Use of Catastrophe Models in California Homeowners Ratemaking Formula

Commissioned by Personal Insurance Federation of California and American Property Casualty Insurance Association

Nancy Watkins, FCAS, MAAA, Principal and Consulting Actuary
Robert Lee, FCAS, MAAA, Actuary

Milliman

Executive Summary

PURPOSE OF REPORT

The Personal Insurance Federation of California (PIFC) is an association of property and casualty insurers in California. The American Property Casualty Insurance Association (APCIA) is a national trade association for property and casualty insurers. Together, PIFC and APCIA engaged Milliman, Inc. (Milliman), an independent actuarial consulting firm, to study how enabling California insurers to use wildfire catastrophe models for ratemaking might affect homeowners premiums and market conditions.

BACKGROUND

The 2017 and 2018 wildfire seasons were the most destructive and deadliest on record in California history at the time. Throughout the two years, the fires burned close to 4 million acres and destroyed or damaged more than 20,000 structures.[1] Excluding the effects of reinsurance or other recoveries, Milliman estimated that the combined 2017 and 2018 wildfire seasons wiped out about two times the combined underwriting profits for California homeowners insurers for the prior 26 years.[2] These events had a drastic impact on the indicated premiums for homeowners insurers calculated in accordance with the California Code of Regulation 2644.5 ("the CCR"), which specifies that a minimum 20-year average of historical catastrophe losses must be used to calculate catastrophe loads within the CDI promulgated ratemaking formula (the "CDI Rate Template"). Prior to 2017, homeowners insurance premiums for many companies did not reflect the buildup of wildfire risk that had occurred over many years. With the extreme wildfire events in 2017 and 2018, some companies more than doubled their expected catastrophe loss projections, and premium actions allowed in response to the sharply increased indications created an affordability crisis in certain areas of the state.

An alternative to relying solely on historical experience is to employ the use of catastrophe models. Catastrophe models draw from fields like atmospheric science, environmental science, actuarial science, and engineering. While California regulation currently does not permit the use of catastrophe models in lieu of experience for projecting catastrophe losses, the California Department of Insurance (CDI) has held public hearings to explore consumer and industry sentiment around allowing catastrophe models to be used as a basis for wildfire premiums in rate filings.

SCOPE, METHODOLOGY AND DATA

The scope of Milliman's analysis is to provide an illustrative comparison using realistic and detailed hypothetical data to study the implications of each method of determining catastrophe loads. We simulated both historical losses and expected average annual losses (AALs) using CoreLogic's wildfire catastrophe model and the Milliman Market Basket, a portfolio representing about 10% of single-family homes in California. We calculated two sets of yearly rate indications that follow the CDI rate template: one with wildfire catastrophe loads based on experience as currently required by the CCR (the "historical experience method"), and one with wildfire catastrophe loads based on AALs from the catastrophe model (the "model method"). Aside from the catastrophe load, all other parameters were held constant across the two methods.

[1] 2017 and 2018 Incident Archives. Cal Fire.

[2] Eric Xu, Cody Webb, David D. Evans. Wildfire catastrophe models could spark the chances California needs. Milliman (2019).

Under each scenario, we assumed that the insurer would request the average of the minimum and maximum indicated rate change calculated according to California regulations, and that the indications would be approved by CDI to be implemented the following year.[3] The indications were then compared over time, for indications calculated annually from 2010 through 2020, for a variety of scenarios:

- A static statewide portfolio
- Portfolios in Northern vs. Southern California
- Portfolios in wildland-urban interface (WUI)[4] and non-WUI areas
- A portfolio actively shifting from riskier to less risky areas
- A portfolio actively shifting from less risky to riskier areas

Additional information about data sources is contained in the Data section of this report.

KEY FINDINGS

Our analysis yielded seven key findings, as follows:

1. Even in a portfolio that is large and fairly stable, indications based on historical experience create situations where indicated premiums are subject to drastic increases, leading to a misunderstanding of risk and inability for homeowners to plan their expenses.
2. In a stable exposure situation, indications from a given catastrophe model would tend to be much smoother over time than indications based on historical data. In some cases the resulting premiums will be more affordable, and in other cases they will be less affordable.
3. Even if experience indications reach a price level that is comparable to the model indications on a statewide basis, insurers with concentrations in different areas can have drastically different outcomes and may still experience severe underpricing, leading to reduced availability.
4. Although the percentage difference between the experience-based formula and model-based indications can be similar for high-risk and low-risk policies, the dollar difference is much larger for high-risk policies. This is why the insurance availability problems have been most acute in the WUI, driving risks into the FAIR plan.
5. The historical experience-based formula has a bias towards producing negative wildfire rate indications for insurers who increase wildfire risk. The bigger the increase in risk, the more severely understated the indicated premiums will be, all else equal.
6. The experience-based formula gives insurers a disincentive to take on more risky properties, and an incentive and mechanism to drop high-risk policies in order to avoid requesting big rate increases.
7. Effective risk mitigation measures can have a significant impact on total wildfire premium need, but this will not show up for many years using historical experience. Using catastrophe models in ratemaking will allow for an immediate incorporation of an objective and accurate view of these impacts, promoting more affordable insurance sooner and better equipping insurers to write in areas with availability and affordability concerns.

HIGHLIGHTS OF ANALYSIS

Statewide Portfolio

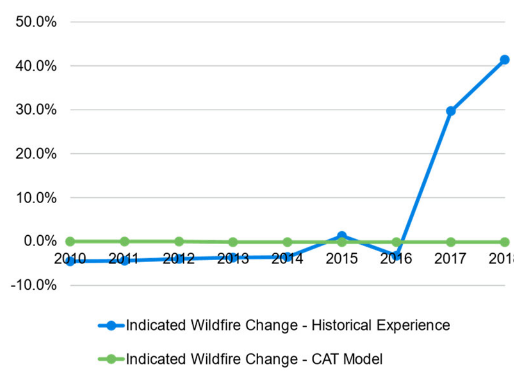
Our most stable scenario is based on a statewide portfolio of risks that grew in volume as new homes were built each year and grew in value as annual average coverage increased, but otherwise remained static. We modeled annual rate indications using nine successive 20-year experience periods ending 2010 through 2018, for both the historical experience method and the model method.

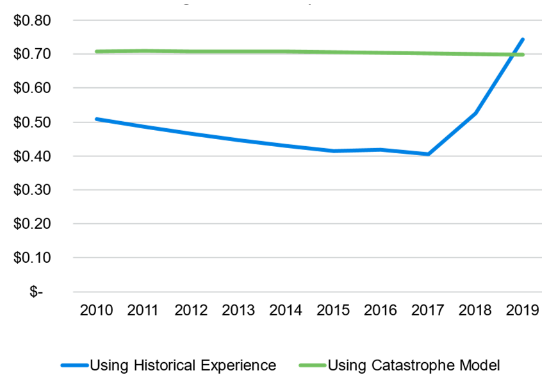
[3] According to CCR 2644.1 "Excessive or Inadequate Rates," no rate shall be approved or remain in effect that is above the maximum permitted earned premium, as defined in section 2644.2, or is below the minimum permitted earned premium, as defined in section 2644.3.

[4] The U.S. Fire Administration defines the wildland-urban interface as a zone of transition between unoccupied land and human development. It is the line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels. It is commonly known as the area that has most wildfire risk in the state, due to its combination of housing density and elevated risk.
What is the WUI? U.S. Fire Administration. https://www.usfa.fema.gov/wui/what-is-the-wui.html

Figure 1A shows the indicated wildfire rate changes by year using both methods of determining the catastrophe load. Figure 1B shows the average wildfire rates per $1,000 of total insured value (TIV) corresponding to the indicated changes. In each chart, historical indications are shown in blue and model indications are shown in green. The rates shown for any given year in Figure 1B correspond to one year after the indications in Figure 1A.

FIGURE 1A (L): WILDFIRE RATE INDICATION BY YEAR (STATEWIDE PORTFOLIO)
FIGURE 1B (R): AVERAGE WILDFIRE RATE PER $1,000 TIV (STATEWIDE PORTFOLIO)





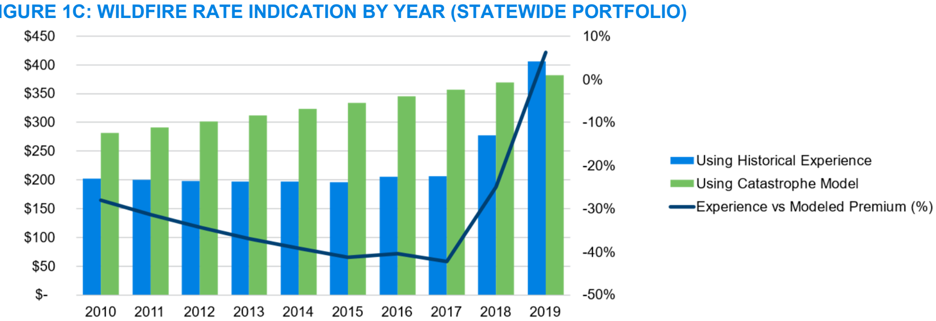
As shown in Figure 1A, under the historical method, the indicated rate changes for the years ending 2010-2014 and 2016 are negative, suggesting a decrease in wildfire rates. This is not due to any true reduction in the underlying risk, but rather that in these periods the incidence of extreme wildfire events was relatively low in the historical experience period. Then, once the severe events of 2017 and 2018 are included, the historical method indicates a +83% combined increase over the two years.

As shown in Figure 1B, the indicated wildfire rate per $1,000 of TIV using the historical method decreased from $0.51 in 2010 to $0.41 in 2016, only to then climb steeply to $0.74 in 2019. In comparison, the model indications are extremely consistent, with rates per $1,000 of TIV decreasing slightly from $0.71 to $0.70 over time.

Even in a portfolio that is large and fairly stable, indications based on historical experience create situations where indicated premiums are subject to drastic increases, leading to a misunderstanding of risk and inability for homeowners to plan their expenses.

Figure 1C shows how this translates into statewide average wildfire premiums.

FIGURE 1C: WILDFIRE RATE INDICATION BY YEAR (STATEWIDE PORTFOLIO)



Under this statewide scenario, if the modeled indication reflects the company's best estimate of wildfire risk, the wildfire premiums would be underpriced in 9 out of 10 years, with the difference averaging -25% to -42% of statewide wildfire premium or $79 to $151 per policy. The gap would be closed only after taking the 83% rate increase allowed under the CDI rate template once the 2017-18 years were included in the experience indication. This example also shows that the model indication is not always greater than the historical indication. In the latest year, the 2019 premium based on the historical indication actually overshoots the model indication by about +6%.

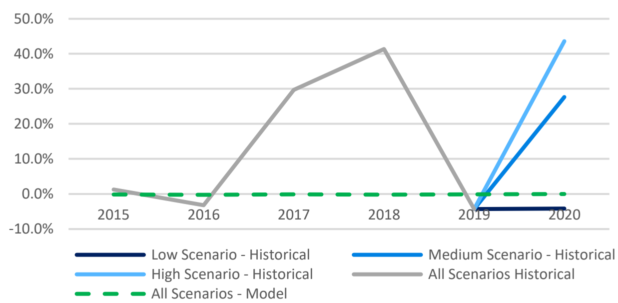
In a stable exposure situation, indications from a given catastrophe model would tend to be much smoother over time than indications based on historical data.

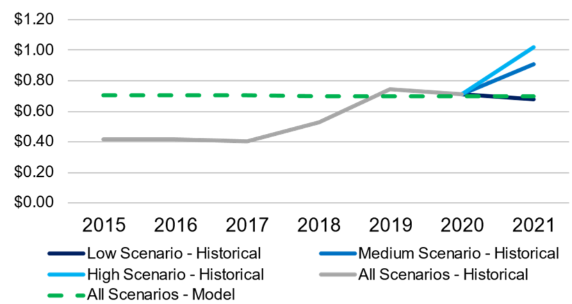
To further illustrate the volatility of the historical method, we created three hypothetical scenarios to extend the example for 2019 and 2020. In all three scenarios, we assumed no extreme wildfire events in 2019 and three different levels of losses associated with wildfire events in 2020, when over 4 million acres burned in California. Figures 2A and 2B show the resulting average wildfire indication and rate per $1,000 of TIV using the historical method from each scenario, as follows:

- Low Scenario (Dark blue): No losses from extreme wildfire events in 2020
- Medium Scenario (Medium blue): Wildfire losses from extreme events comparable to 2018
- High Scenario (Light blue): Wildfire losses from extreme events at 150% of 2018

The corresponding indications and rates from the model method are depicted as the dashed green lines.

FIGURE 2A (L): WILDFIRE RATE INDICATION BY YEAR (STATEWIDE PORTFOLIO)
FIGURE 2B (R): AVERAGE WILDFIRE RATE PER $1,000 TIV (STATEWIDE PORTFOLIO)



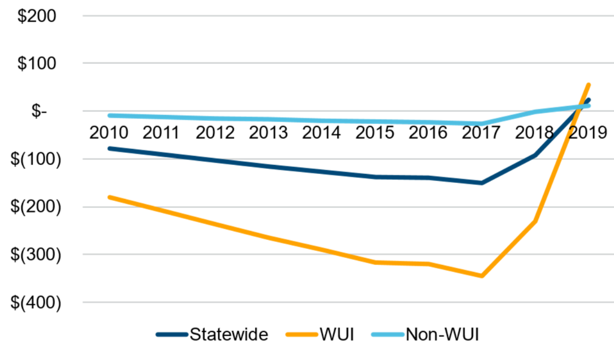


As before, the model method produces stable indications consistent with a view that there are no drastic exposure changes, resulting in wildfire rates of about $0.70 per $1,000 of TIV. In contrast, the 2020 wildfire rate indications from the historical method are materially impacted by the extreme events from the latest year. Under the Low Scenario the indicated rate drops by 4% to $0.68 even though there has been no decrease in risk. In the other scenarios, large wildfire events increase the historical average catastrophe load, indicating wildfire rate increases of +28% under the Medium Scenario to $0.91, and +44% to $1.02 under the High Scenario. In general, even under a very large and geographically diverse statewide portfolio where the risk does not change drastically from one year to the next, the historical indications are highly unstable and overly influenced by random events such as the location and timing of wildfires.

WUI vs. non-WUI Portfolios

Figure 3 below compares the difference in average indicated wildfire premiums produced by the two methods by dividing the statewide portfolio into two portfolios: the risks located in the WUI (which in 2019 represented 38% of properties and 46% of TIV), and the remaining risks located in non-WUI areas of the state.

FIGURE 3: DIFFERENCE IN AVERAGE INDICATED WILDFIRE PREMIUM: HISTORICAL EXPERIENCE MINUS MODEL (STATEWIDE PORTFOLIO, WUI, NON-WUI)



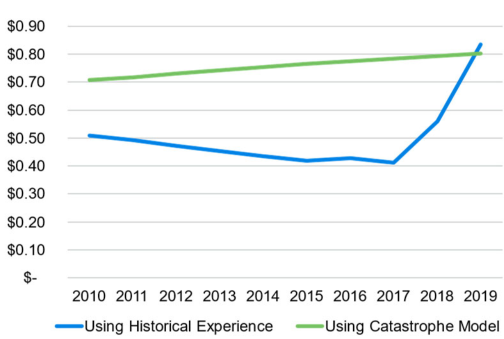
The trends of the Statewide, WUI and non-WUI indications are mostly similar, with historical indicated premiums falling below model indicated premiums for all years through 2018, only exceeding model indications in 2019 following two years of sharp premium increases. However, Figure 3 shows that the deficit is much larger in the WUI, with several years showing an average deficit per policy of over $300, versus deficits of up to $26 in the non-WUI.

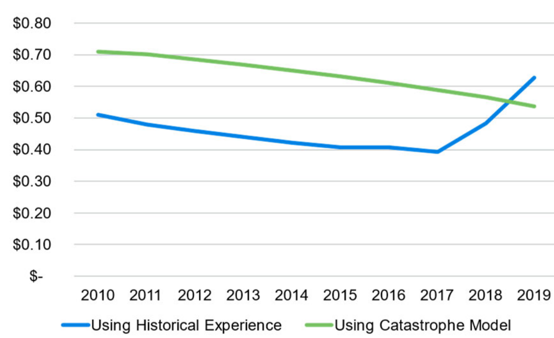
If insurers are unable to justify premiums under the historical formula that represent their estimated cost of risk transfer, or if the time and cost of taking large rate increases is deemed to be prohibitive, they may restrict exposure in the areas deemed to be most underpriced. These results are consistent with the much greater insurance availability problems that have been recently experienced by Californians in the WUI.

> Even if experience indications reach a price level that is comparable to the model indications on a statewide basis, insurers with concentrations in different areas can have drastically different outcomes and may still experience severe underpricing, leading to reduced availability. Although the percentage difference between the experience-based formula and model-based indications can be similar for high-risk and low-risk policies, the dollar difference is much larger for high-risk policies.

Aside from producing volatile results, the historical method is especially vulnerable to shifts in the overall risk of a portfolio. To demonstrate this point, we modeled two portfolios with changing risk profiles: one becoming more risky and one becoming less risky. Figures 4A and 4B show the average wildfire rate per $1,000 of TIV of a portfolio growing in the WUI and the portfolio shrinking in the WUI, respectively, using both the historical and model methods to calculate the catastrophe load.

FIGURE 4A (L): AVERAGE WILDFIRE RATE PER $1,000 TIV (PORTFOLIO GROWING IN WUI)
FIGURE 4B (R): AVERAGE WILDFIRE RATE PER $1,000 TIV (PORTFOLIO SHRINKING IN WUI)





In both scenarios, the green lines representing rate indications from the model method are trending in directions that one would expect: increasing average rates for the portfolio that is taking on more risk in the WUI, and decreasing average rates for the portfolio that is taking on less risk in the WUI. Conversely, the blue line representing average rates under the historical method does not differ significantly across the two scenarios, despite the drastic changes in risk. In both cases, the blue lines decrease in years prior to 2017 due to the lack of extreme wildfire events, and increase sharply in years subsequent to 2017. They bear no relationship to the material trends in the risk profiles of the portfolios being measured.

Thus, if an insurer were to actively add riskier policies to its portfolio, the wildfire rates following the CCR mandated method would not respond to the change in risk in the absence of catastrophic events, but only “catch up” after large losses flow through the experience underlying the historical formula. For insurers, there is an extremely strong disincentive to taking on new business in the WUI, because increasing their portfolio risk is not accompanied by a commensurate increase in the premium they are allowed to collect.

The historical experience-based formula has a bias towards producing negative wildfire rate indications for insurers who increase wildfire risk. The bigger the increase in risk, the more severely understated the indicated premiums will be, all else equal.

The experience-based formula gives insurers a disincentive to take on more risky properties, and an incentive and mechanism to drop high-risk policies in order to avoid requesting big rate increases.

Likewise, for an insurer actively lowering the risk of its portfolio, even if the historical data were to be adjusted by removing claims from the experience for areas where policies have been nonrenewed, such adjustment may or may not impact the indication if historical fires did not impact these areas.

For risk-mitigating techniques such as fuel reduction, it may not be feasible to adjust historical data, as the state of the fuel in areas where fires occurred, and the outcomes of the fires should the fuel levels have been lower, would generally not be known with any reasonable specificity. However, some wildfire catastrophe models (including the CoreLogic model) are able to reflect certain mitigation techniques such as home hardening and fuel reduction, allowing insurers to adjust their estimates of wildfire risk as the mitigation techniques are captured in their data. Further, the models will continue to evolve by incorporating more precise data and more advanced modeling to reflect the impact of mitigation actions in reducing wildfire risk. This evolution will allow for an immediate incorporation of an objective and accurate view of these impacts, promoting more affordable insurance sooner and better equipping insurers to write in areas with availability and affordability concerns.

Effective risk mitigation measures can have a significant impact on total wildfire premium need, but this will not show up for many years using historical experience. Using catastrophe models in ratemaking will allow for an immediate incorporation of an objective and accurate view of these impacts, promoting more affordable insurance sooner and better equipping insurers to write in areas with availability and affordability concerns.

CONCLUSIONS

The experience method currently required under the CDI rate template exposes both insurers and consumers to rate shock, as brutally evidenced by the availability and affordability crisis California has been experiencing. Catastrophe models introduce rate stability, the ability to plan ahead, and a better understanding of how wildfire risk is changing.

Ultimately, a major flaw of the historical method is that it is inherently retrospective, whereas the first principle of ratemaking is that it is a prospective estimate of the expected value of future costs.[5] The historical method does not respond to changes in the underlying risk, and is subject to the randomness of the timing, location, and severity of wildfires that occur. While the historical method relies solely on an insurer's past experience to calculate a catastrophe load for the future, catastrophe models can recognize changes in exposure, the environment, and mitigation.

Data

A market basket is a portfolio of hypothetical risks with a realistic distribution of characteristics used for insurance pricing and underwriting. The Milliman Market Basket used in this study is based on a random sample of single-family residential parcels, which represents approximately 10% of all California single-family residences or about 750,000 homes in 2020. The locations for each risk are the actual locations of real risks in the marketplace, as well as certain characteristics of those risks.

We utilized catastrophe model output obtained from the CoreLogic RQE® Wildland Fire model to simulate AALs and historical losses for the Milliman Market Basket risks over the study period. The modeled historical losses were based on 12 of the top 13 fires occurring from 1991 through 2018, representing 98% of structures burned.

Estimated average premiums were developed using NAIC's report on dwelling fire, homeowners owner-occupied, and homeowners tenant and condominium/cooperative unit owner's insurance.[6]

Catastrophe to non-catastrophe ratios were based on data from rate filings from the top 10 CA homeowners carriers.

The definitions of WUI in this study are from a U.S. Department of Agriculture research data archive.[7]

Limitations

Use of report

The data and exhibits in this report are provided to support the conclusions contained herein, limited to the scope of work specified by PIFC and APCIA, and may not be suitable for other purposes. Milliman is available to answer any questions regarding this report or any other aspect of our review.

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[5] Statement of Principles Regarding Property and Casualty Insurance Ratemaking. Casualty Actuarial Society (May 2021): https://www.casact.org/statement-principles-regarding-property-and-casualty-insurance-ratemaking

[6] Dwelling fire, homeowners owner-occupied, and homeowners tenant and condominium/cooperative unit owner's insurance: market distribution and average cost by policy form and amount of insurance. National Association of Insurance Commissioners.

[7] Forest Service Research Data Archive. https://doi.org/10.2737/RDS-2015-0012-2

Data reliances

In performing this analysis we relied upon information obtained from CoreLogic, the U.S. Census Bureau, rate filings, SNL, NAIC, USDA, and other sources. We have not audited or verified this data and information. If the underlying data or information is inaccurate or incomplete, the results of our analysis may likewise be inaccurate or incomplete. In that event, the results of our analysis may not be suitable for the intended purpose.

We performed a limited review of the data used directly in our analysis for reasonableness and consistency. We did not find material defects in the data. If there are material defects in the data, it is possible that they would be uncovered by a detailed, systematic review and comparison of the data to search for data values that are questionable or relationships that are materially inconsistent. Such a detailed review was beyond the scope of our assignment.

Model reliances

Our analysis is based on catastrophe models. We have reviewed the model output for reasonableness and consistency. However, no catastrophe model is entirely accurate. To the extent that the models used are biased, the resulting analysis may be biased.

Uncertainty

Our analysis was intended to be realistic enough for the purpose of illustrating how the CCR formula works in practice but does not reflect all factors and may not be indicative of actual experience, rate history or rate level for any given company. Different portfolios, catastrophe models, and assumptions would produce different results, and the differences could be material.

We based our results on generally accepted actuarial procedures and our professional judgment. Our results reflect assumptions that are built into the catastrophe models used, as well as assumptions such as those regarding expense. However, due to the uncertainty associated with the estimation of rates and future loss payments and the inherent limitations of the data, actual results will vary from our projections. Our indications are based on long-term averages and results for any single year may vary significantly from those implied by the indications.

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CONTACT

Nancy Watkins

Nancy.Watkins@milliman.com

Robert Lee

Robert.Lee@milliman.com