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Innovative Alternatives for Crop Insurance: Rainfall-Index-Based Insurance and Futures

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Abstract

For mitigating the rainfall risk, there is a need to create hedging opportunities which may provide comprehensive relief to farming communities and other sectors. Crop insurance is one such programme currently being implemented by Government of India. A good number of studies have provided enough evidence of poor performance of crop insurance programme due to factors like delay in compensation, moral hazard, high transaction cost and lack of product knowledge. This paper attempts to reinforce the need for creating rainfall risk market in India to complement the rainfall-index based insurance. The discussion is focused on the development of a new set of rainfall indices. The proposed Deficit Rainfall Days (DRDs) and Excess Rainfall Days (ERDs) indices are different from rainfall indexation attempted by National Commodity and Derivative Exchange (NCDEX) in 2005. Rainfall-index based insurance programme introduced in India in the recent past has met with limited success. By comparing Rainfall-Index Based Insurance with Rainfall-Index Based Futures, the study highlights the necessity and significance of Rainfall Futures to create rainfall risk hedging opportunities for a wide range of stakeholders, particularly farming community.

Keywords: Rainfall-Index-Based Insurance, Rainfall-Index-Based Futures, Sustainable Risk Markets

JEL Classification: G22, G28, Q14, Q59

Introduction

The impact of rainfall on the Indian economy is highly significant as agriculture continues to be the backbone of the country's economy. Any deviation in the onset or departure of monsoon, apart from floods and droughts, would adversely impact agricultural production. The variability in rainfall continues to be a major source of risk for farmers across the country, especially in the drought-prone regions. A majority of farmers are still dependent on the monsoon for irrigation. Rainfall also affects different industries like power generation, construction, manufacturing, transportation, recreation, tourism, budgets of local municipalities, retailing, and so on.

In order to mitigate rainfall risk, there is a need to create hedging opportunities that may provide comprehensive relief to farming communities and other sectors. Crop insurance is one such programme currently being implemented by the Government of India. Since the inception of these programmes, they are heavily subsidised and unsuccessful, with low coverage. A good number of studies have provided enough evidence of poor performance of crop insurance programmes due to factors such as delay in compensation, moral hazard, high transaction cost, and lack of product knowledge. Recent developments in the capital market involve designing financial derivative instruments based on rainfall indices for facilitating a broad-based absorption of rainfall risk. Therefore, rainfall-index-based derivatives are the nascent tool used to hedge the systemic rainfall risk. Rainfall derivatives are a new kind of financial instrument developed to manage rainfall-related risk. At present, the rainfall derivatives market is the fastest growing derivatives market globally. The development of rainfall derivatives marks the convergence of insurance and capital market.

This paper is conceptual in nature and uses the published articles and reports of reputed journals. The evolution

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of rainfall risk markets and the limitations of rainfall-index insurance in India are analysed. The study analysed rainfall risk products, i.e. index-based insurance and rainfall-index-based futures, and explains similarities and differences between both. Lastly, the study suggests why India needs rainfall-index-based futures and its significance in the Indian economy. This study has a unique contribution in terms of rainfall indexation as a basis for developing the sustainable rainfall risk market in India.

Review of Literature

Agriculture is the main source of livelihood for millions of households in India. Indian agriculture production is heavily dependent on the south-west monsoon rainfall. Chakravarti (1920); Mishra (1995); Raju and Ramesh (2007); and Venkatesh (2008) opined that rainfall risk can be diversified through rainfall index insurance rather than the traditional crop insurance. The crop insurance programme was found to be ineffective due to factors like higher administrative cost, moral hazard, expensive premium, adverse selection, lack of awareness about the programme, and complex settlement of claims.

Veeramani et al. (2003) stated that wide availability of reliable rainfall data attracts the private insurance sector and reduces the moral hazard, adverse selection, and the problem of an extensive margin. Kenneth Sibiko et al. (2017) suggested that rainfall index insurance was a promising innovation to absorb rainfall risk.

Abhijit and Sayaka (2019) explained that weather index insurance was a simplified form of insurance in which indemnity payments are based on values obtained from an index that serves as a proxy for losses, rather than upon the assessed losses of each individual policyholder. Kotreshwar (2015) and Bharath (2020) opined that there was a need for sustainable rainfall risk markets that will facilitate hedging monsoon risk effectively. According to David and Philippe (2009), when the correlation of rainfall risk increases, the magnitude of potential losses increases, and the efficiency of handling rainfall risk by index insurers and reinsurers comes down. So, there is a need for securitisation of rainfall risk through rainfall derivatives.

Convergence of capital and insurance markets is one of the recent developments in the financial system. David and Mary (2009) opined that convergence was driven by factors like increasing frequency and severity of catastrophic risks, inefficient insurance and reinsurance, and advancements in technology. Marcel and Andreas (1999) suggested that convergence helps the transfer of insurance companies' risks to the capital market, via bonds and derivatives. It has been in use as an instrument for covering insurance companies' risks.

According to Marcel and Andreas (1999); Andrea and Giuseppe (2008); Christopher Kampa (2010); and Nadine Gatzert et al. (2017), development of rainfall risk markets contributes to the development of hybrid security. This hybrid security can play the role of both traditional insurance and rainfall derivatives. So, it helps to access the capital market directly. The low transaction costs and the greater leverage make rainfall derivatives an ideal instrument for hedging, speculation, and for achieving arbitrage profits of the catastrophic risk. Therefore, convergence of insurance market and capital market through an alternative risk transfer product enables global rainfall risk pool. According to Turvey (1999), creation of rainfall risk markets helps insurance companies, financial institutions, hedge funds, and other stakeholders to share the rainfall risk collectively. Sandor (2012) stated that Indian monsoon dependence poses a high degree of rainfall risk, and hence, it is the perfect opportunity to design rainfall derivative products.

Evolution of Rainfall Risk Market

The ecosystem of rainfall risk market comprises three complementary and interdependent components: crop insurance, rainfall-index-based insurance, and rainfall-index-based derivatives. The crop insurance scheme was started during the 1930s in Japan and the US. In India, General Insurance Corporation (GIC) introduced the crop insurance programme in 1972-1973 in Andhra Pradesh, Karnataka, Gujarat, Tamil Nadu, and West Bengal. This scheme included cotton, groundnut, wheat, and potato in a limited and ad-hoc manner. The pilot crop insurance scheme was launched by the GIC in 1978-1979, based on the area approach. Afterwards, Kharif, 1985-1986, was the first nation-wide scheme, i.e. comprehensive crop insurance scheme (suggested by Dandekar (1976)) launched in 15 states and two Union Territories. This scheme was operated until Rabi, 1999.

Later, the Agricultural Insurance Company (AIC) converted the comprehensive crop insurance scheme into National Agricultural Insurance Scheme (NAIS) from the Rabi season, 1999-2000, to increase the coverage; it was introduced all over India. This scheme was available to all farmers – both loanee and non-loanee, irrespective of size of land holding. However, due to operational problems of crop insurance, rainfall index insurance was introduced as an alternative. Abhijit and Sayaka (2019) observed that rainfall index insurance was superior to traditional crop insurance because it attracts even small size farms. It was a simplified form of insurance in which indemnity payments are based on the values obtained from an index that serves as a benchmark for losses, rather than the assessed losses of each individual policyholder. The sum insured was normally based on production cost on an agreed value basis, and pay-outs were made based on a pre-established scale set out in the insurance policy.

Rainfall index insurance is an attractive and feasible risk management tool to manage rainfall risk. The pioneering work on rainfall index insurance commenced as far back as 1912 by Chakravarti (1920), as a scientific tool to compensate crop losses. He published a book entitled 'Agricultural Insurance: A Practical Scheme Suited to Indian Conditions', in 1920. It explained how rainfall index used to make the pay-out to farmers for the weather shocks. If the aggregate of rainfall in one particular rain gauge station is below the predetermined rainfall level, then a certain amount of money will be paid in respect of loss to the insured.

India is one of the leading countries offering rainfall index insurance. Rainfall-index-based insurance was first introduced in India in 2003. It was designed by two microfinance institutions, ICICI Lombard General Insurance and BASIX, with help of the World Bank and IFC, as an alternative tool to crop insurance. Initially, it was a pilot scheme introduced to 200 farmers in the Mehboobnagar district of Andhra Pradesh, for groundnut and castor farmers. Barry and Oliver (2007) stated that it was sold to 700 farmers in 2004 by BASIX. Between 2003 and 2006, a total of 7,653 rainfall index insurance policies were sold in 36 locations in six states in India.

After the pilot scheme of ICICI Lombard General Insurance Company, IFFCO General Insurance Company and AIC of India stepped forward in 2005-2006 for commercialisation of rainfall index insurance. In 2005-2006, AIC sold weather-index-based insurance policies to more than 1,25,000 farmers (Berry et al., 2007). Since 2005-2006, Varsa Bima of AIC, Barish Bima of IFFCO TOKYO GIC, and Rainfall Insurance Scheme for Coffee (RISC) are the ongoing schemes available to mitigate rainfall risk. From 2016, IFFCO TOKYO GIC started Restructured Weather Based Crop Insurance (RWBCI) to cover the composite of various risks that affect agriculture. Rainfall index insurance is superior because of its transparency, faster settlement, and low transaction cost.

The World Bank has given technical assistance to the GOI and AIC in the development of weather index insurance. This assistance helps in product design, rating, and large-scale implementation. This insurance can be purchased by farmers and others who face rainfall risk. Since 2003, the Indian insurance market has grown rapidly and reinsured with the international rainfall risk markets.

The ecosystem of rainfall risk market is incomplete in the absence of rainfall-index-based derivatives, i.e. rainfall-index-based futures and options. Rainfall-index-based futures are the innovative alternative tool that would facilitate hedging rainfall risk by a wide range of stakeholders. These are now presently traded only by the Chicago Mercantile Exchange in the US. It is the world's leading and most diverse derivative market place. It launched standardised futures and option contracts in 2010. It was initially offered in ten cities. At present, rainfall-index-based futures contracts are traded in 25 cities in the US, 11 in Europe, six in Canada, and three each in Australia and Japan.

However, in India, these markets are not yet developed, because of lack of research and the absence of regulatory support. The government needs to undertake measures to amend the regulation, provide infrastructure facility in the rain gauge stations, provide free rainfall data, support transaction costs, and fund research in the area of rainfall risk markets. Once these markets are created, it will provide opportunities to a wide range of stakeholders to hedge their rainfall risk.

Rainfall Indexation

Rainfall indexation represents a numerical methodology for measuring deficit or excess rainfall over a defined

period of time. The National Commodity and Derivative Exchange (NCDEX) proposed a rainfall index for trading purposes during the year 2005. A high rainfall index would signify higher rainfall than cumulative average rainfall, for certain date of index, and vice-versa. The first index was launched on June 1, 2005, for Mumbai. Index for Belgaum, Erode, Guntur, Karimnagar, Ganganagar, Kottayam, Murshidabad, Rajkot, and Ujjain were launched on June 1, 2006. NCDEX rainfall index indicates what percentage of cumulative normal expected rainfall has been realised. The following methodology was adopted to calculate the rainfall index:

Rainfall index = Actual rain/Normal expected rain × 1000 (1)

For example:

- Historical normal expected rainfall data for June 2, 2020: 25 mm
- Actual rain by June 2, 2020: 12.5 mm
- Rainfall Index (Scaled by 1000) on June 3, 2020 (12/25) x 1000 = 480
- There has been 48 per cent normal rain by June 2, 2020.

A lower index indicates the failure of monsoon and lowers the monetary value of rainfall index and vice-versa. The farmer would sell the index at the starting of the monsoon and buy it back at the end of the monsoon, implying compensation for the loss of crop due to deficit rainfall.

The Multi Commodity Exchange (MCX) and Weather Risk Management Services Pvt. Ltd. jointly developed rainfall indices like RAINDEXMUM, RAINDEXIDR, and RAINDEXJAI, which record rainfall at Mumbai (Colaba), Indore, and Jaipur, respectively. This rainfall index has been constructed by considering the normal historical rainfall in Mumbai, Indore, and Jaipur. These indices are computed based on historical cumulative rainfall and adjusted with net surplus or deficit of actual cumulative rainfall as of that date. The normal index value for Mumbai, Indore, and Jaipur are 1950, 950, and 350, respectively. The rainfall indices are calculated for the monsoon season, i.e. from June to October.

Chicago Mercantile Exchange (CME), the world's leading and most diverse derivatives marketplace, launched standardised rainfall futures, options on futures, and binary option from October 14, 2010. The CME rainfall contracts are based on rainfall index for monthly and seasonal variability. Initially, rainfall contracts were traded in ten cities. López Cabrera et al. (2013) developed the pricing model and rainfall index for the rainfall future contracts for CME. The rainfall indexation discussed in this paper is based on a new set of rainfall indices, i.e. Deficit Rainfall Days (DRD) and Excess Rainfall Days (ERD) developed by Kotreshwar et al. (2015). These indices are constructed on par with the Heating Degree Days (HDD) and Cooling Degree Days (CDD) as an underlying for temperature derivatives. DRDs and ERDs can be determined separately for each of the rain gauge stations or meteorological subdivisions that serve as a benchmark for designing the rainfall derivatives contracts for trading in both OTC and an organised market. The underlying variable being rainfall, let R_i denote the rainfall (in millimetres) measured on i^{th} day, and R_x denotes the average daily rainfall (in millimetres). The average daily rainfall, R_x, should serve as the reference level of rainfall in millimetres. The value of R_x is based on the past rainfall data for any chosen length of the period. The standard underlying variable then, would simply be the difference between the daily average value of rainfall (in millimetres), R_x, and the actual value of rainfall (in millimetres) on i^{th} day, R_i. The rainfall days generated on a given i^{th} day is calculated as:

$$DRD_i = \text{Max. } \{R_x - R_i, 0\} \quad (2)$$

Similarly,

$$ERD_i = \text{Max. } \{R_i - R_x, 0\} \quad (3)$$

Rainfall-Index-Based Insurance and Futures: A Comparison

Rainfall-index-based insurance is an attractive approach to managing rainfall risk, because it uses rainfall index as a benchmark to determine pay-outs. These can be made more quickly compared to conventional crop insurance. Under the rainfall-index-based insurance, an insurance company need not visit the field; instead, they decide the pay-out based on the variability in the rainfall index. If the rainfall index is below the agreed threshold, the farmers get their claims paid.

An index-based rainfall derivative is a financial contract used to manage the hostile rainfall conditions like droughts and floods. The pay-outs or settlement of contracts depends on the rainfall index. Rainfall index is the value which is calculated based on the rainfall data. Rainfall-index-based derivatives can be used to hedge adverse rainfall events. The value of rainfall contracts depends on the value of the underlying, i.e. Deficit Rainfall Days (DRD) or Excess Rainfall Days (ERD).

The buyer must pay the premium for specific events for a specific period. The seller of the index-based rainfall derivatives accepts the hostile weather event by receiving the premium. The buyer receives the pay-out if the index crosses the predetermined threshold before the end of the contract period. The rainfall-index-based derivatives are more cost effective for low probability events and highly liquid instruments. These can be bought and sold by both the hedgers and speculators.

There are similarities between rainfall-index-based insurance and rainfall-index-based derivatives. These instruments are used to hedge against the systemic rainfall risk. In the case of coverage, both are based on the rainfall index, which is calculated based on the rainfall data. Both are subject to basis risk. In both the cases, there is an imperfect correlation between the rainfall index and the losses suffered by the policy holder, because pay-out depends on the rainfall index. There is no need for field studies to measure the loss, because in both the cases, rainfall index is used as a basis for loss measurement. The information provided in the policies and contracts are easily understood by the purchaser.

However, rainfall index insurance is different from rainfall-index-based derivatives even though both are used for the same purpose. The rainfall index insurance covers high rainfall risk with the low probability of rainfall events. On the other hand, rainfall-index-based derivatives cover low rainfall risk with the high probability of events. A major difference is that rainfall index derivatives can be purchased and sold by anyone, while rainfall-index-based insurance can only be insured by the farmers and sold by the insurers.

Secondly, the value/price of index-based-insurance depends on the insurer and government participation in the event, whereas the price of rainfall-index-based derivatives is determined by market demand and fair price of contract. Thirdly, rainfall-index-based derivatives are publicly traded in the open market and daily market values are easily available through marking to market facility. So, it is more transparent than rainfall-index-based insurance. On the other hand, rainfall-index-based insurance cannot be traded and daily market data is not available for the insured.

Finally, the purchase and sale of rainfall-index-based insurance needs just a shared knowledge, whereas trading in the rainfall-index-based derivatives requires market familiarity and analytical skill of the investors. So, an ordinary farmer cannot afford this instrument. In the case of rainfall-index-based insurance, there exists a problem of adverse selection and moral hazard due to non-availability of information. On the contrary, in rainfall-index-based derivatives trading is transparent, and hence, the problem of moral hazard and adverse selection does not exist. Even though both are used for hedging rainfall risk, they are not the same.

The following is the summary of rainfall-index-based insurance and rainfall-index-based futures. There are similarities and differences between the two.

Table 1: Summary of Rainfall-Index-Based Insurance and Rainfall-Index-Based Futures

Point of Difference	*Rainfall-Index-Based Insurance*	*Rainfall-Index-Based Futures*
Issuer/Seller	Insurer	Investors selling the futures
Insured/Buyer	Farmers	Farmers and other investors
Underlying/Coverage	Changes in rainfall index	Changes in rainfall index
Settlement/Claim	Based on the actual index and contact price	Based on the difference of actual value of index and strike value of index of the futures contract
Basis risk	Occurs	Occurs
Type of risk cover	Used to hedge the systemic rainfall risk	Used to hedge the systemic rainfall risk
Issuers risk	Generally limited exposure	Always limited exposure
Type of risk covered	High risks with low probability events	Low risks with high probability events

Point of Difference	*Rainfall-Index-Based Insurance*	*Rainfall-Index-Based Futures*
Transparency	Moderate level of transparency	High level of transparency
Initial cost for start-up	Huge cost needed for start-up	Huge cost needed for start-up
Loss measurement cost	Zero	Zero
Problem of adverse selection/Moral hazard	Absent	Absent
Government financial support	Strongly needed	Needed for farmers, not for investors
Tradability	Non-tradeable	Publicly traded
Price of a contract	Determined by insurer, insured, and participation of concerned government	Determined by market demand and fair price of contract
Marking to Market	Not available	Available
Contract specification	Based on issuers and government intervention	Based on market and investor demands

Sources: Chengyi et al. (2018)

Need for Rainfall-Index-Based Futures

Rainfall risk constitutes a major source of uncertainty in agriculture production. Extreme rainfall conditions can lead to huge unexpected losses. Traditionally, farmers try to minimise these losses by purchasing rainfall-index-based insurance. However, this scheme was found to be ineffective due to factors like higher administrative cost, moral hazards, expensive premium, adverse selection, lack of awareness about the programme, and complex settlement of claims. In the meantime, a new class of more flexible contingent claims has emerged, namely rainfall derivatives. Rainfall derivatives are financial instruments that allow the trading of rainfall risks. These instruments can be structured as futures, options, and swaps.

Rainfall-index-based futures provide businesses with the possibility of managing adverse rainfall events. They also provide financial institutions with a new investment tool that is uncorrelated with other financial instruments, such as equities or bonds. In addition, there is significant potential for rainfall futures in numerous industry sectors, as a prominent proportion of the industrialised economy is rainfall sensitive.

The instruments can create opportunities for arbitraging and speculation that could immensely help reduce illegal betting on monsoon rainfall. Some of the industry sources predicted that nearly 25,000 crore betting take place every year on the arrival of the rainfall. So, it is better to bring the unorganised transactions into the well organised exchanges. Nearly 30% of the US economy depends on the weather. So, the country started temperature derivatives in 1999 and rainfall derivatives in 2011. They are successful in trading these instruments. Rainfall plays a major role in the development of the Indian economy; the country faces rainfall variability risk similar to the temperature risk in the USA. And the variability of rainfall is prominent in the different Indian geographical locations.

There are some countries keen on participating in the Indian weather risk market; however, the Indian markets are not yet set up with the proper platforms for trading. These factors indicate that India needs rainfall-index-based futures market for the sustainable development of the country.

Conclusion

This paper aimed at explaining why India needs to develop, adopt, and trade the rainfall-index-based futures complementing traditional insurance. The rainfall risk market can provide an opportunity for integrating weather insurance markets with the capital markets. The stakeholders can use these markets to hedge, arbitrage, and speculate uncertain monsoon events.

The need of the hour is to create a sustainable rainfall risk market for the economy to absorb the rainfall risk. The development of these markets requires an elaborate research and regulatory support. The commodity regulatory provisions need to be amended to provide a platform to trade rainfall futures. The success of the rainfall risk markets requires well-developed weather infrastructure, index designing, and awareness among the stakeholders. The governments need to invest in the development of infrastructure, and stakeholder awareness and product knowledge, apart from ensuring reliable rainfall data from the meteorological sub-divisions.

Research Implication

The present study yielded some useful inputs for policy making by highlighting the implication of rainfall derivatives to create rainfall risk market for hedging opportunities for a wide range of stakeholders, particularly the farming community.

Limitations and Scope for Further Research

The current study presents a conceptual framework of rainfall risk market in India. It is important to study the perception of market participants and stakeholders to understand the feasibility of trading rainfall futures. Therefore, there is scope for further research in understanding market sentiment of a target group consisting of risk managers, insurers, reinsurers, corporates, policy makers, financial experts, agriculturists, and so on.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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