
Using Participating and Financial Contracts to Insure Catastrophe Risk: Implications for Crop Risk Management: *Abstract*

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High losses generated by natural catastrophes reduce the availability of insurance. As their effects are more and more frequent and violent, there are new needs in insurance for innovative products, especially in the agricultural sector.

Many developed countries have already modernized their crop insurance system, e.g., the USA, Spain, and France. Global funds are progressively suppressed and the development of (subsidized) private insurance is encouraged.

These reforms are globally a success, but in fact at least a third of the agricultural surfaces is still not covered, even in the most developed systems (Spain). Moreover, the States' intervention remains compulsory and at a high level (USA). Last but not least, reinsurances face a risk because there exists a possible correlation of world losses as a result of global warming.

Facing these constraints, we propose to cover the whole risk by introducing two innovative contracts: participating policies and financial contracts. Participating policies are already developed in life insurance. The principle is the following: the policyholders pay an extra premium compared to standard insurance contracts. In counterpart, they can be refunded depending on the individual behavior of the stakeholder and on the overall performance of the insurance company.

One can easily understand this tool is a persuasive way for the insurance companies to reduce informational asymmetries and for the insured to receive coverage.

Weather-risk contracts are now exchanged on financial markets. They are characterized by an underlying asset that is not traded, e.g., temperature or rain. They take the form of weather options and futures, as well as Cat bonds. Although this kind of market is quite marginal at the moment, its growth is consistent. Thus, potential applications to the agricultural sector are very promising. The main question concerns the correlation between meteorological indexes and financial ones. An imperfect correlation may attract investors seeking to diversify their portfolios. In counterpart, the subscriber is directly exposed to a basis risk, which reduces the coverage's efficiency. Our model takes into account this noisy parameter.

We then develop a formulation that proposes to manage catastrophic risk assuming it can be decomposed into an individual (or idiosyncratic) component and a collective (or systemic) one. According to Raviv (1979), the set of participating and nonparticipating policies allows implementing the two major principles of risk allocation: the mutuality and the transfer principles. In our analysis, we substitute a financial policy for the standard nonparticipating one. Moreover, we measure the impact of unfair premia (i.e., with deductibles and transaction costs) on the coverage level.

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Our model is based on the framework of the expected utility theory. We maximize the expected final wealth of an insured subscribing to both participating and financial policies, with respect to their corresponding premia and indemnities. Then we can formulate some conclusions.

Optimizing the expected wealth of the insured, we first determine the optimal design of insurance policies, with the calculus of the optimal indemnities and premia of both participating and financial contracts. Assuming participating policies exist, we also define the optimal level of deductibility. As we consider unfair contracts, we introduce deductibles and loading ratios into our formulation.

Next, we show that participating contracts hedge the individual losses under a variable premium subject to transaction costs and risk premia. We also find that the loss after the subscription of a participating contract is equivalent to the purchase of call options indexed on a weather-based financial index but subject to a basis risk and unfair premia. Finally, the combination of the two policies leads to an expected loss equal to the sale of futures contracts indexed on a weather-based financial index. The basis risk is deleted while the existence of unfair premia reduces the coverage efficiency.

Direct applications of our formulation to crop risk management are plentiful. Such a combination of contracts provides advantages to all insurance actors. The policyholders may insure their global risk with an integrated product. As shown in

the paper, the insurers are the only ones able to design the contracts; thus, the greater will be the market and the better will be the pricing of the contracts. Moreover, the States may encourage the development of such products, as the model suggests their intervention should be focused on the subsidization of the contracts. Such an involvement may reduce the negative impact of unfair pricing for the insured. In terms of public policies, our formulation offers substantial advantages.

Primary References

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