The Impact of Crop Insurance on the Outcome of Corn Production in the state of Iowa from 2019 to 2024

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Abstract:

The essay investigates whether crop insurance has a role in the financial and outcome risks for corn production in Iowa. Using data from the U.S. Department of Agriculture Risk Management Agency (RMA) for each county from 2019 to 2024. Counties from each year are divided into two sets of groups: high liability groups and low liability groups, to compare their average loss ratios. The outcome of the analysis shows that high liability groups experienced a higher loss ratio in the years 2019, 2020, and 2023. 2022 is the only year out of the 6 years where high liability has a lower loss ratio; meanwhile, there are no major differences between years 2021 and 2024. These results show that crop insurance does not have a consistent contribution to the outcome due to other factors, such as the weather conditions and land management. The essay supports this idea by using the results posted by the State, along with literature that introduces factors like environmental impacts, policy, and moral hazards.

Keywords: Crop insurance. Liability. Loss ratio. Corn production.

1. Introduction

There are many risks associated with agricultural production in the United States. Extreme weather, pests, and sudden changes in markets all play a role. The Federal Crop Insurance Program was developed by the federal government to support farmers. The leading state of corn production is Iowa, according to the U.S. Department of Agriculture. (USDA NASS, 2024) [1]. Iowa was chosen for the data analysis since they have consistent data for both insured and non-insured groups, meanwhile being the number one state for corn production. This literature review highlights the advantages and disadvantages of crop insurance. In Smith, V. H., and Goodwin, B. K.'s article, they mentioned the term moral hazard, which suggests that farmers who are covered by insurance might make decisions that will put them at a higher risk [2]. In the article by Wu, how people use their land is also affected by crop insurance [3]. In the newer article by Lu et al., the idea of nutrient runoff reduced by crop insurance was introduced, which can be beneficial to the environment [4]. Lastly, Zulauf et al. noted that the design of the project has a huge impact on the results, such as loss ratios. These studies prove that financial protection is not the only thing

that shapes farmers' behavior [5]. In this essay, the purpose is to investigate and find out whether crop insurance has a direct correlation to the loss ratio and liability between the years 2019 and 2024. The USDA RM summary of business data was used for this analysis. High liability and low liability groups were separated from each county into two individual groups; an independent samples t-test was conducted to compare the average loss ratio for each group from every year. The analysis shows how much crop insurance plays a role in corn production in Iowa. This study shows evidence on how crop insurance is related to corn production, along with other factors such as land management and moral hazard.

2. Literature Review: The Topic of Crop Insurance and the Program behind

Farm households have a higher possibility of facing income risks, which is due to changes in weather, unpredictable events that can significantly impact agricultural production across the seasons. To reduce this risk, the Federal Crop Insurance Program (FCIP) was created, which allows farmers to pay an annual fee in order to be financially covered should they experience a loss, according to Glauber [6]. The FCIP can cover almost all the major crops and every state in America since the 90s, with a goal to build a stable income for farms. So, if the revenue from production drops below a specific level, insurance will cover the financial loss of the producer stated by the Congressional Research Service [7]. With this policy, farmers can support their families better, plan their purchases ahead, and receive loans if needed. With this program, individuals will have the opportunity to pursue things such as education or jobs outside the farm. The FCIP is under the federal government support, farmers pay a premium for their insurance, the fee is partially subsidized by the Government, meaning the individual only has to pay part of the total cost. The Standard Reinsurance Agreement combines its shared risk with private insurers [8]. This policy is widely adopted by farmers because it reduces their costs. Over the years, government spending on the program kept on increasing, which led to suggestions such as lowering payments made to insurance companies alongside cutting administration fees, making the program more financially sustainable over a long period, according to the Congressional Research Service and GAO [7, 8]. Even with the rising problem, the FCIP still plays a major role in supporting farmers in the U.S. A key topic is how crop insurance influences farmers' behavior. Two main problems are moral hazard and adverse selection in the writing of Smith, V. H., and Goodwin, B. K. [2]. Moral hazard is when the insured individual changes the

way they operate, for example, changes their input when it comes to production, because they are financially covered. Adverse selection occurs when somebody who tends to take higher risks when it comes to farming is more likely to purchase insurance. Empirical studies suggest that insured farmers often have a different management of inputs for their production compared to uninsured farmers. For example, Smith, V. H., and Goodwin, B. K. mentioned that farmers might reduce their input after being insured to cut their costs, since they are being covered [2]. Wu found that when farmers are insured, they might choose to increase the number of crops they plant because they feel more reinsured with financial protection [3]. Both articles support the idea that crop insurance can indirectly affect the decision-making of the producer. Insurance affects farmers differently. When it comes to larger farms, they usually benefit more because they are financially able to insure a larger area, alongside higher liabilities, and receive more money from subsidies. Small farms, on the other hand, cannot do the same and collect as much; therefore, they rely on insurance for stable production [9]. This leads to an uneven distribution as it ties the size of the farm to the benefits. Their study shows that there is more to crop insurance than just protection against losses. In recent studies, crop insurance has a direct relationship with the weather conditions. Schlenker and Roberts highlighted that heavy rainfall and extreme heat will greatly increase the rate of yield loss, making insurance an almost necessary practice for farmers who are operating under these conditions [10]. Through their studies, they found that corn and soybeans will have an increased rate of production with a higher temperature, all the way until 29°C (84.2 °F) before they start declining. Similar to cotton, cotton has a slightly higher heat resistance and can last until 32°C (89.6 °F). With the climate being projected to become warmer in the future, their results suggest that the plants will be more exposed to high heat [10]. Making crop insurance essential in a lot of areas like Iowa, where corn is one of the main agricultural products, insurance helps stabilize the income while providing sustainable production for the long term.

3. Method

This study is to show whether crop insurance has a relationship with the liability rate and loss ratio. The study examines whether counties with insurance have a different loss ratio compared to those that are not insured. For this analysis, the corn production of Iowa from the year 2019 to 2024 is taken from the USDA EMA summary of business dataset. Iowa was chosen because, according to the United States Department of Agriculture National Agricultural Statistics Service, Iowa was the leading producer of corn in the year 2024, along with a few other products

such as animal products. It is also the first in Principal Crops Harvested Acreage [1]. For the analysis, three variables were used: liability, loss ratio, and groups with high and low liability. The raw data set from each year contains variables like quantity, policy earnings, and policies sold. Since loss ratio and liability are the only values needed, a new sheet was created for each year, and those values were extracted along with the high liability and low liability groups. Counties without any data were removed to increase the accuracy of the results. On the new data sheet counties for each year, separate the counties into two groups: one being the counties that are more insured and the other being the counties that are less insured. This allows me to compare the loss ratio between the groups. Finally, a t-test was conducted using the built-in data analysis tool in Excel, with the data from each of the six years analyzed individually.

4. Data

For the statistical test conducted, the goal is to see if the counties that are more insured will have a different loss ratio compared to the counties that are less insured from the year 2019 to 2024. For each year, an independent samples t-test was used to compare the mean loss ratio by splitting the data for each year into two groups. It is worth mentioning that both groups have similar numbers of counties, which allows the result to be fairer. For the results, the pattern is not the same for every year. For 2019, the test showed a huge difference in the value, with the high liability mean of 1.25, a low liability mean of 0.61, meaning that the counties with high liability experienced a higher loss ratio than the low liability counties. $t(95)=3.59$, $p <0.01$. In 2020, the results showed that the high liability group had a mean loss ratio of 2.236, the low liability group had a loss ratio of 0.495, with the lower group having a better performance again, $t(58)=3.49$, $p<0.01$. As for the year 2021, the group with higher liability had a mean loss ratio of 0.107; meanwhile, the lower liability group had 0.163. However, the p-value is 0.172, which is higher than the significance level, making the result not statistically significant enough to show clear evidence. In 2022, the group with high liability's mean loss ratio was 0.131, and 0.317 was the mean loss ratio for the low liability group. $t(92)=-2.98$, $p<0.01$. The test results for 2023 showed that the low liability group had a 0.485 mean loss ratio. The high liability group had a value of 1.380, $t(73)=5.35$, $p<0.01$; the higher liability group experienced a higher loss ratio than the low liability group. Lastly, for 2024, similar to 2021, the p-value was 0.470, which is higher than 0.05, making the result not significant, meaning that there's no solid evidence about the difference between the two groups. The test showed that in most years, the higher liability group had higher loss ratios overall, with years 2021 and 2024 not significant enough to show a difference. The only year where the pattern changed was in 2022, with a worse performance from the low liability group. These outcomes showed that there isn't a strong relationship between crop insurance and loss ratio.

5. Findings From the Analysis

Findings from Iowa data are in line with some of the recent studies, which show that crop insurance could impact the level of production. Here are some recent case studies to support this. In the peer-reviewed article by Lu et al., the authors mentioned two crucial elements, nitrogen and phosphorus [4]. These two elements are harmful to the environment but nutrients to the plants. Insured groups have better land management and are more financially stable compared to the uninsured ones. With insurance, farmers can grow more highly valued plants such as corn, making sure the reduction of nutrients run off. While having insurance doesn't mean that they are guaranteed a high income, it does help with the farmers' decision-making, knowing that they will be covered, and allows them to expand or plant differently. One example is how farmers can apply fertilizer with more efficiency, making sure that the rate of nutrient runoff is reduced [4]. Lu et al. also mentioned that counties that are covered by crop insurance show a lower level of nitrogen runoff [4]. Based on the article, it is safe to assume that in the state of Iowa year 2022, the insured groups had better management and decision-making. In 2019, 2020, and 2023, the insured groups experienced a higher loss ratio; this might have been due to the fact that they were trying out a new method with high risk. In the article written by Zulauf et al. from the Department of Agricultural, Environmental, and Development Economics, Ohio State University, they compared four different units: Enterprise units, Whole Farm units, optional units, and basic units [5]. The goal of this study, like the analysis this paper conducted, is to see if there is a correlation between insurance and loss ratio. Their studies showed that units such as Whole farm or enterprise units have a lower loss ratio. This is because they tend to have a larger area with a variety of crops, meaning it is unlikely for everything to fail altogether. Units that are smaller, like basics, have a higher loss ratio. The results showed that the outcome isn't strictly impacted by insurance, but also by the design and policy of farms [5]. Bring this theory to the findings for Iowa, the loss ratio and liability are not always consistent over the years. High liability groups often performed worse; this could be the fact that they did not have the best design when it comes to spacing and growing the corn out, also the choice of the different crops they have coverage on, or the type of insurance they bought. The article by Zulauf et al. reinforces the idea that the design of the project and the area in use also play

a significant role when it comes to the result, not just the insurance itself [5].

6. Results

This study investigates the effect of crop insurance on the outcomes for the state of Iowa's corn production from 2019 to 2024. Using data from the USDA RMA summary of business. Two groups were formed from each county, with one being a high liability group and the other being a low liability group. Their mean loss ratio was calculated by an independent samples t-test and compared. The results varied, with a higher loss ratio from the high liability group, who were insured in 2019, 2020, and 2023, indicating they had a lower financial income. However, in the year 2020, the insured group had a lower loss ratio. Meanwhile, in 2021 and 2024, the two groups did not show a significant difference, making it hard to draw a conclusion. The findings showed that crop insurance does not always shape the outcome of production. These results support both articles by Smith, V. H., and Goodwin, B. K., and Wu, suggesting that crop insurance may influence land management and the moral hazard producer faces [2,3]. The study from Lu et al. found that crop insurance could reduce nutrient runoff, making production more efficient and environmentally friendly [4]. Zulauf et al. pointed out that the policy design has a direct impact on the loss ratio [5]. The data analysis from Iowa's corn production between 2019 to 2024 indicates that these two factors most likely played a role. Insurance is no doubt helpful, but it could also indirectly cause a worse outcome in some cases.

7. Conclusion

Overall, the findings do support that crop insurance has an indirect correlation to the outcome, even though they are not always consistent. Other factors, such as the decision-making of the farmer, the condition of the environment, and the weather, also shape the production level. These trends relate to the literature referenced in the essay. Smith and Goodwin mentioned that moral hazard can put farmers who are insured at higher risk, or change the way they operate their lands, as mentioned by Wu. More recent work by Zulauf et al. suggests that the program design, including the unit's structure, has a direct impact on the outcome. This research has its own flaws: it only covers one state and one agricultural product from the state over six years, meaning that the outcome could be different when more states and longer periods are included. The only method used during the analysis was the t-test. Future studies should use a different approach, across multiple states, and extend the time for a better understanding of the influence of crop insurance on agricultural production, financial gain, and impact on households.

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