Big-Data-Based Economic Insights

Building in Harm's Way

Insurance Pricing, Housing Supply, and Wildfire Risk in San Diego

Key Messages

- Risk-based pricing works best when safer neighborhoods can add housing
- Compressed wildfire premiums mute price signals and encourage risky development
- Safer neighborhoods are often more supply constrained than the risky urban fringe
- Targeted upzoning reduces worker costs but mostly reallocates who bears risk
- Future wildfire risk increases costs and makes housing constraints more consequential

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California is changing how insurers price wildfire risk in homeowners policies. After years in which regulated premiums varied less with wildfire risk than expected losses did, the state's Sustainable Insurance Strategy moves the system toward more forward-looking catastrophe models and more risk-based pricing. That shift raises a broader question for climate adaptation: When insurance prices reveal where risk is high, do households have affordable safer places to go?

This article is a non-technical summary of Ospital (2026), which studies this question in the San Diego metropolitan area. San Diego is a useful setting because wildfire risk rises toward the urban fringe, while many lower-risk central and coastal neighborhoods are already closer to the building limits set by local land-use regulations. This creates an adaptation bottleneck. Risk-based insurance premiums can discourage residence and construction in high-risk areas, but land-use constraints determine whether lower-risk neighborhoods can absorb additional housing demand.

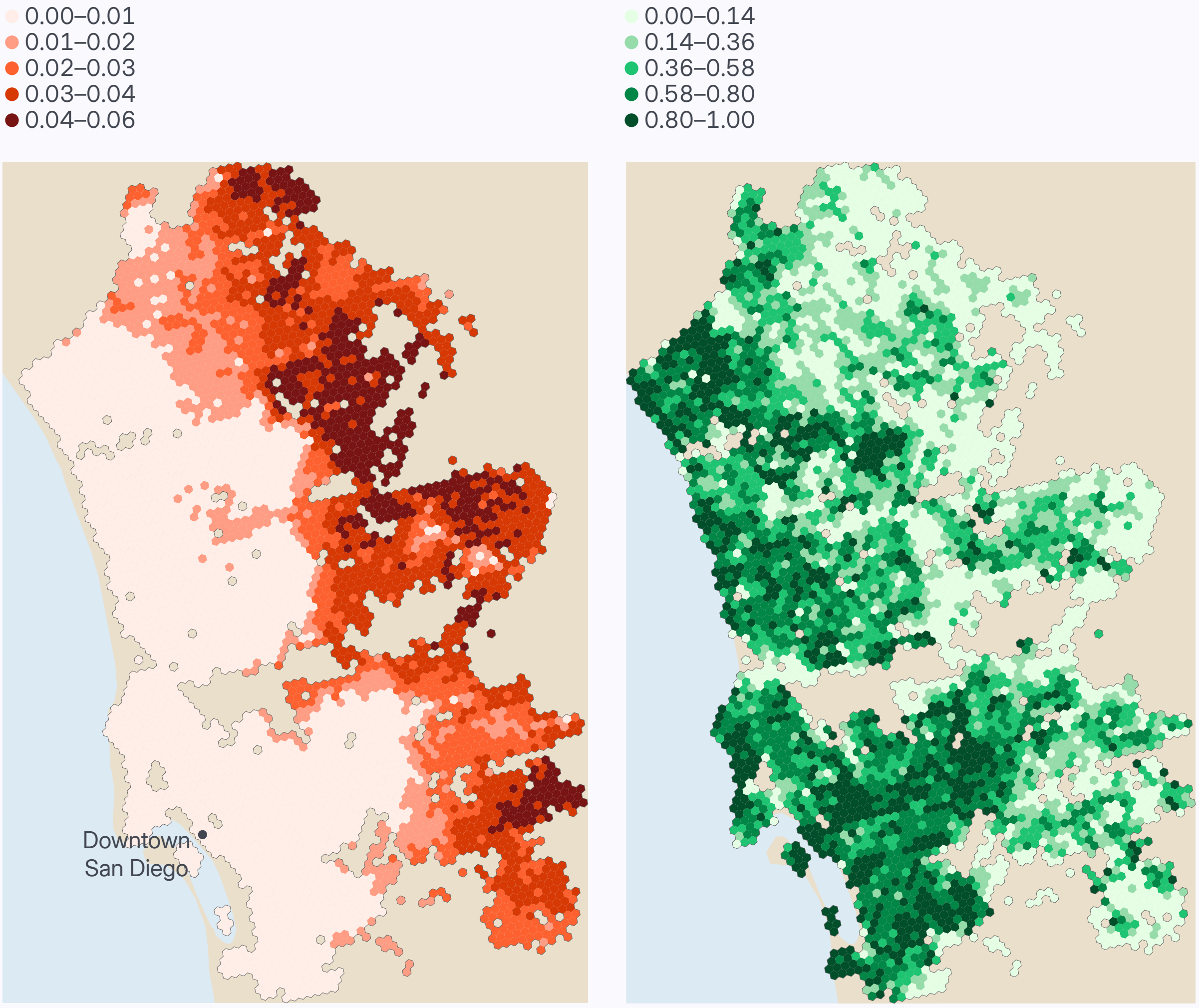
The article combines granular spatial data with a quantitative model of household location choice, housing supply, and insurance pricing. The data links wildfire risk, parcel-level housing, zoning capacity, commuting patterns, rents, property values, and insurance premiums at a fine geographic scale. The model then asks how rents, population, housing construction, insurance costs, and welfare would change under alternative policy environments: more risk-based insurance pricing, targeted housing supply reform in safer areas, and both policies together.

The main lesson is that insurance reform and housing supply reform should be evaluated jointly. More risk-based pricing is a step toward improving the spatial allocation of development relative to wildfire risk. However, if safer neighborhoods remain supply-constrained, insurance pric-

Figure 1

Wildfire Risk and Regulated Building Capacity in San Diego[a]

A. Annual burn probability **B. Fraction built out of maximum allowed**



[a] Panel A shows annual burn probability aggregated from the model's 215-meter-side hexagonal grid to 560-meter hexagons for display. Panel B shows housing built as a share of the maximum allowed under current land-use rules. Only populated hexagons are shown.
Source: Author's calculations.

ing reform may impose large costs on workers and renters with limited relocation options. Climate adaptation therefore depends not only on whether premiums correctly reflect risk, but also on whether housing policy allows households to respond to that risk.

Safer Areas Are Closer to Regulatory Build-Out

San Diego combines high climate risk exposure with large within-city differences in risk. Wildfires spread from surrounding wildland into the urban periphery, especially toward the eastern and northern edges of the metropolitan area. In the research sample, about 12 percent of the population live in locations with at least a one percent probability of wildfire over 30 years, and about seven percent live in locations with at least a 20 percent probability over the same horizon.

The geographic pattern of risk is not the same as the geographic pattern of housing capacity. The safest and most accessible parts of the city are often closer to existing regulatory capacity, while peripheral areas facing higher wildfire risk have more unused building capacity. This does not mean that every safe neighborhood is legally impossible to develop. It means that the places where additional housing would be most valuable for risk adaptation are frequently the places where supply is steepest. More than 80 percent of residential land in the San Diego metropolitan area is reserved for low-density detached single-family homes, and high-density zoning is concentrated in a small set of central and coastal locations. This is one local example of a broader literature linking land-use regulation to high prices and inelastic housing supply (Gyourko and Molloy 2015).

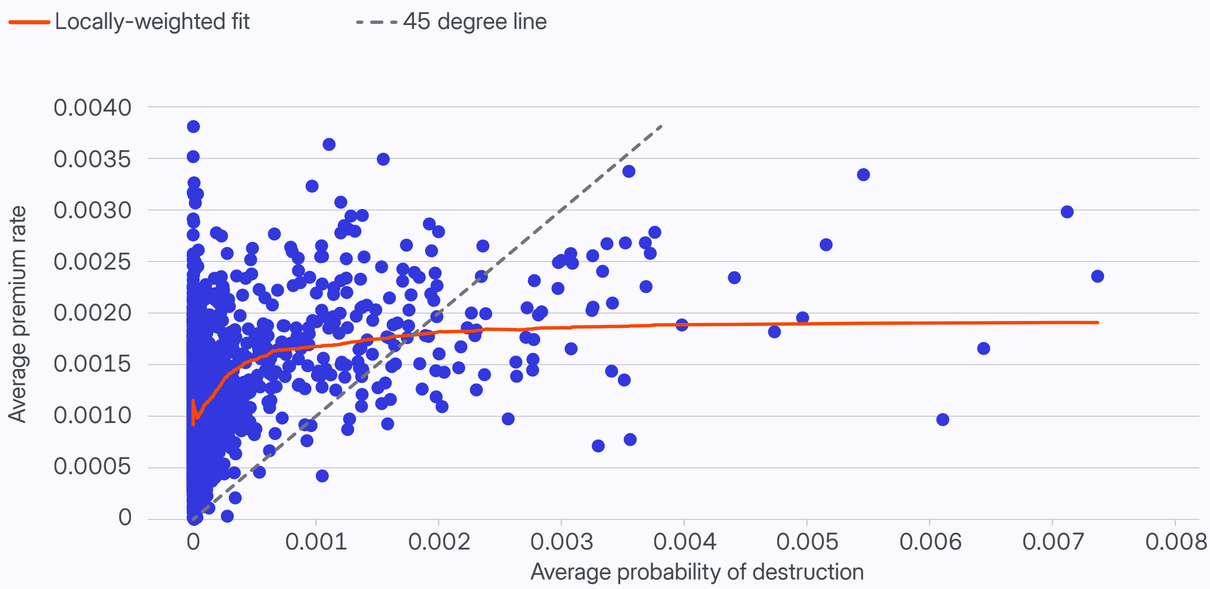
Figure 1 illustrates the central spatial fact. Panel A maps annual burn probabilities, and Panel B maps housing built as a share of the maximum allowed under current land-use rules. High-risk locations tend to lie further away from downtown and the coast. Safer central areas, by contrast, are more likely to be built out. The combination creates an adaptation bottleneck. Households can respond to insurance price signals only if safer places can expand.

Insurance Premiums Do Not Fully Reflect Wildfire Risk

Insurance is the second institution shaping exposure. Standard homeowners policies in California typically cover wildfire damages, but the insurance market has historically been regulated in ways that compress premiums across risk levels. Past rules emphasized historical loss experience, limited the use of forward-looking catastrophe models in rate filings, and excluded reinsurance costs from rate review. The FAIR Plan also provides last-resort coverage when house-

Figure 2

Insurance Premiums and Destructive Wildfire Risk across California ZIP Codes[a]



[a] Dots are California ZIP-code-year observations. The premium rate is the average fire premium per dollar of fire coverage. Destructive wildfire risk is burn probability multiplied by the conditional probability of flame length above four feet. The dashed line is the expected-loss benchmark.
Source: Author's calculations.

holds cannot obtain market coverage. These institutions can protect access and affordability in the short run, but they also mute the local price signal associated with wildfire risk.

Figure 2 plots average California ZIP-code fire premiums per dollar of coverage against destructive wildfire risk. The dashed line shows the benchmark in which premiums equal expected losses. Low-risk ZIP codes often lie above the line, while high-risk ZIP codes lie below it. The fitted curve is much flatter than the expected-loss benchmark, which is consistent with cross-subsidization from lower-risk to higher-risk policyholders. This pattern is in line with recent evidence that insurance regulation can decouple premiums from climate risk (Oh, Sen and Tenekedjieva 2026), as well as with property-level estimates of homeowners insurance pricing in California (Boomhower, Fowlie, Gellman and Plantinga 2024).

Recent reforms in California make this mechanism policy relevant. The state's Sustainable Insurance Strategy moves the homeowners insurance system toward the use of forward-looking catastrophe models and California-only reinsurance costs, while requiring insurers that use those tools to write more policies in wildfire-distressed areas (CDI 2024, 2025). The model in this article should therefore be read as isolating one key component of the reform package: the spatial and distributional consequences of moving away from compressed wildfire premiums toward more risk-based pricing. It does not model insurer withdrawal, FAIR Plan depopulation, coverage mandates, or mitigation-credit design.

Measuring the Key Forces with Granular Spatial Data

The empirical challenge is that wildfire exposure is determined at a very fine spatial scale. The analysis therefore builds the model on a grid of hexagons with 215-meter sides, then links those locations to commuting zones, zoning rules, housing-market outcomes, and insurance data.

The data combines several sources. Parcel records from the San Diego Association of Governments measure the number and size of homes. Eighteen years of real estate transactions are used to convert California assessed values into market-value estimates, since Proposition 13 prevents assessed values from tracking market prices continuously. Zoning maps and municipal codes are digitized to measure maximum permitted housing capacity parcel by parcel. LEHD Origin-Destination Employment Statistics identify commuting patterns. The United States Forest Service wildfire-risk data provides probabilistic wildfire measures (Scott, Gilbertson-Day, Moran, Dillon, Short and Vogler 2020), and California Department of Insurance data provides ZIP-code premiums and fire coverage.

This data identifies the key economic forces listed in Table 1. Households are sensitive to rents, but they also place a large value on safety from wildfires. The estimated willingness to pay to eliminate wildfire risk averages 3.5 percent of annual income. At the property-insurance margin, the estimated premium schedule implies that wildfire risk is underpriced relative to expected losses and underpriced

Table 1

Key Estimated Objects Used in the Quantitative Model

Object	Estimate	Interpretation
Residential rent sensitivity	Composite estimate = 3.590; housing share = 0.743	Combining the estimates implies a residential-choice elasticity of about 14.
Willingness to pay for safety	3.5% of income on average	Average income-equivalent value of eliminating current wildfire risk.
Wildfire premium parameter	Premium coefficient = 0.895	Premium rates are 10.5% below actuarially fair pricing and 24.1% below fair pricing plus an 18% load.
Cross-subsidy elasticity	Pooled-premium elasticity = 0.227	A 10% increase in wildfire premiums lowers pooled other-peril premiums by 2.27%, all else equal.
Wildfire insurance cost share	8.2% average; 27.3% at the 90th percentile	Wildfire insurance is a material component of housing development or ownership costs.
Housing-supply steepness	Average 1.24 in 2017; about 1.2-1.5 in the safest hexagons and below 0.2 in the riskiest	Higher markup elasticity means local rents respond more strongly to additional demand; estimates are higher in safer, more built-out locations.

Note: Monetary values are in 2018 USD.
Source: Author's estimates and calculations.

even more relative to an expected-loss benchmark with an 18 percent risk load. The estimates also imply that a ten percent increase in wildfire premiums would reduce pooled premiums for other perils by 2.27 percent, which captures the cross-subsidy built into the pooled insurance-premium arrangement.

A final object is the local steepness of housing supply. In the model, this is summarized by a markup elasticity, which measures how strongly rents rise when additional housing demand pushes a location closer to its regulatory or physical capacity. The estimates imply a clear wildfire-risk gradient: Markup elasticities are highest in safer, more built-out locations and decline toward the higher-risk urban fringe. This matters because it creates an adaptation bottleneck. Risk-based insurance premiums discourage residence and construction in high-risk areas, but the safer locations that could absorb displaced demand are often the places where additional demand raises rents most sharply.

How the Key Parameters Are Identified

The estimation uses different sources of variation for the different objects in Table 1. Residential demand is disciplined by changes in population and rents across small hexagons between 2010 and 2017. To address the possibility that rising rents reflect improving local amenities rather than housing scarcity, I instrument rent growth with a leave-one-out measure of surrounding initial build-out within the same tract. The idea is that nearby build-out shifts the local steepness of supply, while excluding the hexagon itself reduces mechanical correlation with its own demand shocks.

The wildfire disamenity estimates come from very local comparisons near the wildland-urban interface. I compare small locations within the same tract that have similar access to jobs and similar broad neighborhood characteristics but different burn probabilities. The regressions control for distance to wildland, distance to the coast, topography, weather, and land-cover shares, and they exclude places that burned in the previous five years so that the estimates are not driven by temporary rebuilding after a recent disaster. The estimates also allow nearby wildfire risk to matter, because smoke, disruption, and perceived safety do not stop exactly at a hexagon boundary.

The main robustness checks address two concerns. First, development itself may affect wildfire risk through ignitions, firefighting, or land management. To address this reverse-causality concern, the paper instruments burn probability with a non-anthropogenic wildfire-risk measure. Second, topography and climate may directly affect amenities, not only wildfire risk. To address this omitted-amenity concern, the paper also uses variation in expected risk driven by the salience of nearby historical burns before 2010. In both cases, the estimated wildfire disamenities remain large and statistically significant, suggesting that the baseline estimates are not driven solely by omitted landscape amenities or by the effect of development on wildfire risk.

Housing-supply elasticities are identified from 2010-2017 changes in rents and housing quantities. Because housing growth may respond to unobserved local demand shocks, I instrument housing growth with lagged nearby job-access growth from 2001-2010. The estimates imply that supply is steeper in places that were already built out and in places with steeper terrain. This is the empirical basis for the article's central supply-side mechanism: Safer, constrained neighborhoods cannot absorb demand as easily as riskier peripheral locations.

A Spatial Model of Urban Climate Risk Exposure

The model translates these empirical objects into a citywide equilibrium. Workers choose where to live and where to work. Their location choices depend on rents, commuting costs, wage opportunities, amenities, and wildfire risk. Wildfire risk enters household welfare as an amenity cost, summarizing expected health, safety, smoke, comfort, and recreation losses. Workers are mobile across locations inside the city and can also choose to live outside the modeled metropolitan area.

Landowners supply housing. They earn rents but face expected property damages from wildfire. They can insure those damages, and the cost of insurance changes the effective cost of developing or maintaining housing in each location. Land-use regulations cap the number or size of homes that can be built. When a location is close to its regulatory capacity, housing supply becomes steep, allowing scarcity rents to rise. This supply-side channel is crucial because wildfire risk is not only a household disamenity, but also a cost to the owners of structures in risky places.

The insurer is modeled as self-funded. If wildfire premiums are compressed, the revenue shortfall from risky policies is offset through a pooled premium on other perils. This creates a link between high-risk and low-risk locations. A reform that raises wildfire premiums in risky areas can reduce other insurance costs elsewhere, but it also changes where homes are built and where households live.

The equilibrium concept is useful because it forces all margins to adjust simultaneously. A policy that raises premiums in risky places does not merely change the insurance bill for current residents. It changes rents, construction, the value of safe land, and the distribution of households. A policy that expands safer housing supply does not merely add units. It changes the incidence of wildfire risk by changing the outside options available to households facing higher risk-based premiums.

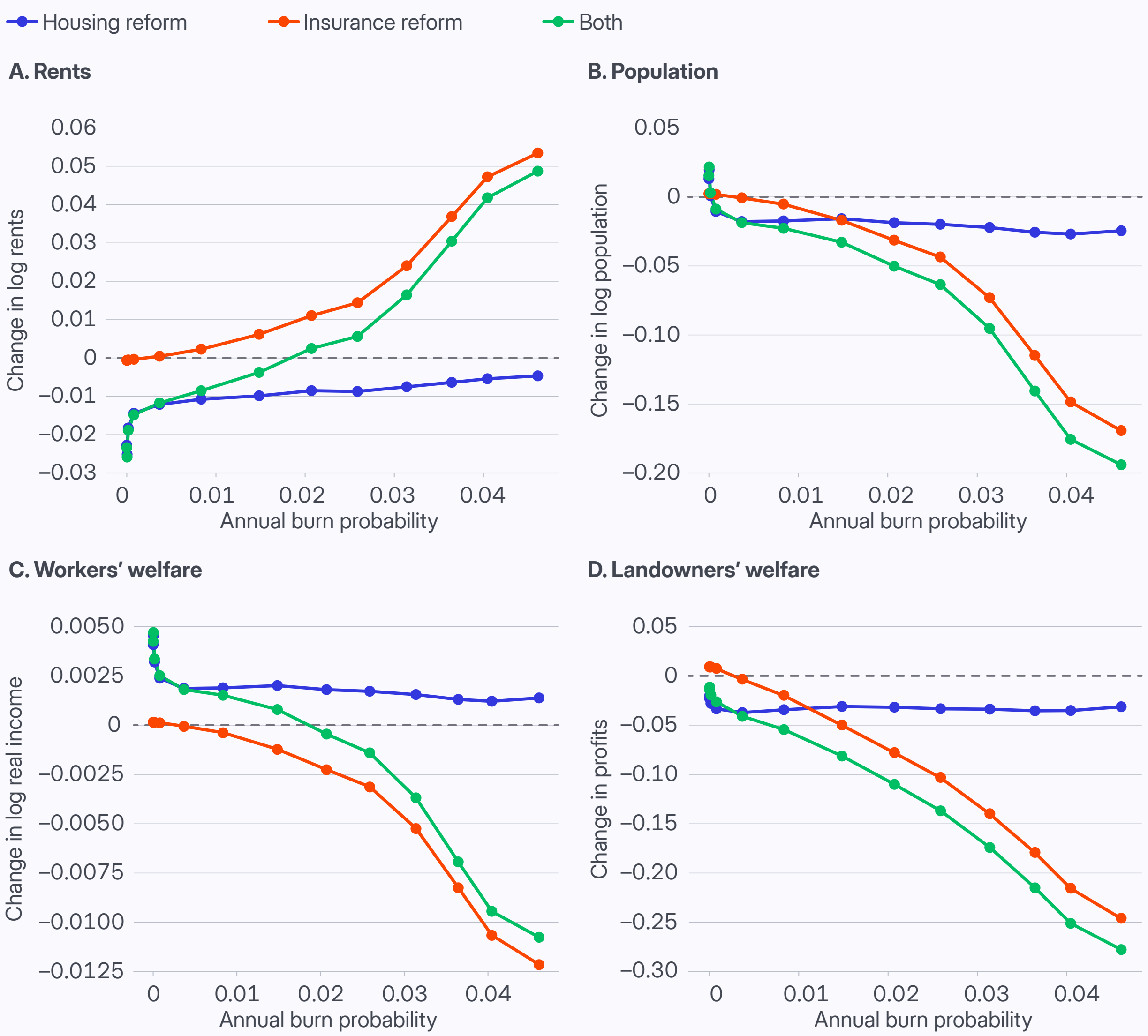
Counterfactuals: Insurance Pricing and Housing Supply

The counterfactuals follow a simple scenario ladder. The first policy replaces the current compressed wildfire premium schedule with risk-based pricing. In the model, risk-based pricing sets wildfire premiums equal to expected losses plus an 18 percent risk load, following the benchmark used by Boomhower et al. (2024). The second policy increases housing capacity by 15 percent within a half-mile of major transit stops in the City of San Diego. These Transit Priority Areas (TPAs) account for 8.11 percent of baseline housing capacity, so the reform raises total permitted building space by only 1.22 percent. The third scenario combines both policies.

The targeted housing reform lowers rents across the city, especially in safer places. Average rents fall by 2.1 percent,

Figure 3

Targeted Policy Reforms by Wildfire Risk[a]



[a] Binned scatter plots of simulated counterfactual changes by annual burn probability.
Source: Author's model simulations.

housing rises by 2.9 percent, and the population shifts away from the fire-prone fringe. In present-value terms, workers gain USD 7.5 billion from lower housing costs and improved access to safer locations. Landowners lose USD 5.3 billion as scarcity rents fall, so the direct net effect is USD 2.2 billion. The policy is therefore pro-worker and pro-affordability, but it also redistributes away from incumbent landowners.

Risk-based insurance pricing has a different spatial pattern. It raises development costs and rents in risky places and reduces the cross-subsidy embedded in pooled premiums. Figure 3 shows that rents rise most in high-risk bins under risk-based pricing, while population falls sharply in those same bins. The combined reform has two offsetting forces: Safer supply reduces rents and attracts residents toward lower-risk locations, while risk-based pricing discourages development and residence in the riskiest places. The figure makes clear why the policies should not be evaluated independently. Housing reform changes the ability of households to respond to insurance reform.

Who Bears the Cost of Wildfire Risk

To compare policy environments, the model computes the welfare cost of wildfire risk. This statistic asks how much welfare would rise if wildfire probabilities were reduced to a very low level, keeping the rest of the policy environment fixed. It is not the same as the direct welfare effect of a policy reform. Instead, it measures how the cost of living with wildfire risk is allocated across workers and landowners under each policy regime.

In the current baseline, wildfire risk imposes a present-value welfare cost of USD 17.5 billion (Table 2). Workers bear USD 15.5 billion. Owners of risky land bear USD 8.3 billion. Owners of safe land receive an offsetting gain of USD 6.3 billion because wildfire risk makes safer land scarcer and thus more valuable. For workers, the average annual cost is USD 788 per household, or 0.80 percent of income. For owners of land exposed to wildfire, the annual cost is USD 2,227 per home, or 17.6 percent of profits.

The policy counterfactuals show that targeted housing supply can offset the worker burden created by risk-based insurance pricing. Moving to risk-based insurance pricing raises the aggregate welfare cost of wildfire risk by USD 460 million. TPA upzoning is nearly neutral in the aggregate, but it lowers worker costs by USD 475 million and raises landowner costs by almost the same amount. When both policies are combined, the aggregate cost rises by USD 458 million, but worker costs fall by USD 136 million relative to the baseline. Robustness exercises reinforce this interpretation: The aggregate effect of targeted upzoning is sensitive to how local amenities and wildfire probabilities respond in equilibrium, but the incidence result – housing supply changes who bears the cost of risk-based insurance – is more stable.

The future-risk exercise does not simply scale up current damages. I estimate the historical relationship between maximum summer temperatures and annual burn probabilities across California, then combine that relationship with

Table 2

Welfare Cost of Wildfire Risk Under Alternative Policy Environments

Scenario	Total	Workers	Owners of safe land	Owners of risky land
Current baseline level	17.46	15.47	-6.26	8.25
Change: risk-based insurance	+0.46	+0.36	-0.84	+0.94
Change: TPA upzoning	-0.003	-0.47	+0.36	+0.12
Change: joint targeted reform	+0.46	-0.14	-0.47	+1.06
Future baseline level	20.46	17.88	-7.96	10.54
Future change: risk-based insurance	+0.69	+0.32	-0.84	+1.21
Future change: TPA upzoning	-0.002	-0.56	+0.42	+0.14
Future change: joint targeted reform	+0.69	-0.25	-0.41	+1.35

Notes: Values are present-value welfare costs in USD billions in 2018. Baseline rows report levels; other rows report changes relative to the corresponding baseline. Negative entries mean that the group gains from wildfire risk or that the reform lowers the group's wildfire-risk burden.

Source: Author's model simulations.

downscaled climate projections for 2060. In the baseline future exercise, wildfire probabilities change with projected temperatures, while local building constraints and insurance institutions determine how the city absorbs the resulting risk. Robustness exercises also allow wildfire probabilities to respond endogenously to changes in housing density.

Future climate risk raises the stakes. In a combined future scenario with higher wildfire risk and population growth, aggregate costs rise from USD 17.5 billion to USD 20.5 billion. Most of that increase comes from higher wildfire probabilities rather than citywide population growth. Under future risk, the aggregate effect of risk-based pricing rises from USD 460 million to USD 691 million. Population growth matters more for incidence: As the city's building constraints become tighter, more of the burden shifts toward workers.

Policy Implications

First, risk-based insurance pricing and housing supply should be considered together. Premiums that remain below expected wildfire losses flatten the spatial price signal and shift costs across policyholders through pooled insurance charges. Moving toward more forward-looking, risk-based pricing is therefore a sensible direction. However, pricing reform by itself mainly tells households where risk is high. It works better when lower-risk neighborhoods can absorb additional housing demand without large rent increases.

Second, land-use policy is climate adaptation policy. In San Diego, lower-risk areas are often more built-out and have steeper estimated housing supply than the higher-risk urban fringe. This means that regulatory limits in safer areas can unintentionally push population growth toward places where wildfire premiums, expected damages, and disamenity costs are higher. A climate-oriented housing strategy should prioritize additional capacity in lower-risk, job-accessible, and transit-accessible locations rather than allowing the path of least regulatory resistance to be the risky fringe.

Third, policymakers should be mindful of changes in who bears risk. The targeted upzoning experiment lowers rents, improves workers' access to safer locations, and reduces the worker burden of risk-based insurance. But it is nearly neutral for the aggregate welfare cost of wildfire risk because it also reduces scarcity rents for landowners and changes the value of safe and risky land. This makes targeted upzoning valuable as an affordability and incidence policy, even in cases where it does not significantly decrease total wildfire damages.

Fourth, policy should be forward-looking. Future wildfire risk raises costs in the model, and population growth makes local housing constraints bind more tightly. Insurance regulation, land-use plans, and infrastructure investments should therefore rely on forward-looking risk information rather than only on historical losses. Today's land-use decisions have long-lived consequences: Housing allowed in lower-risk neighborhoods can reduce future adjustment costs, while housing allowed mainly at the fringe can lock in exposure.

Fifth, affordability concerns should be addressed explicitly, but without hiding the risk signal. The model does not simulate income-targeted transfers, liquidity constraints, insurer withdrawal, FAIR Plan depopulation, or mitigation credits. It therefore should not be read as a complete evaluation of California's Sustainable Insurance Strategy. Its narrower but important implication is that broad premium compression is a blunt way to manage distributional concerns. When policymakers want to cushion existing households from abrupt premium increases, transition assistance is preferable if it preserves risk-based signals for new development and is paired with housing capacity in safer neighborhoods. •

References

Boomhower, J., M. Fowlie, J. Gellman, and A. Plantinga (2024), "How Are Insurance Markets Adapting to Climate Change? Risk Classification and Pricing in the Market for Homeowners Insurance", *NBER Working Paper* 32625.

California Department of Insurance (CDI, 2024), *In a California 'First,' Commissioner Lara Announces Enforcement of Regulation to Expand Insurance Coverage Across State*, Press Release, December 13, 2024, https://www.insurance.ca.gov/0400-news/0100-press-releases/2024/release062-2024.cfm (accessed June 7, 2026).

California Department of Insurance (CDI, 2025), *Reform Made Real: California Department of Insurance Completes Final Evaluation of Innovative Forward-Looking Model to Address California's Coverage Crisis*, Press Release, July 24, 2025, https://www.insurance.ca.gov/0400-news/0100-press-releases/2025/release052-2025.cfm (accessed June 7, 2026).

Gyourko, J. and R. Molloy (2015), "Regulation and Housing Supply", in G. Duranton, J. V. Henderson, and W. C. Strange, eds., *Handbook of Regional and Urban Economics*, Vol. 5, Elsevier, Amsterdam, 1289–1337.

Oh, S. S., I. Sen, and A.-M. Tenekedjieva (2026), "Pricing of Climate Risk Insurance: Regulation and Cross-Subsidies", *Journal of Finance*, in press.

Ospital, A. (2025), "Housing Supply and Natural Hazards within and across US Cities", *AEA Papers and Proceedings* 115, 380–384.

Ospital, A. (2026), "Housing Supply, Property Insurance, and Exposure to Wildfire Risk", *CESifo Working Paper* 12613.

Scott, J. H., J. W. Gilbertson-Day, C. Moran, G. K. Dillon, K. C. Short, and K. C. Vogler (2020), *Wildfire Risk to Communities: Spatial Datasets of Landscape-Wide Wildfire Risk Components for the United States*, Forest Service Research Data Archive, Fort Collins, CO.