, central a/c and earthquake retrofitting. Ideally located near award-winning Newport- Mesa schools, 17th St. shops, restaurants, and just a short distance to the beach.



# Get similar data about ~10 nearby, similar-size homes

## Comparable homes

These are recently sold homes with similar features to this home, such as bedrooms, bathrooms, location, and square footage.



This home

**\$1,996,800**

**Sold**

**3 beds**

**2 baths**

**1723 sqft**

**\$1,159 / sqft**



282 E Bay St

**\$1,688,625**



**Sold 11 months ago**

**3 beds**

**2 baths**

**1708 sqft**

**\$989 / sqft**



257 Esther St

**\$1,515,000**

**Sold 3 months ago**

**3 beds**

**2 baths**

**1419 sqft**

**\$1,068 / sqft**



312 Esth

**\$1,695,000**

**Sold 11**

**3 beds**

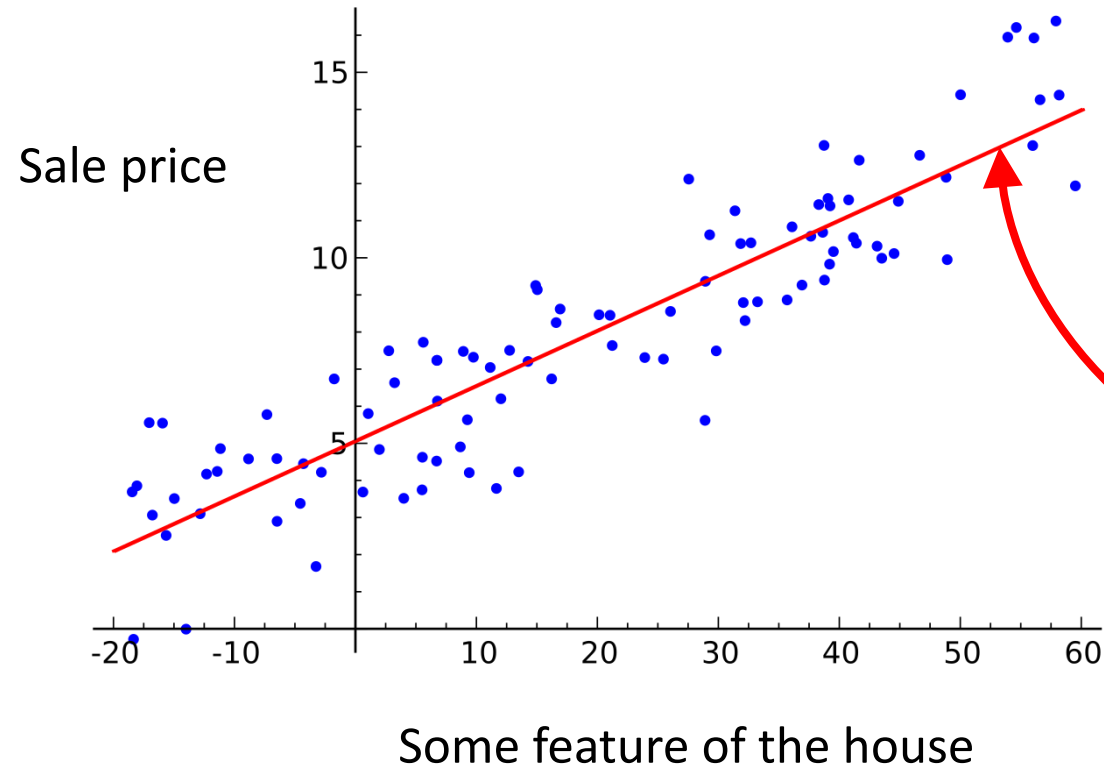
**2 baths**

**1603 sqft**

**\$1,057 / sq**



# Do fancy math



Slope of 0.10 means some feature adds 10% to the sale price per unit of the feature





## Seismic Retrofit Added 17% to the Resale Value of Older California Houses

Keith Porter, Ph.D., P.E.<sup>1</sup>; Jasem Alhumaidi<sup>2</sup>; and Zachary Reed<sup>3</sup>

**Abstract:** We examined the resale prices of 217 recently sold California single-family dwellings built before 1960 to determine whether buyers value seismic retrofit. Of these, sellers indicated that 29 houses had been seismically retrofitted: 17 pre-1940 houses (when unanchored foundations and unbraced cripple walls were common) and 12 built between 1940 and 1959 (when unbraced cripple walls were common). A stepwise regression analysis indicates that in 2020 California home buyers paid 17% more for retrofitted pre-1940 houses. Buyers may have paid about 1% more for retrofitted 1940–1959 houses, but the correlation is weak. A higher resale price is a powerful incentive for people to invest in foundation bolts and cripple wall bracing. It reinforces findings by other researchers that natural hazard mitigation not only *saves* (by avoiding future losses), but it also *pays* (through higher resale value). DOI: 10.1061/(ASCE)NH.1527-6996.0000579. © 2022 American Society of Civil Engineers.

### Introduction

Californians know they live in earthquake country. When they buy a house built before 1960, they learn through a mandatory disclosure form and pamphlet (most recently, California Seismic Safety Commission 2020) whether their house has certain seismic deficiencies, including whether it lacks bolts that secure it to the foundation (common before about 1940), and whether it has unbraced cripple walls (common before about 1960). Both problems can be fixed at a cost on the order of a few thousand dollars. But, with a few notable exceptions, the cost burden falls entirely on the owner and California law requires neither buyer nor seller to fix the problems.

Should an owner bolt an old house to its foundation and brace the cripple walls? Earthquake experts and public-safety advocates frequently advise people to do so. The aforementioned pamphlet bases its arguments on preventing injuries and costly property damage; that is, that the retrofit will reduce the owner's loss if an earthquake occurs during the ownership period. Other sources offer a business case for retrofit, in terms of the cost-benefit ratio. For example, the Multi-Hazard Mitigation Council (2019) estimates that spending \$1 to seismically retrofit soft-story woodframe multi-family dwellings avoids \$12 of future loss, on a long-term average basis, accounting for earthquake occurrence probabilities.

Neither reason to retrofit is perfect. First, the average US homeowner own their home for about eight years (Guerin 2019). In the San Francisco Bay Area, the chance of a magnitude 7 or larger earthquake in the next eight years is about 17%, meaning that if one retrofits one's house, the effort will not save the owner anything five times out of six. The long-term average savings are real and do

outweigh the cost, but the investment is still a gamble that probably will not pay off for any one particular owner. Second, the owner makes the investment, but even if the earthquake occurs, some savings go to tenants, insurers, lenders, and others who did not pay for the retrofit, which seems unfair.

In this work, we examine evidence that might support a different, complementary argument to retrofit. We often say that mitigation *saves*, but it might also *pay*. The present work was inspired by recent research by Awondo et al. (2016, 2019), who studied the resale price of recently sold existing single-family dwellings in four coastal Alabama communities frequently threatened by hurricanes. They found that buyers paid up to 25% more for houses near the Alabama coast that had IBHS FORTIFIED Home Hurricane ("Fortified") certifications, and 7% more on average over four Alabama communities.

We wondered if the same were true for earthquake resilience, and set out to imitate Awondo's study as closely as possible. We asked the question: If one owns a pre-1940 house that lacks foundation bolts and braced cripple walls, or a pre-1960 house with unbraced cripple walls, does seismic retrofit have a market value? A seismic retrofit can reduce loss if an earthquake occurs during one's ownership period. But might it also represent a more certain investment, paying for itself by an increased sale price?

We rely solely on publicly accessible real estate sales data, supplemented with household income data from the US Census and a real estate market price index as additional explanatory variables. We do not attempt to address the important, but separate, question of why. That is, we did not speak with sellers or real estate professionals to understand their decisions of whether and how to signal that a property has been seismically retrofitted, or with buyers to understand whether, why, or to what degree they value seismic retrofit. We did not speak with real estate appraisers to discover whether and how they consider retrofit in valuing a home. We ignored other important classes of real property, and other real estate transactions, such as renting or leasing. We considered only houses sold in the greater Los Angeles region and the San Francisco Bay Area, which together represent about 80% of California's housing stock.

We ignore the avoided future losses associated with retrofit, a separate topic that has been treated elsewhere. We mostly ignore insurance and other incentives and do not attempt to quantify risk attitude. We focus almost exclusively on resale value.

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# Retrofit seems to add 17% to resale value

**Table 3.** Best model for pre-1940 houses sold between 2018 and mid-2020 (N = 115 houses)

| i  | Term                              | Coefficient $a_i$   | SE                  | p-value | S     | R <sup>2</sup> | R <sup>2</sup> (adj) |
|----|-----------------------------------|---------------------|---------------------|---------|-------|----------------|----------------------|
| 0  | Constant                          | 13.726              | 0.815               | —       | —     | —              | —                    |
| 1  | Household income                  | 0.000003            | 0.000001            | 0.000   | 0.435 | 43.2%          | 42.7%                |
| 2  | Peninsula                         | 1.238               | 0.092               | 0.000   | 0.374 | 58.4%          | 57.6%                |
| 3  | House size m <sup>2</sup> (sq ft) | 0.00390 (0.000362)  | 0.000560 (0.000052) | 0.000   | 0.340 | 66.0%          | 65.1%                |
| 4  | East Bay                          | 0.669               | 0.068               | 0.000   | 0.275 | 77.9%          | 77.1%                |
| 5  | South Bay                         | 0.613               | 0.191               | 0.002   | 0.266 | 79.6%          | 78.6%                |
| 6  | Garage                            | -0.07               | 0.0353              | 0.050   | 0.262 | 80.4%          | 79.3%                |
| 7  | Lot size m <sup>2</sup> (sq ft)   | 0.000172 (0.000016) | 0.000075 (0.000007) | 0.022   | 0.257 | 81.2%          | 80.0%                |
| 8  | Improved                          | 0.113               | 0.054               | 0.038   | 0.253 | 81.9%          | 80.6%                |
| 9  | Retrofitted                       | 0.168               | 0.077               | 0.031   | 0.250 | 82.8%          | 81.1%                |
| 10 | CASTHPI                           | -0.002              | 0.001               | 0.088   | 0.250 | 82.8%          | 81.2%                |



# BCR = 12:1 for an average-sized pre-1940 California house

## Cost

$$\$5.00/\text{ft}^2 \times 2,000 \text{ ft}^2 = \$10,000$$

1001  
09-765/432  
PAY TO THE ORDER OF Seismic Retrofitters, Inc. \$ 10,000.00  
DATE May 6, 2022  
Ten thousand and no/100 DOLLARS  
MEMO You  
⑆ 123456789⑆ 0987654321⑆ 1001⑆

## Benefit

$$0.17 \times \$750,000 = \$125,000$$

CASHIER'S CHECK No. 1234567890 5673  
DATE Oct 6, 2022  
PAY TO THE ORDER OF You \$  
One hundred twenty-five thousand and no/100 DOLLARS  
AMOUNT  
LOCATION: Bank Name  
123 First St.  
AnyCity, US 10101  
Bank Teller  
AUTHORIZED SIGNATURE  
⑆ 1234567890⑆ ⑆ 1234567890⑆ ⑆ 7890⑆ 5673⑆



# Challenges

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1. Could a \$10,000 retrofit really add \$125,000 to sale price?
2. Representative sample?
3. Reliable data?
4. A Zillow variable we omitted, e.g., schools
5. Other available data, e.g., stories
6. Controlling for wealth, neighborhood, remodeling...
7. *Larger sample size, more recent data, & focusing on the boundary between communities with retrofit ordinances and those without.*
8. *Correlation is not causation. What caused buyers to pay more?*





## Some outreach options

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- Insurers
- Lenders
- Homeowner associations; BOMA
- Real estate professionals through their societies
- Local governments
- Engineers, e.g., EGBC, to promote adoption of standard plans



## Bottom line

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- Retrofit seems to add 17% to resale value, 12x the cost
- Mitigation not only saves, it pays
- Return also acts as a policy incentive
- The market force advantages the already-advantaged, leave others behind

A prod for both private and public efforts to do the right thing

Watch for our follow-up study in the next year or so.



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# Thanks

