Axis Brokerage LLC

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Background

As associate actuaries at Axis Brokerage LLC, our goal for this project is to assist Montgomery Realty with optimizing their Commercial Property insurance program. With assets concentrated in Tampa, San Francisco, and Chicago, Montgomery is concerned with exposure to Named Windstorms (NWS), Earthquakes (EQ), and fire. Given the company's loss profile, our objective is to run a series of simulations to then stress test a selection of insurance options provided by our brokers. This will ensure Montgomery is provided with the insurance program that best aligns with their internal objectives while remaining cost-effective.

Severity Distributions and Fire Modeling

When looking to model Montgomery Realty's loss profile, we first focused on fire. To fit a severity curve to the fire loss data, we considered three potential distributions: gamma, lognormal, and Pareto. We then had to determine which distribution best fit our data by considering various fitting statistics. We compared the Kolmogorov-Smirnov (K-S) Test, Akaike Information Criterion (AIC), and Bayesian Information Criterion (BIC). We ultimately decided to use the K-S Test as it prioritizes the alignment of empirical and theoretical distributions, whereas AIC and BIC focus more on model complexity.

Applying the K-S Test to each distribution, we found that the lognormal distribution best represents Montgomery's annual aggregate fire losses. The lognormal distribution yielded a K-S statistic of 0.0558 and a p-value of 0.4432, indicating a good fit. In comparison, the gamma distribution produced a K-S statistic of 0.1545 and a p-value of 2.12e-05 , while the Pareto distribution resulted in a K-S statistic of 0.0616 and a p-value of 0.3228.

In addition to determining the optimal distribution for a severity curve, we were informed of a recent $150M fire loss that a competitor endured. In determining whether or not we should consider this data in our analysis we first have to ask if this competitor's loss represents a credible or likely scenario for Montgomery Realty. Now, taking a look at the previous losses of Montgomery Realty in the loss profile, we observe that the mean and median are significantly lower than $150M. This indicates the competitor's loss is considered an outlier. Including this outlier in the severity test could skew the results and reduce the accuracy of our analysis. While we initially decided we should not incorporate the data, the following Monte Carlo simulation led us to decide otherwise.

Monte Carlo Simulation and Fire Loss

In running a Monte Carlo Simulation, we calculated both central tendencies and variability. The annual aggregate mean loss is $11,062,480, while the median loss is slightly lower at $9,539,855, as depicted in Figure 1. This difference reflects the influence of rare, but severe losses that skew the distribution. In calculating the standard deviation, we have that annual aggregate losses can vary significantly, fluctuating from the mean by $6,986,206. Additionally, we found the coefficient of variation (CV) to be 63.1%, which highlights the moderate-to-high volatility and the variability of annual losses.

Key insights from our analysis suggest that while most years will see a loss of around $11M, loss during any year can fluctuate by about $7M. To address this volatility, Montgomery should secure an insurance policy with policy limits to cover potential losses at or above the 95th percentile ($23M) to avoid financial strain in high-loss years. Additionally, we recommend stress testing focuses on the 95th and 99th percentile to ensure Montgomery is prepared for extreme but rare events. Thus, we should include the competitor's $150M loss in consideration for stress testing. Following our recommendations, Montgomery is ensured to be well prepared in managing fire loss effectively.

Incorporating Catastrophe ("CAT") Modeling

When reviewing Montgomery Realty's loss profile, we noticed NWS and EQ events were rare and not adequately represented in the data. Due to the lack of data on these two losses, we must turn to the CAT model provided by our CAT modeling team. This model incorporates computer-assisted calculations, environmental conditions, and regional analysis to provide a more comprehensive assessment of Montgomery Realty's exposure to NWS and EQ events.

The simulated CAT risks are concentrated around realistic loss levels based on the provided assumptions, which helps reduce the occurrence of extreme outcomes. For instance, the NWS data from the CAT team indicates that the 99th percentile aggregate loss reaches approximately $8 million. However, historical data reveals large windstorm claims in years like 2024, 2020, and 2014.

This suggests that while the CAT team's data provides a valuable baseline for expected losses under typical assumptions, it may underestimate the potential for extreme losses. Therefore, it is essential to also incorporate these historical outliers into the risk calculations to provide a more comprehensive analysis.

Combined Monte Carlo Simulation

To analyze Montgomery Realty's total annual aggregate losses, we combined insights from the fire loss profile with the CAT models on NWS and EQ. Using a Monte Carlo simulation, we modeled all three loss types over 100,000 simulated years, assuming that all losses are mutually exclusive. The results revealed a mean total annual loss of $15,931,531 and a median total annual loss of $12,866,712.

These findings, along with the percentiles outlined in Figure 2, allow us to compare each loss type. While EQ events are infrequent, their losses tend to be much more extreme when compared with fire and NWS. For NWS, the annual loss percentiles are lower than that of fire. This is not because NWS losses are smaller per occurrence, but instead because they occur less frequently. In contrast, fire claims are more frequent resulting in higher aggregate losses despite being smaller losses per occurrence.

Now, observing Figure 3, the loss distribution is right-skewed, with most simulated years experiencing relatively low total losses, but a few extreme years showing very high losses. Stress testing should focus on the tail of this distribution, ensuring that the extreme years are adequately considered to prepare clients for rare but significant events.

Appendix

Figure 1

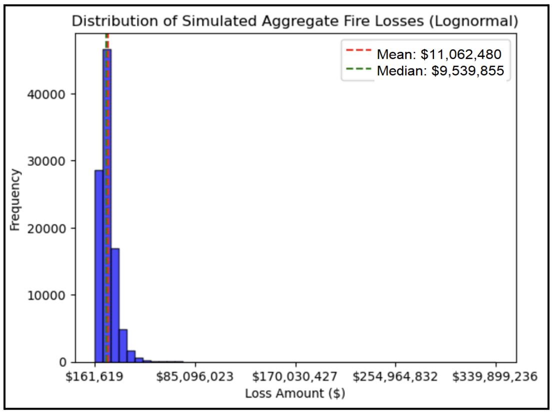

Figure 2

Percentile	Fire_Claims	EQ_Claims	NWS_Claims
25%	6529297	0	392469.0
50%	9539855	0	786476.6
75%	13724395	2927033	1473269.1
90%	19010306	10353974	2558629.8
95%	23436596	17567183	3629923.0
99%	35362962	44158114	7522784.6

Figure 3