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Managing weather-related risks and the usefulness of weather insurance

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Abstract

Weather risk refers to the potential for unfavorable weather conditions to disrupt business operations or cause damage to property. Weather insurance provides financial protection against losses resulting from various weather events such as wind, snow, rain/thunderstorms, fog, and extreme temperatures. It can assist farmers in recovering from losses incurred due to adverse weather conditions. Farmers' willingness to pay (WTP) indicates the maximum premium they are willing to pay for crop protection. New options for smallholder farmers include crop insurance or climate insurance, offering coverage against climate-related risks like low rainfall, temperature stress, and market price fluctuations. Comprehensive weather risk insurance programs may offer better coverage compared to traditional schemes that only cover a portion of the risk.

Keywords: Weather risk, insurance, agriculture, crops, farmers, rainfall

1. Introduction

Weather variability poses significant challenges to agricultural productivity and economic stability in Punjab, a region highly dependent on agriculture. The unpredictable nature of weather patterns, including erratic rainfall, extreme temperatures, and unexpected weather events, can severely impact crop yields and farm incomes. In response to these challenges, the concept of weather risk management has gained prominence, with weather insurance emerging as a crucial tool for mitigating the financial impacts of adverse weather conditions on farmers. This introduction focuses on exploring the management of weather-related risks and the potential benefits of weather insurance for agricultural sustainability in Punjab. By examining the role of weather insurance in safeguarding crop production and supporting farmer livelihoods, this study aims to shed light on the significance of proactive risk management strategies in the face of climate uncertainty.

2. Objectives of study

Studying weather-related risks and the usefulness of weather insurance is vital in today's climate-volatile world. It aims to understand weather dynamics' impacts on sectors like agriculture, construction, tourism, and transportation, enabling informed strategies for risk mitigation and resilience. Additionally, it assesses weather insurance's efficacy in providing financial protection against losses, ensuring business continuity. Understanding its accessibility, affordability, and suitability across regions and industries equips decision-makers with insights to optimize risk management strategies in a changing climate landscape.

3. Weather Risk

Weather risk encompasses the potential for severe weather events to disrupt business operations or inflict damage on properties. This risk significantly affects various industries, including construction and agriculture, where outdoor activities are particularly vulnerable. While the impact of severe weather can often be anticipated, the severity and frequency of such events can vary widely from year to year. Weather risk is characterized by deviations from expected weather patterns, which can be influenced by factors such as climate and geographical location. In certain regions, adverse weather conditions, such as prolonged droughts, can lead to significant delays in outdoor operations like construction.

Moreover, weather risk often presents challenges that defy traditional insurance criteria. Certain weather hazards, especially those that develop gradually like droughts, tend to be localized and can result in widespread systemic issues. Additionally, climate change has the potential to increase the volatility of weather patterns, leading to unpredictable loss distributions and complicating actuarial rate calculations. Furthermore, the scarcity of reliable data on crop yields and weather conditions hampers the development of accurate loss distributions, further complicating risk assessment and insurance pricing.

4. Insurance for Weather Events

Weather insurance provides financial protection against losses or damages incurred due to specific adverse weather conditions. These conditions include wind, snow, rain/thunderstorms, fog, and unfavorable temperatures. Businesses often opt for weather insurance as a standalone policy to safeguard their operations and related activities. It serves various purposes, such as safeguarding valuable events from weather-related disruptions. In the event of weather-related incidents causing revenue losses, insurers compensate the insured businesses accordingly.

5. Operations of weather insurance

- Weather insurance premiums are influenced by various factors, such as geographic location and seasonal timing. In essence, the price of coverage is based on the probability of the insured weather event happening and the potential magnitude of losses. To establish appropriate pricing for a policy, actuaries at the insurance company analyze historical meteorological data spanning decades.
- Weather profoundly influences our daily lives and can significantly affect business revenues and sales. Consequently, weather insurance is often procured as a standalone policy to protect businesses and their associated activities. This includes safeguarding costly events that might be jeopardized or severely disrupted by adverse weather conditions. Weather insurance covers a diverse range of events, including festivals, concerts, trade shows, seasonal gatherings, parades, film productions, fundraisers, and sporting events. Moreover, individuals can utilize weather insurance to safeguard major occasions like outdoor weddings. Traditional weather insurance typically covers low-probability meteorological events such as hurricanes and blizzards.

6. The importance of weather insurance

- Businesses sometimes use these regulations as a marketing strategy to lure customers. For instance, a furniture store might advertise that if there's more than a two-inch snowfall on Christmas, all furniture purchases made in December will be complimentary. In such cases, the store would invest in coverage to protect against this specific event.
- For numerous businesses, weather insurance is indispensable and a crucial risk management strategy. It's also highly flexible. For instance, a insured entity can customize factors such as the duration, types of weather events, and their severity covered by the insurance.
- Weather insurance offers businesses financial security

and peace of mind during unpredictable weather conditions. Whether it's a sudden storm disrupting operations or an unexpected heatwave impacting crop yields, having weather insurance ensures that businesses can mitigate potential losses and maintain stability. This proactive approach not only safeguards against immediate financial setbacks but also fosters long-term sustainability by enabling companies to focus on growth and innovation without the constant threat of weather-related disruptions.

7. Significance of the Topic

- This study highlights strategies for managing risks associated with climate change and adaptation. It presents a straightforward approach to assessing weather risk, considering the vulnerability and responsiveness of business and economic indicators to weather fluctuations in the Punjab region.
- Weather risk assessment serves two primary objectives: quantifying the financial impact of weather volatility and climate change and evaluating the efficacy of weather insurance in mitigating weather-related risks.

8. Literature Review

- The significance of resilience pillars is paramount both prior to and following extreme weather events. Data spanning from 2014 to 2019 was gathered using simple random sampling methods. The study revealed that extreme weather events are on the rise due to a combination of socioeconomic development and climate change. Consequently, fostering societal resilience to extreme weather disasters is imperative. Moreover, insurance, when appropriately structured and regulated, has the potential to serve as a transformative tool for enhancing resilience. (Hudson *et al.* (2020))^[1].
- Explored the gap and enhanced comprehension of choice diversity in weather-index insurance by examining data from 433 male and female farmers residing on a climate-exposed coastal island in Bangladesh. This region witnesses an increasing number of farmers opting for maize cultivation, a potentially lucrative yet high-risk cash crop. Data spanning from 2014 to 2016 with a sample size of N was utilized, employing regression sampling methods. The study's revelation suggests that initiatives aimed at promoting gender equality in climate-resilient agricultural schemes, leveraging weather-index insurance as a risk mitigation tool, may necessitate bolstering institutional credibility. Additionally, coupling such interventions with financial literacy programs tailored for female farmers is likely imperative for success (Akter *et al.* (2016))^[2].
- We delve into the exploration of three selected Archimedean copulas, with a particular emphasis on managing the left tail dependence index. Employing regression analysis, a widely-used method in empirical research, we examine the sensitivity of crop yields to a weather index—an essential consideration in evaluating the feasibility of weather index insurance contracts. Our aim is to develop a framework for weather index insurance using copula-based methodologies. Compared to traditional linear mathematical models, the copula approach demonstrates superior capability in capturing tail dependence. This innovation shows

promise in bolstering the effectiveness of weather insurance contracts designed to mitigate the impact of severe weather events, by integrating the joint distribution of agricultural yields and specific weather variables (Bokusheva (2018))^[3].

- Explored in this study is the correlation between farmers' disaster experiences and their uptake of weather insurance. Our research focuses on counties situated in Jiangxi province, a significant rice-producing region in China. Probability sampling techniques were employed to select sample groups. Utilizing a two-sample t-test, we interpreted the findings. Our investigation reveals that farmers' decision to adopt weather insurance is influenced not only by their perceived probability of experiencing disasters or their understanding of insurance benefits but also significantly shaped by their firsthand experiences with disaster events. Moreover, we observe that familiarity with the payout probability aspects, acquired through participation in risk-related games, strongly motivates farmers to enroll in weather insurance programs (Cai and Song)^[4].
- Explored in this research is the efficacy of Picture-based Insurance (PBI) as a cost-effective method to broaden coverage. In contrast to index-based insurance, PBI assesses insurance claims through smartphone images taken by farmers of their insured plots. This approach aims to mitigate asymmetric information and reduce verification costs while minimizing basis risk. Data for the study was collected in 2014 using simple random sampling methods. The findings suggest that farmers can adhere to prescribed picture-taking protocols and submit smartphone images of their crops regularly. Expert loss assessments, based on these images, can accurately identify the majority of severe damage cases. PBI, therefore, presents a reduction in downside basis risk compared to both weather index-based insurance and area-yield insurance (Ceballos, Kramera, and Robles (2019))^[5].
- The development of more effective and sustainable index insurance schemes tailored for small-scale farmers. Mexico was engaged to utilize publicly available rainfall and temperature data sourced from the government's network of weather stations. These weather datasets, alongside detailed soil maps providing information on soil types, were input into a dynamic crop model. This model enabled the estimation of the relationship between crop yields and specific weather conditions. Our research focused on three distinct schemes: catastrophic weather insurance in Mexico, satellite-based insurance for pastoralists in Kenya, and a theoretical area-yield insurance scheme in Ecuador. Through our analysis, we assessed the design and implementation of these contracts and subsequently evaluated the impacts of the insurance on investment, nutrition, and income stability (Castillo, Boucher, and Carter)^[6].
- This study investigates how weather shocks affect the uptake of micro-insurance for livestock mortality, especially when the insured risk is influenced by various covariate factors. The research included a sample of 360 rural Ethiopian households, and data were collected using a panel structure covering three agricultural seasons (2011-2013). Our results indicate

that weather shocks significantly impact the willingness-to-pay for insurance coverage, especially when other covariate factors are prominent in the conditional distribution (Castellani and Vigan)^[7].

- Turenne investigated how the choice of translation method to estimate weather conditions can impact risk assessment. For instance, a temperature-based insurance index was established using fodder plants from Ontario, Canada. Data from weather stations in Ontario, Canada, collected between 1967 and 2004 from April to August, was analyzed. Regression analysis was utilized to assess whether the climate observed in the stations aligns with the climate experienced by farmers (Turenne D.)^[8].
- According to Zada, Mohapatra, and Anand, the PMFBY and MWBCIS programs were extensively promoted at district-level camps organized by the Indian Council of Agricultural Research's Krishi Vigyan Kendra (ICAR) in Punjab, although not fully implemented. The study, conducted in 2019 with a sample size of 150 respondents selected through simple random sampling, found that compared to scientists and extensionist farmers, understanding of PMFBY elements such as crop coverage, risk coverage, post-harvest coverage, and premium subsidies was relatively low. The sample comprised progressive farmers assumed to have a higher awareness level. However, over half of these progressive farmers were found to be aware of the various features of PMFBY. The study suggests that through awareness drives, farmers should be educated about crop/weather insurance, which could be integrated into various risk management training programs (Zada AMW, Mohapatra L, Anand A.)^[9].
- Discovered the crucial role of insurance in mitigating risks posed by severe weather events, in conjunction with predicted storm trajectories, thereby ensuring human safety through cost-effective measures in building construction and infrastructure. Data was gathered from a government-operated insurance program in Florida in 2012, employing correlation tools for analysis. The study elucidates two primary distortions stemming from government intervention in these insurance markets: firstly, subsidies are unevenly distributed among households, leading to a notable regressive redistribution that favors affluent homeowners in coastal regions. Secondly, subsidies incentivize excessive development and redevelopment in areas susceptible to storms and erosion (Ben, Shahar, and Logue)^[10].

9. Conclusion

Weather insurance stands as a crucial mechanism for stabilizing farm revenue and reducing agricultural risks in Punjab. Subsidies on insurance premiums are essential to incentivize farmer enrollment and enhance the efficiency of insurance programs. However, determining the appropriate premium amount or subsidy poses a challenge for the government. Farmers' willingness to pay (WTP) serves as a valuable indicator of their readiness to invest in crop insurance, highlighting the importance of understanding their financial thresholds. Innovative options, such as indexed crop insurance or weather insurance against climatic risks, offer potential solutions, particularly with triggers tied to factors like low rainfall, temperature stress,

and market-based price risks. Transitioning from partial coverage to comprehensive climate risk insurance could significantly improve risk management for farmers. To realize the full potential of these programs, efficient distribution networks for premium collection, claim processing, and payout management are crucial, especially for reaching millions of small farmers cost-effectively. Integration of GIS/RS-based technologies like the Normalized Difference Vegetative Index can enhance the effectiveness of market-based, risk-sharing weather-indexed insurance for agriculture. The relationship between risk management and credit markets is pivotal, as unmanaged risks can lead to increased borrowing costs and limited access to credit, hindering technological advancements in farming. Moreover, market-based insurance options could alleviate strain on government expenditures by reducing the need for free disaster relief. Farmers are likely to embrace specialist weather-indexed insurance, enhancing efficiency and reducing dependency on government support. By meeting the risk management needs of rural communities, market-based weather-indexed insurance can also contribute to addressing critical food security issues in Punjab.

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