Optimal Decision Making under Extreme Event Risks

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1. Introduction

The insurance and reinsurance industries have begun to address the convergent nature of the losses/risks that occurred on 9/11. The traditional measures of diversification, such as historical correlations, do not include the complete breakdown of the correlations across lines of insurance – works compensation, airline insurance, etc. Thus, a number of companies suffered losses outside of the range of projections from their risk analysis systems. Some of these companies are limiting their future exposure to terrorist attacks, expecting the U.S. government to take on these risks. In addition, the level of capital has dropped for a number of companies; this gap is being filled by start up ventures in Bermuda and elsewhere.

The area of Dynamic Financial Analysis (DFA) provides a unified approach for evaluating the major decisions of a property/casualty insurance company. The basic idea is to build a consistent mathematical model of the entire company – assets, liabilities and the capital structure. See the references listed below. These models have not included unexpected events such as terrorist attacks, in general. Research will be needed in this regard.

2. Risk Reduction

How can an insurance company reduce its risks, especially the on the tails of the profit/loss distribution? There are four basic approaches: 1) purchase reinsurance, 2) diversification of risks, 3) supplement capital to reduce the asset to surplus ratio, and 4) limit capacity in selected domains. Each of these strategies comes with advantages and disadvantages. In all cases, it is important to evaluate the extreme (tail) losses since a company's capital allocation decisions and relative profit potential hinges on these calculations. We briefly survey each of the risk mitigation approaches below.

2.1 Purchase Reinsurance

Perhaps, the simplest approach to reducing the extreme losses is to purchase reinsurance from a well-capitalized reinsurance company. This approach has the advantage of minimizing the basis risks. It is also useful for other purposes, such as convincing shareholders, policyholders, and regulators that the worst-case losses have been largely eliminated (baring a unexpected breakdown of industry capital). In a highly regulated marketplace, this approach is often chosen since it largely eliminates the chances of a miscalculation.

The chosen reinsurance company must be able to reduce their worst-case losses and in some cases they face much the same problem as the primary insurers. The reinsurance company may pass along their tail risks to other reinsurance companies through retrocession insurance. In certain cases, such as the well-publicized losses at Lloyds of London the chain of risk management strategies must stop somewhere and the backup capital must be adequate to fund the projected losses.

A central disadvantage of purchasing reinsurance is the decrease in expected profits by the primary insurer due to the company's risk aversion, the degree of regulation, and the tightness or looseness of the marketplace for the coverage needed. Typically, the potential for moral hazard and risk aversion will lead to a sizeable decrease in expected profits. As a consequence, many primary insurers generate predictable but slow growing profit streams. And there is little incentive for bringing innovations into the market. Also, the current environment, despite the high degree of regulations, gives rise to a number of bankruptcies by insurance companies or major crises, such as Equitable in the UK.

2.2. Diversification

Traditional insurance, such as life insurance, depends upon a large number of uncorrelated events. In this environment, the most important criterion involves estimating the expected losses for setting prices and determining capital needs. The law of large numbers will take care of the tails of the loss distribution, or the policies are written so that the breakdown of correlations will void the insurance. Take the case of the usual exceptions such as losses occurring during war.

Modern insurance policies are much more complex than to assume that the losses are uncorrelated by their nature. For instance, a company writing earthquake insurance must be quite careful to ensure that they do not simply sell insurance in a single location such as San Francisco. Such as strategy might make sense from the standpoint of marketing or understanding the customer needs, but is foolish with respect to the worst case losses, especially if the policies are unconstrained and open to all people interested in purchasing the insurance.

Applying modern stochastic models in conjunction with optimization strategies can control the extreme losses. Herein, the company broadens their exposure to a wider set of risks, such as selling catastrophic insurance worldwide or by restricting the level of policies written in a single

geographic area. There strategies can lead to a profitable business as evidence by the work of Renaissance Reinsurance Company and the St. Paul Company (Geo Vera).

Also, global insurance companies can free up capital by diversification of risks. This benefit is important for developing an efficiently managed company.

2. 3. Additional Capital

The asset to surplus ratio (degree of leverage) will have a direct impact on the reward/risk tradeoff for an insurance company. Of course, the degree of conditionality between the losses must be part of the calculations. The work on DFA aims to help the company executives in setting this number in a sensible way. However, as before with the purchase of reinsurance, the additional capital will likely lead to lower expected profits in certain cases. One could argue that a policyholder will be willing to pay a higher price for insurance issued by a top capitalized company. But not all individuals act in such a manner, especially when the States regulate the companies.

2.4. Limit Capacity

To limit the worst case, an insurance company can fix the total exposure for a particular risk category or across a business unit. For example, company AAA may sell insurance up to the target limit in California. The designation of the worst-case depends upon the determination of conditional losses. This approach can be implemented in a naïve fashion, such as strict limits – or within the context of a selective constraint approach by means of an optimization model.

3. Possible Directions for Future Research on DFA

Ideally, insurance should be available to people and companies in need of coverage. Rates should be fair and at a reasonable cost. Who can argue with these goals? An efficient insurance industry would reward companies for reducing costs and for developing superior risk management systems. It is in the best interest of all parties to reward efficiency and risk management. After all, policyholders will pay for inefficiencies and the general public will ultimately bailout companies who fall into financial distress and bankruptcy.

What are the characteristics of an efficient company? First, the company must be able to estimate losses due to the insured risks. Complicating the analysis is the need to measure the company's position in several ways, including statutory surplus, accounting measures (GAAP), and economic market value. In addition, the asset uncertainty must be addressed in the context of the underlying factors driving the returns, such as interest rates and the state of the economy. The goal of Dynamic Financial Analysis is to assist in major decisions in a coordinated fashion.

We list some topics for future research on DFA and extreme events.

A. Address the nature of extreme risks

- Evaluate the tail losses under unexpected events. Improve stochastic scenario generators.
- Develop organizational structures that respond to changing conditions, such as new securities that are based on unanticipated events – the finite risk domain can provide ideas – in conjunction with U.S. Federal Government policy.
- Improve methods for reducing the tails of the loss distribution as discussed above.

B. Improve regulations to encourage innovations in risk management strategies.

C. Develop stress-testing methods for DFA in the context of unexpected events. What are the limits for the industry as a whole? What can be done when losses exceed these limits?

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