Discussion of Ronald T. Kozlowski and Stuart B. Mathewson's "Measuring and Managing Catastrophe Risk"

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1 Introduction

Mr. Kozlowski and Mr. Mathewson's paper provides a good introduction to the development and use of models in the property insurance industry. It will be a valuable addition to the regrettably sparse actuarial literature in this area. This discussion will offer several comments on the ideas raised in the paper, focusing on how models can be used to enhance an actuary's work.

The use of models has sparked major controversies between regulators and insurers in several jurisdictions, notably Florida. Controversy is not limited to the regulatory arena, however. Because models are being used by reinsurers to rate contracts and by A.M. Best to rate companies, management often must react to the application of modeling to the company. Many insurance company executives find themselves arguing with regulators for higher primary rate levels based on models but chafing under reinsurance costs developed using the same models.

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2 Ratemaking: Models vs. Traditional Approaches

2.1 Loss Cost Issues

In the introduction the authors discuss how events of the late 1980s and early 1990s led to severe disruptions in property insurance markets. The factors driving the property insurance crisis are complex and beyond the scope of their paper. A brief discussion of how traditional actuarial methods led to errors in estimates of loss costs and probable maximum losses, however, is an excellent way to emphasize the need for the development of computer models.

Ratemaking problems developed due to:

- An abnormal lull in catastrophic activity;
- A substantial shift of population to high risk areas;
- Use of actuarial techniques whose basic assumptions were violated by both of the above factors; and
- Limited availability of data and the computer power necessary to analyze it.

Prior to the late 1980s actuaries used a technique known as the *excess wind procedure* to estimate hurricane catastrophe provisions in rates. This technique examines the ratio of excess to normal losses in statewide aggregations of annual loss data and measures excess losses as those that exceed some multiple of a long-term mean. Losses above this threshold are excluded from the traditional five year ratemaking experience period and spread over a long (30 year) experience period. This method assumes that the last 30 years were typical in terms of storm frequency/severity and that the ratio of wind to non-wind (i.e., fire, theft, and liability) losses is constant over time. Both of these assumptions were grossly violated from 1960 to 1990 by abnormally low hurricane activity and explosive population growth in coastal areas.

In 1992 the Insurance Service Office calculated an excess wind factor of 1.14 for Florida homeowners, which would have generated approximately $80 million in premiums for the entire Florida insurance industry annually.[1] At this funding rate it would have taken over 100

[1]This figure is developed as follows: Total homeowners premium volume was approximately $1 billion. Assuming an expected loss ratio of 65 percent, this yields $650 million in loss cost, which equals normal losses multiplied by 1.14. Thus, normal losses were $570 million, leaving $80 million for excess catastrophe losses. While this calculation is a crude approximation of a complicated ratemaking process, it illustrates the magnitude of the pricing error.

years just to pay for Hurricane Andrew's homeowner losses, assuming no other storms in the interim.

Computer modeling techniques now allow actuaries to project the actual storm data of the 1920s onto the population and construction patterns of the 1990s, overcoming the limitations of the prior method.

2.2 Risk Load Issues

The authors also discuss the relationship between the purchase of reinsurance and primary price adequacy. In their Section 1 (fifth paragraph) the authors state "Without reinsurance costs these companies were able to write business at lower prices and thereby increase their market share, ..." This raises another significant point about the actuarial techniques employed in the past.

Risk loads generally are considered to be an essential ingredient of an actuarially sound rate in lines subject to highly variable losses. While reinsurers long have considered risk load explicitly in their ratemaking, traditional primary ratemaking procedures used in property ratemaking did not. Companies that purchase reinsurance and reflected those costs in primary rates thereby included some risk load.

Standard techniques used by many insurers and rating bureaus for primary ratemaking focused on mean loss costs, ignoring potential variance of these loss costs. Risk loads were accounted for in profit and contingency factors often set using rule-of-thumb figures such as 5 percent or industry average return on equity adjusted for anticipated investment income. It has not been unusual for primary profit and contingency factors to be the same for low risk auto physical damage and high risk coastal homeowners. Even rarer was any consideration of differing risk load within a book of business. One might expect that a risk load would be different for homeowner risks in coastal areas versus risks in inland areas, but the notion of varying the risk load within a filing was virtually nonexistent.

As is the case with loss costs, computer models provide a wealth of information to actuaries on the variance and skewness of the aggregate loss distribution. The authors note that modeling provides the raw material for calculating theoretical risk loads, but they discuss the issue only in the context of pricing property catastrophe reinsurance. The issue is also of critical importance in pricing primary insurance; the lack of generally accepted actuarial and regulatory methods of handling this problem is related directly to the shortage of primary insurer capacity in high risk areas.

3 Building Models

3.1 Exposure Considerations

Their paper discusses the key elements of exposure data needed in the modeling process. But the actuary should not forget that the exposure on the statistical record may not be the actual level of exposure on which the loss will be adjusted. For example, many companies offer guaranteed replacement cost coverage that will pay the insured an amount greater than that shown on the policy declaration if the actual loss exceeds that amount. This feature contributed to far greater than expected losses in Hurricane Andrew, when a demand surge for materials and labor caused prices to inflate after the loss. The actuary must understand what policy provisions may be lurking behind the statistical records in order to accurately use a computer model.

Insurance to value is also critical. Most models assume that property is insured to 100 percent of replacement cost. If the company insures to 80 percent of value, the reduction in expected losses will not be 20 percent because most catastrophe losses are not total.[2] The actuary must work with the modeling vendor to correctly adjust for the actual insurance-to-value practices of the company.

The authors state in their Section 2.2: "Replacement cost and insurance-to-value provisions identify those provisions where the insurance coverage may be greater than the specified coverage amount." Company-specific practices in these areas could result in insurance coverage either above or below the specified coverage amount. For example, most models assume replacement cost, but the company's contract provisions may provide for actual cash value settlement of contents or roof claims.

3.2 Statistical Considerations

The authors make a key point that most insurance company property statistical systems are designed for traditional perils of fire and

[2]For example, consider two $100,000 houses, one insured for $100,000 and the other for $80,000. A partial loss requiring the roof to be replaced will result in the same loss to the insurer on both homes. Because only a small proportion of risks is totally destroyed in a given event, the reduction in insured losses must be less then the reduction in coverage amount when a book of business' insurance to value standard is reduced from 100 percent to 80 percent. If actuaries are not careful, a mismatch of assumption between the modeler and the company can lead to significant errors in estimated losses.

theft, rather than wind or earthquake. Thus, the actuary may have detailed coding on whether a home has fire extinguishers or how close it is to a fire hydrant, but no information on type of roof, existence of storm shutters, etc. Addressing this issue is perhaps the most daunting challenge modelers face in improving accuracy, given the enormous expense that is required to change established statistical systems.

3.3 The Authors' Insurance Coverage Module

The reader may gain additional insight into the authors' presentation of the insurance coverage module by more fully exploring the assumptions underlying their equation (6), which is repeated here for convenience:

$$\begin{aligned}(ID)_z &= f_{ID}(D_z, r, d, l) \\ &= \min[\max[(r \times D_z) - d,\ 0],\ l] + a \times D_z\end{aligned}$$

where

$$\begin{aligned}(ID)_z &= \text{Insured damage at location } z; \\ D_z &= \text{Damage at location } z; \\ r &= \text{Guaranteed replacement cost multiplier;} \\ d &= \text{Deductible;} \\ l &= \text{Reinsurance limit; and} \\ a &= \text{ALAE percentage.}\end{aligned}$$

This form assumes (i) a single risk subject to a per risk excess contract that does not cover loss adjustment expense; (ii) guaranteed replacement cost applies; and (iii) ALAE is a function of damage (excluding guaranteed replacement cost and deductible).

If we assume, however, (i) the risk were subject to quota share reinsurance (at percentage q); (ii) guaranteed replacement cost applies; (iii) ALAE is assumed to be a function of loss adjusted for guaranteed replacement cost before application of the deductible; and (iv) ALAE is covered under the quota share, then

$$(ID)_z = [\max[(r \times D_z) - d,\ 0] + r \times a \times D_z] \times (1 - q).$$

This example illustrates the importance of constructing the insurance coverage module with a full understanding of the underlying assumptions. Actual insurance coverage models can become extremely complex, particularly if several types of policies with differing reinsurance coverages are involved.

4 Exposure Management Considerations

The authors discuss several techniques to locate and prevent dangerous concentrations. Their main focus is the aggregate level of exposure in a given area and its density within a given zip code. They show how models can be used to estimate loss potentials and control the writing of business in areas of dangerous concentration. I see this problem from a slightly different perspective. The analysis should not be limited to the quantity of risk, but also should consider the types of risks within a given area of concentration, their levels of coverage, etc. The model can be used to devise strategies (such as making coverage changes) to manage the exposure without necessarily reducing writings.

The key issue facing a company is how to decide whether $\$X$ of aggregate liability can be supported by the company's capitalization and reinsurance. From this standpoint, \$100 million of concrete bunkers may be as attractive as \$10 million of glass greenhouses. Holding construction constant, \$100 million in exposure in Inland City may be as attractive as \$20 million in Beach City. The probable maximum loss of a \$100 million aggregate exposure in Inland City at a \$250 deductible may equal a \$100 million aggregate exposure in Beach City with a 5 percent deductible. Comparisons of this type require models—comparisons cannot be performed by simply looking at aggregations of exposure on a map.

5 Reinsurance and Excess Modeling

In this section of the paper the authors discuss how modeling can increase availability of reinsurance coverage in the market. It is also important to understand the relationship between the use of models among reinsurers, primary companies, and regulators.

As the authors note, models help reinsurers to measure potential losses more accurately, increasing their confidence in both pricing and amount of capital exposed. Unfortunately, unless the reinsured primary company also considers modeled loss costs and an appropriate risk load in its rates, there will be insufficient funds to pay for needed reinsurance, leading to the appearance of a capacity shortage. Even if the reinsurer and primary reinsurer can synchronize their pricing, a clash between an unregulated reinsurance market and the highly regulated primary market still can pose difficulties. Thus, it is important that a common understanding of the elements of modeled loss costs and needed risk loads be developed between reinsurers, primary insurers, and regulators.

The authors do an excellent job of showing why the traditional practice of using a market share analysis to estimate individual company loss potential is seriously flawed. I have had firsthand experience with the pitfalls of using market share-based methods by working for an insurer that specializes in farm insurance. The company's book of business contains a large amount of rural property in Florida. The rural book's high fire rates cause the premium market share to be substantially higher than the exposure market share. The market share approach also assumes that the farms are distributed in the same manner as the population, which generally lives much closer to the coast. The combination of these factors leads to dramatic differences between loss estimates derived from geocoded exposure data and premium-driven county market share estimates.

Market share approaches also are biased by the level of rate adequacy in the company, with more adequately rated companies having relatively higher market shares and apparently greater loss potentials. This creates the ironic situation whereby companies that ought to be viewed more favorably by reinsurers (due to adequate rates and a greater ability to afford coverage) appear to be less desirable because their rate-inflated market shares overstate their true catastrophic loss exposure.

For these reasons, the ability of primary company actuaries to provide their reinsurance counterparts with high quality information is critical.

6 Pricing and Reinsurance Allocation Issues

The authors state that modeling can be used to help a company determine the appropriate allocations of reinsurance costs. An often neglected but important area of actuarial work is the communication of the components of rate levels to other persons in the organization.

Consider the example of an underwriter making decisions on agent performance based on a loss ratio. Often such loss ratios are direct incurred loss over earned premium, with an adjustment to remove large or catastrophic losses in consideration for some reinsurance cost. If the underwriter has two agents writing property insurance, one in Beach City and another in Inland City, it is likely that the rate level in Beach City has a significant catastrophic load. If the loss ratio described above is used without an accurate allocation of the reinsurance cost, the Beach

City agent can be expected to post a better loss ratio, even if the book is less profitable. The underwriter could draw inaccurate conclusions about the profitability of the book and write more business at a less adequate rate. This could prompt the actuary to raise the price, leading the underwriter's report to show the Beach City agent to be even more profitable, and thus continuing the cycle.

In situations such as this, the actuary must use tools such as catastrophe models to assure that internal management information reports allow users to make accurate decisions. The actuary's job does not end when the rate filing is approved.

7 Conclusion

Computer modes will become increasingly important to actuaries in coming years. An actuary's ability to use these tools effectively is critical to the future health of our organizations and the property insurance industry as a whole. Actuaries must play a key role in educating the public about this issue and must combat the impression that models are incomprehensible black boxes.

Mr. Kozlowski and Mr. Mathewson's paper is an important step to educate the actuarial profession about the development and use of catastrophe models. I share their hope that the paper will stimulate new modeling ideas and enhancements.

Authors' Reply to Discussion

Ronald T. Kozlowski and Stuart B. Mathewson

We greatly appreciate the discussion of our paper that Mr. Musulin has provided. It adds further understanding to the use of catastrophe loss modeling in property insurance management.

Mr. Musulin commented that in 1992 the Insurance Services Office (ISO) used an excess wind factor based upon historical loss information. Today ISO recognizes the value of catastrophe modeling and now creates loss costs using these same models.

In his discussion of the insurance coverage module, Mr. Musulin expands the formula that we offered. We would like to clarify that the formula in our paper was simply a representative way to view the process. There are a myriad of possible combinations that will govern terms. The equation also varies depending upon whether policy levels or aggregated exposure data are provided. The discussant has shown how one of those more complex situations can be represented. We are grateful for Mr. Musulin's additional equation, as it gives one example of the complications that can arise in modeling insured loss, given a certain amount of damages to the insured property.

In Mr. Musulin's discussion of the section on reinsurance and excess modeling, he re-emphasizes the problem between pricing an unregulated reinsurance market and a highly regulated primary market. In some states regulators allow catastrophe reinsurance to be loaded as an expense in primary company rates.

We also would like to add that additional research can improve significantly the results of these models. The insurance industry needs more information about the long-term history of catastrophic occurrences as well as better information on actual building damage from these events. Today catastrophe modelers are using historical weather data from the past 100 years to predict losses at return times of 250 years or more. Current scientific research using pollen dating, coastal sediment, and tree rings can be used to estimate hurricane severity thousands of years ago. Earthquake scientists also are using new methods to better estimate earthquake frequency. For instance, paleoscismologists are using evidence from trenching to uncover evidence of large earthquakes that occurred before records were kept.

We believe that the insurance industry would be best served if insurance companies would pool their catastrophe loss data to validate the damage functions used in catastrophe models. These data should be provided in detail by location indicator (e.g., zip code), by construction, by policy type, and by any other factor deemed important to damage estimation. This type of validation should convince doubters that models are credible in their calculation of damages

Again, we thank Mr. Musulin for his thoughtful discussion, as it offers significant additional insight into this area.