2019-20 Scenario

Zimberries Crop Insurance
Student Workbook

A program of The Actuarial Foundation

Modeling The Future Challenge

Introduction

For years the country of Zimlandia has kept a very well-hidden secret – the production of a tasty, nutritious berry known as the Zimberry. Zimlandia managed a government insurance program from 1989 to 2018 in which the government offered insurance policies to their Zimberry farmers. Zimlandia includes three counties: Fanta, Jacks, and Rueda. The government has tracked information about their insurance policies from each county.

The government of Zimlandia is becoming increasingly concerned with how climate change factors – particularly increasing temperatures – could affect the future of their Zimberry industry. Because of this Zimlandia has decided to open the opportunity for other companies to provide their own insurance policies to help protect the Zimberry industry from severe losses.

Zimsurance, a new insurance company, is exploring creating Zimberry policies. They have hired you as a consulting actuary to help them analyze the Zimlandia data and make some recommendations about how they could potentially create their own insurance policies to protect Zimberry farmers.

Review the information on the following pages and the data in the attached spreadsheets, then answer the questions as best as you can to qualify for competing in the main Modeling the Future Challenge.

Relation to MTFC Project Phase:

While Zimlandia is a fictional name, and Zimberries are not a real berry, the data in this scenario is real. It is taken from the USDA's Risk Management Agency, and although the county names have been changed, they are real counties. This USDA database is one of the primary resources that teams will use in the Project Phase of the MTF Challenge, so the scenario could provide ideas to help with your own project should you qualify for the main MTF Challenge.

Background Concepts

In this scenario you will see insurance and risk analysis concepts that may be new. Before answering the questions it may be helpful to review these concepts:

- **Expected loss:** is the value of a loss multiplied by the probability of that loss happening. This would be the expected value one would see if the chance of the outcomes happened many times.
- **Indemnity:** an amount the insurance company is required to pay based on the terms of an insurance policy. Also known as the loss on the policy for the insurance company.
- **Liability**: the total amount that the insurance company may have to pay if 100% (or is liable for) of an insurance policy was required to be paid out.
- **Loss Cost or Loss Payment:** The amount of money (per exposure) to cover the cost of loss and settlement.
- **Loss Ratio:** the amount of the expected payout on a claim divided by the premium for the policy. A loss ratio of 1 means the premiums taken in are equal to the loss paid out.
- **Premium**: the amount the policy holder is charged to purchase an insurance policy, typically on a monthly, or annual basis.
- **Pure Premium:** the amount needed to pay the expected losses on an insurance policy.
- **Required Premium:** the amount needed to cover an insurance company's losses plus some profit margin and expected expenses.

About the Data

Your research team at Zimsurance has provided you with a spreadsheet including three tabs of information. The first tab includes data from Zimlandia's Federal Insurance Program about the insurance claims due to losses from "Heat" that were paid to Zimberry farmers in the three county of Fanta, Jacks, and Rueda, between 1989 and 2018. Data on this first tab includes information from claims that had a loss from "heat" ONLY and is organized by month. The second tab includes annual summaries of ALL the Zimberry insurance policies from 1989 to 2018. The third tab includes data on monthly maximum temperature values across the three Zimlandia counties.

Policies with Loss from Heat Spreadsheet Information:

- This sheet provides data for policies that had a claim due to loss from "heat" ONLY. It DOES NOT include the policies that had no claim (indemnity), or policies with loss from other reasons. This data is arranged by month rather than annual summaries.
- Zimlandia tracked claims by month; however, some months will have no claims, and others will have multiple claims. Be careful to note that not every row corresponds to a new month, or to single claims.
- Zimlandia tracks the "**Cause of Loss**" for each of their claims. There are many causes of loss they tracked; however, in Zimlandia the largest cause of loss is due to "heat" so your research team has only included this information in your spreadsheet.
- The "**Policies Indemnified**" is the number of claims that are included in the values for each row.
- The "**Acres Planted**" is the # of acres covered in the policies included in each row.
- The "**Liability**" is the total dollar amount that Zimlandia would have paid if there was a complete, 100% loss on the policy. This is the total the Zimlandia was liable for in each policy or the total value of the insurance policy. In the Indemnified Policies sheet, the Liability is just for the Indemnified Policies, which is different from total liabilities of all policies.
- The "**Premium**" is the annual cost of the insurance policy.
- The "**Indemnity Amount**" is the total dollar value of each loss (or group of losses).
- The "**Loss Ratio**" is the amount of indemnity divided by the amount of premium.

About the Data

All Policies Annual Summary Data Information:

- This spreadsheet provides annual summaries of ALL the Zimlandia insurance policies between 1989 and 2018.
- Annual summaries may be different from the annual sum of monthly information in the previous spreadsheet because some policies may have more than one claim per year, not all causes of loss were accounted for in the first spreadsheet, and there may be other discrepancies.
- The "**Policies Sold**" indicates the total number of policies for that year including those with and without a loss.
- The "**Policies Indemnified**" indicates the number of policies that had a loss that year due to any cause of loss.
- The "**Acres**" is the total number of acres covered in the policies sold for the year.
- The "**Liabilities**" is the annual summary of the value of the policies (potential loss for the FCIC to pay out if a 100% loss).
- The "**Premium**" is the total premium paid for insurance policies during the year. In this tab the premium includes that paid for policies with and without a loss.
- The "**Indemnity"** is the total loss from the policies during the year.
- The "**Loss Ratio"** is the total loss for the year divided by the total premium for the year.

Max Temp Monthly Information:

- The Zimlandia tracks values in many types of climate factors from weather stations across the globe. This spreadsheet includes the maximum recorded temperature in each Zimlandia county each month.
- The "**Value**" column records the maximum temperature in Acme county in degrees Fahrenheit.
- The "**Anomaly**" column records the offset from the 1901-2000 mean.

Level 1 Questions: Basic Statistics & Probability

The CEO of Zimsurance, has asked you to gather basic information about the government crop insurance policies for Zimberries so that they can understand the overall liabilities, indemnities, and premiums and better predict how Zimsurance's new insurance policies might help the Zimberry industry. Complete these questions using the data attached in the spreadsheets.

1. For each of the three Zimlandia counties (Fanta, Jacks, and Rueda), what are the average annual losses (indemnity) from all policies sold?

2. What is the average annual loss per policy sold for each county?

3. What is the average annual loss per acre of all policies sold for each county?

4. Which value, average annual "Loss", "Loss per Policy Sold", or "Loss per Acre", can give Zimsurance the best understanding of the potential to insure other Zimberry farms? Explain why.

5. Create a histogram of the percentage of policies indemnified each year (the percentage of the policies sold that had a loss) for Fanta County. Describe the shape of the histogram and explain logically why you think it is this shape.

6. Which of the three Zimlandia counties has the most robust data? In other words, which county's data is the most credible in creating high-confidence projections? Explain why.

7. Which month has the highest average monthly loss due to heat for Zimberries? Explain why you think this is.

Level 2 Questions: Trends and Relationships

8. Which two Zimlandia counties are the most closely correlated in terms of the percent of acres indemnified due to heat (acres of policies indemnified due to heat / acres of all policies sold) each year?

9. Explain what these correlations mean. Why would two counties have a strong correlation when others have a poor correlation?

10. Graph the annual loss (indemnity) per acre sold for all three counties. Can you identify any outliers in the data? For which year and which county would you consider the data an outlier?

Level 2 Questions: Trends and Relationships

11. In question #4, you determined there was a difference in the usefulness of information being provided in analyzing the annual overall loss, loss per policy, and loss per acre sold. What difference in the usefulness of information do you see in analyzing the annual loss per liability ratio? What does the annual loss per liability tell you that the other ratios do not?

The research team at Zimsurance has also provided you with data about the monthly maximum temperatures in Zimlandia – found on the Max Temp tab of your data spreadsheet. The values include the maximum temperature in degrees Fahrenheit and the "anomaly" from the 1901-2000 mean for Acme county.

12. Between 1989 and 2018, what is the likelihood of having a positive monthly max temperature anomaly for all three counties of Zimlandia?

13. Using the monthly Max Temperature anomalies and monthly indemnity values for losses due to heat, what is the likelihood of having an indemnity due to heat if the anomaly is less than or equal to 0? What is the likelihood if the anomaly is positive?

14. Use these percentages to calculate the overall likelihood of having a loss in any given month across all of Zimlandia. What is it?

15. How could this information help Zimsurance better predict or plan for future indemnities on Zimberries due to heat?

Level 3 Questions: Risks and Insurance

16. If the likelihood of having a positive max temperature anomaly increased by 0.1 above what you calculated previously, what would happen to the likelihood of having a monthly loss? Calculate the new value.

17. To help measure the size or severity of a loss on crops, we can measure the indemnity per acre of policies that had a loss. In 2018, what was the indemnity per acre of the policies that had a loss (just those policies indemnified) from Heat only for all Zimlandia?

18. Expected value is a way to calculate how much, over time one would expect to pay. It is the value of the payment times the likelihood of it happening. In 2020 the Zimsurance plans to insure 110,000 acres of Zimberries. What is the difference in the expected value of the indemnity due to heat if the likelihood of a positive Max Temperature Anomaly remained what it has been between 1989-2018 value, versus if the likelihood increased by 0.1 as you noted above?

19. In Rueda county only, what is the premium per acre off all policies sold (not just indemnified) in 2018? What is the premium per acre of just indemnified policies? Is there a difference? Explain why this might be.

Level 3 Questions: Risks and Insurance

Loss Ratio is defined as the amount of loss divided by the amount of the premium received. If you have a loss ratio of 1 you are breaking even on how much you pay out in losses compared to how much you take in from the policy premium.

20. In the data provided, there are two Loss Ratio columns, in the Policies with Loss by Heat and in the All Policies Annual Summary sheet. Explain the difference between these two columns.

21. Comparing Fanta, Jacks, and Rueda counties, which county was most likely to lose money each year on their insurance policies (have a loss ratio >1) considering all policies sold?

22. Insurance companies, like all companies, have other expenses to be paid in order to maintain a healthy business. Explain how Zimsurance might price the premium for their new crop insurance policies to make sure they can cover these other operating expenses. What data can Zimsurance use to help ensure they have covered not only their expected losses but their expected expenses as well?

Level 4 Questions:
Critical thinking recommendations

23. Zimsurance CEO is considering providing insurance policies to Zimberry farmers, but only wants to provide policies in 1 county. Which county would you start your insurance in to have the best possible return and why?

24. If Zimsurance sold insurance policies in Fanta county, which county would you recommend they expand to next in order to minimize their risk of having very large losses in any one year?

25. Besides what is provided in the spreadsheets, what other information would be helpful in projecting future crop losses and analyzing the potential for Zimsurance to structure their new insurance policies?

26. If you were representing the government of Zimlandia county and were faced with the knowledge that the likelihood of having a positive temperature anomaly were going to increase to 80% by 2030 what recommendations, incentives, or new policies could you make to help the Zimberry farmers?

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