2019-20 Scenario

Federal Crop Insurance Corporation

STUDENT WORKBOOK

A program of The Actuarial Foundation

Modeling The Future Challenge

Introduction

The Federal Crop Insurance Corporation (FCIC) helps the American agricultural industry by providing insurance policies to farmers across the country. These policies protect farmers against severe crop losses due to flood, drought, pests, disease, severe storms and other factors that could cause a loss to the value of the farm.

The FCIC is a national program providing insurance policies to farmers across the country. In this scenario we examine information from the FCIC in Acme County. The data used in this scenario is real, from the online data made available by the USDA's Risk Management Agency, however the name of the county has been changed.

Farmers across the country can choose insurance policies from the FCIC; however, this is not the only option they have for crop insurance. Private insurance company also provide their own insurance policies to help protect farmers.

In this scenario, you have been hired by the Omega Insurance Company to examine FCIC policies from Acme county to help the CEO determine how they could invest in creating their own insurance policies for farmers in Acme county.

We know some basic information about the FCIC policies that has been provided in the attached spreadsheet. Additionally, we know that there are just two major crops in Acme county, almonds and grapes. Almonds take 12,984 m^3 of water per ton of almonds to produce, while grapes take 511 m^3/ton to produce.

Acme county is a large county with many farms. The number of acres of grapes and almonds farmed has been changing over the years. The following information includes how many acres of each have been farmed during Acme census years:

- In 2003 there were 89,000 acres of almonds and 220,000 acres of grapes planted.
- In 2008 there were 103,000 acres of almonds and 204,000 acres of grapes planted.
- In 2013 there were 132,000 acres of almonds and 206,000 acres of grapes planted.
- In 2018 there were 185,000 acres of almonds and 198,000 acres of grapes planted.

Use this information and the data in the attached spreadsheet to answer the questions and help Omega Insurance Co's CEO decide how to move forward.

Relation to MTFC Project Phase:

Though the county names have been changed the data in this scenario is real. It is taken from the USDA's Risk Management Agency. 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.
- **Subsidy:** a portion of the premium that is paid for by someone else, in this scenario the subsidy is paid for by the federal government itself.

About the Data

Your research team at Omega Insurance has provided you with a spreadsheet including three tabs of information. The first tab includes data from the Federal Crop Insurance Company (FCIC) about the insurance claims paid to grape and almond farmers in Acme county between 1991 and 2018. Data on this tab includes information from claims that had a loss ONLY and is organized by month. The second tab includes annual summaries of ALL the crop insurance policies from the FCIC in Acme county from 1991 to 2018. The third tab includes data on monthly maximum temperature values in Acme county tracked by the National Oceanic and Atmospheric Administration (NOAA).

Indemnified Policies Spreadsheet Information:

- The "Indemnified Policies" spreadsheet provides data for policies that had a claim ONLY. It DOES NOT include the policies that had no claim (indemnity). This data is arranged by month rather than annual summaries.
- The FCIC 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.
- The FCIC tracks the "**Cause of Loss**" for each of their claims. 12 causes of loss are noted for claims in Acme county: (1) Cold wet weather, (2) Cold winter, (3) Excess Moisture, (4) Failure of irrigation equipment, (5) Failure of irrigation supply, (6) Flood, (7) Freeze, (8) Frost, (9) Hail, (10) Heat, (11) Insects, and (12) Wind.
- 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 the FCIC would have paid if there was a complete, 100% loss on the policy. This is the total the FCIC 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 "**Subsidy**" is how much of the premium someone other than the policy holder paid for to make the insurance cheaper to the farmer.
- 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 FCIC crop insurance policies for almonds and grapes in Acme county between 1991 and 2018.
- Annual summaries may be slightly different from the annual sum of monthly information in the previous spreadsheet because some policies may have more than one claim per year, and there may be other discrepancies.
- The "**Policies Sold**" indicates the total number of policies for either almonds or grapes for that year.
- The "**Policies Indemnified**" indicates the number of policies that had a loss that year.
- 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 the insurance policies during the year.
- The "**Subsidy"** is the amount of the premium paid for by someone other than the farmers.
- 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 National Ocean and Atmospheric Administration (NOAA) tracks values in many types of climate factors from weather stations across the globe. This spreadsheet includes the maximum recorded temperature in Acme county weather stations 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 at Omega Insurance has asked you to gather some basic information about the FCIC policies in Acme County to help them understand the overall indemnities and liabilities of policies they might provide in the future. Complete these questions using the attached data provided from the FCIC.

1. Determine the loss (indemnity) per policy sold for almonds and for grapes in 2018?

2. Which crop had the higher annual loss per acre of all the policies sold in 2018?

3. Which value, Loss per Policy Sold, or Loss per Acre, can give Omega Insurance a better understanding of the overall value of providing insurance policies to farmers in Acme County? Explain why.

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

Level 1 Questions:
Basic Statistics & Probability

5. Determine which month has the highest average agricultural loss in Acme county? Explain why you think this is the case.

6. Determine which cause of loss for agricultural claims was the largest in Acme county from 1991 to 2018?

7. What was the likelihood that the FCIC had a total annual loss of greater than $10,000,000 in Acme county? In which years were those losses?

8. What are some reasons that the FCIC high-loss years are concentrated in this most recent decade? Provide one or more reasons that the loss increased in these years.

Level 2 Questions: Trends and Relationships

The CEO of Omega Insurance wants to know why the total losses for the FCIC are increasing over the years. To determine this, rather than just analyzing the total indemnity from the FCIC policies, the CEO has asked you to calculate and analyze some other values that will assist them in making their decisions.

9. Graph the total indemnity per year from 1991 to 2018. Create a linear regression trendline for almonds and for grapes.

10. What percent of the total liability between 1991-2018 occurred in the last 5 years (2014-2018). What are some benefits or negative aspects of using just the past 5 years of data to project potential indemnities in the future 2019.

11. In question #3, you determined there was a difference in the usefulness of information being provided in analyzing the annual loss per policy versus loss per acre. 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?

Level 2 Questions: Trends and Relationships

12. Graph the annual loss (indemnity) to liability ratios for grapes and almonds from 1991 to 2018 (for all policies). Compare the variability in these ratios for the first 10 years (1991 to 2000) with the last ten years (2009-2018)? Is there a difference in variability (identified by the Standard Deviation) in the ratios between the first 10 years and last 10 years for either grapes or almonds? Using the data provided explain why it might be the case that some of the data has a higher variability than others.

Level 2 Questions: Trends and Relationships

The research team at Omega Insurance has also provided you with data about the monthly maximum temperatures in Acme county – 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.

13. Between 1991 and 2018, what is the likelihood of having a positive monthly max temperature anomaly?

14. Create a scatterplot of the relationship between the max temperature anomaly and the loss to liability ratio just for the losses due to "Heat". Is there a strong correlation between these values? Should a linear regression be used on this data to predict future values? Explain why or why not.

15. Using the monthly Max Temperature anomalies and indemnity values for losses due to heat, what is the likelihood of having an indemnity due to heat on grape crops if the anomaly is less than or equal to 0? What is the likelihood if the anomaly is positive? Use this information to calculate the overall likelihood of having a monthly loss due to heat for grapes?

16. How could this information help Omega Insurance better predict or plan for future indemnities due to heat?

Level 3 Questions: Risk and Insurance

17. If the likelihood of having a positive max temperature anomaly increased by 0.05 above what you calculated previously, what would happen to the likelihood of having a monthly loss due to heat for grapes?

18. 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) for losses due to heat only?

19. 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 FCIC expects to insure 110,000 acres of grapes. 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 1991-2018, versus if the likelihood increased by 0.05 as you noted above?

20. What are the premiums per acre for grapes and for almonds for all policies (not just indemnified) in 2018? Is the premium per acre different for all policies versus just the policies that are indemnified? Explain why this might be.

Level 3 Questions: Risk and Insurance

The 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.

21. In the data provided, there are two Loss Ratio columns, one in the Indemnified Policies by Month sheet and one in the All Policies Annual Summary sheet. Explain the difference between these two columns.

22. Using the loss ratio for all policies, not just the indemnified ones, how likely was it between 1991 and 2018 that for the grape farmer policies the FCIC lost more money to indemnity than it brought in from the premiums?

23. Insurance companies, like all companies, have other expenses to be paid in order to maintain a healthy business. Explain how Omega Insurance might price the premium for their new crop insurance policies to make sure they can cover these other operating expenses.

Level 4 Questions: Critical thinking recommendations

24. The Omega Insurance Co. CEO is considering providing crop insurance policies to farmers in Acme county, but only wants to insure one type of crop to start. The CEO also wants to minimize the risk for the company on how much they might have to pay due to loss from the policies. Which crop would you recommend Omega pursue, insurance policies for Almond farmers, or insurance policies for grape farmers? Explain why.

A significant subsidy is provided to many of the farmers. A subsidy is a portion of the premium that is covered by someone other than the policy holder.

25. Who do you think is subsidizing the premiums for crop insurance and why?

26. Taking the subsidy into account, how many years did the FCIC lose more from indemnities on grape farms than it took in from the portion of the premiums that were not covered by a subsidy?

Level 4 Questions:
Critical thinking recommendations

27. Besides what is provided in the spreadsheets, what other information would be helpful in projecting future crop losses and analyzing the potential for Omega Insurance to provide crop insurance policies in Acme county in the future?

28. If you were representing the government of Acme county and were faced with the knowledge that the likelihood of having a positive temperature anomaly were going to increase to 75% by 2030 what recommendations, incentives, or new policies could you make to help the farming community in your county?

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