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BUILDING A NERVOUS SYSTEM FOR INSURANCE PRODUCTS

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A COMBINATION OF RISK ANALYTICS AND PROCESSES CAN PROVIDE A BROADLY UNDERSTOOD NERVOUS SYSTEM FOR AN INSURANCE PRODUCT.

Insurance chief financial officers (CFOs), finance departments, analysts and others have had a long-standing aversion to assumption changes and reserve restatements. On top of this backdrop, the approach of principle-based reserving, Own Risk and Solvency Assessment (ORSA) disclosure, and the ongoing maturation of "control environment" concepts such as Sarbanes-Oxley and COSO (updated and expanded in 2013), create a need for actuaries to build consistency and discipline around the monitoring of insurance product assumptions. More than ever, this performance evaluation and assumption-resetting process will have an audience that includes senior management, boards, auditors, rating agencies and regulators, requiring that it be understandable and transparent to many, including those without deep statistical training. Such a combination of risk analytics and processes can be thought of as an insurance product's nervous system.

Consider insurance product assumptions as falling into two categories: market and product. Risk management by financial institutions has been primarily focused on the impact of systemic market risks under the first category. The volatility of interest rates, which began in the early '80s, foreign exchange volatility in the mid '80s, and the 1987 stock market crash provided the impetus for modern-day risk management. Subsequent market volatility has justified this development and intensified the focus.

MARKET ASSUMPTIONS

Our "information age" provides historic market data as well as forward-looking market views that can be used by all financial institutions for setting market assumptions and performing risk analysis. Because market levels represent a consensus, the credibility of market assumptions is not in question. Assumptions are easily monitored as new market data emerges. A common set of techniques and best practices—originally duration and convexity and more recently value at risk (VAR), conditional tail expectation (CTE), etc.—can be used to manage market risk across a wide range of financial institutions.

INSURANCE PRODUCT ASSUMPTIONS

Setting and updating product assumptions are much more challenging than market assumption as there is no fully credible data repository to look to. Even in situations where industry-level data is available, it may not be current and may be only partially relevant. This inherent challenge in setting initial assumptions means the process and analytics involved in updating assumptions are doubly important. Unfortunately, in situations where product assumptions have to be changed and reserves must be significantly increased, the impact on the company's market capitalization often far exceeds the dollar impact of the revision. The capital markets become concerned that other negative revisions are lurking, or that they should attach a degree of conservatism to all of the company's reserves. The capital markets have less transparency into product data and calculations than they do into market data and analysis, and therefore must place more trust in an insurance company's internal math. Sudden reserve increases based on product assumption changes weaken that fragile trust.

STANDARD DEVIATION EXAMPLE

To demonstrate how a nervous system could be defined, we modeled two hypothetical portfolios of T10 life insurance policies with the following characteristics:

- Portfolio A: 1,000 policies with average face amount of $500,000, all age 40.
- Portfolio B: 5,000 policies with average face amount of $100,000, all age 40.

If one assumes (more on this later) that the probabilities of death are known absolutely, and that the deaths are independent, the standard deviation of net claims from such a portfolio is calculated as follows:

$$\sqrt{\sum (Net\ Amt\ at\ Risk)^2 \cdot q_x \cdot (1 - q_x)}$$

Our hypothetical portfolios produce the following results. (See Chart I.)

CHART I

	PORTFOLIO A			PORTFOLIO B		
HORIZON	EXPECTED MORTALITY COST ($K)	ST. DEV. OF MORTALITY COST ($K)	COEFF. OF VARIATION (%)	EXPECTED MORTALITY COST ($K)	ST. DEV. OF MORTALITY COST ($K)	COEFF. OF VARIATION (%)
1 MONTH	14.2	84.0	594%	14.2	37.6	266%
3 MONTHS	42.5	145.6	343%	42.5	65.1	153%
12 MONTHS	169.9	291.3	171%	169.9	130.3	77%
36 MONTHS	587.8	541.3	92%	587.8	242.1	41%

The lower standard deviation of Portfolio B reflects its higher "granularity" than Portfolio A. Given the construction of the hypothetical portfolios, the standard deviation of Portfolio A is higher than Portfolio B by a factor of the square root of five. If one were to graph plus and minus one standard deviation, expressed as an actual-to-expected ratio against time, the result would be a narrowing "confidence band" over time. This phenomenon is sometimes referred to as the "diminishing funnel of doubt." (See page 32.)

The same analysis at age 50 shows expected mortality cost roughly tripling, while the standard deviation doesn't quite double, leading to coefficients of variation down almost by half.

The calculation and communication of these statistics at product inception help management and other interested constituents to understand how much natural variation (or "noise") should be expected from any given book of business. The same statistics can form the basis of an early warning system to identify where assumptions should be reviewed and revised if variation is greater than a level of noise commensurate with the granularity of the block and passage of time.

The analysis should appeal to actuaries who typically track actual-to-expected ratios, as well as finance departments and external analysts who think more in terms of raw dollars. Auditors will be interested in a consistent application of the process. Boards will be interested in all of these perspectives.

NERVOUS SYSTEM EXAMPLE

As an example of a consistent, disciplined nervous system, variation of one or more standard deviations would automatically trigger a review, whereas variation of two or more standard deviations would mandate a change in assumptions. The same standard can be applied at various time horizons. The "review" and "revise" trigger levels should be chosen to provide both an effective early warning indicator, as well as to balance the probability of an incorrect rejection of a correct assumption with a reasonably quick recognition of an incorrect assumption. There will always be a trade-off between these goals.

The analysis and process can be applied consistently across the insurance organization as part of a transparent assumptions policy. In our term insurance example, one could apply the approach to subsets of the block. Subsets will tend to have larger relative standard deviations but may show evidence of flawed assumptions at different parts of the age spectrum, by policy duration, or by underwriting class.

OTHER EXAMPLES

Withdrawal assumptions should be monitored in a similar way. The nervous system described is not as well-suited to the type of multidimensional withdrawal assumptions frequently used for financially oriented products, which often incorporate prevailing economic conditions. Applying the same principles and analytics to assumptions based on multiple factors is beyond the scope of this article, but an area where research would be welcomed.

CAPITAL

AS SHOWN in our two hypothetical portfolios of term life insurance policies, standard deviation is more effective in capturing projected variation than using expected values. In 2005, the Canadian regulator, the Office of the Supervisor of Financial Institutions (OSFI), introduced new mortality components in the MCCSR capital requirement. To reflect volatility risk, the new component utilized the standard deviation of the following year's death claims as one of its inputs. Standard deviation, and related measures, are used in many economic capital models.

CHART II

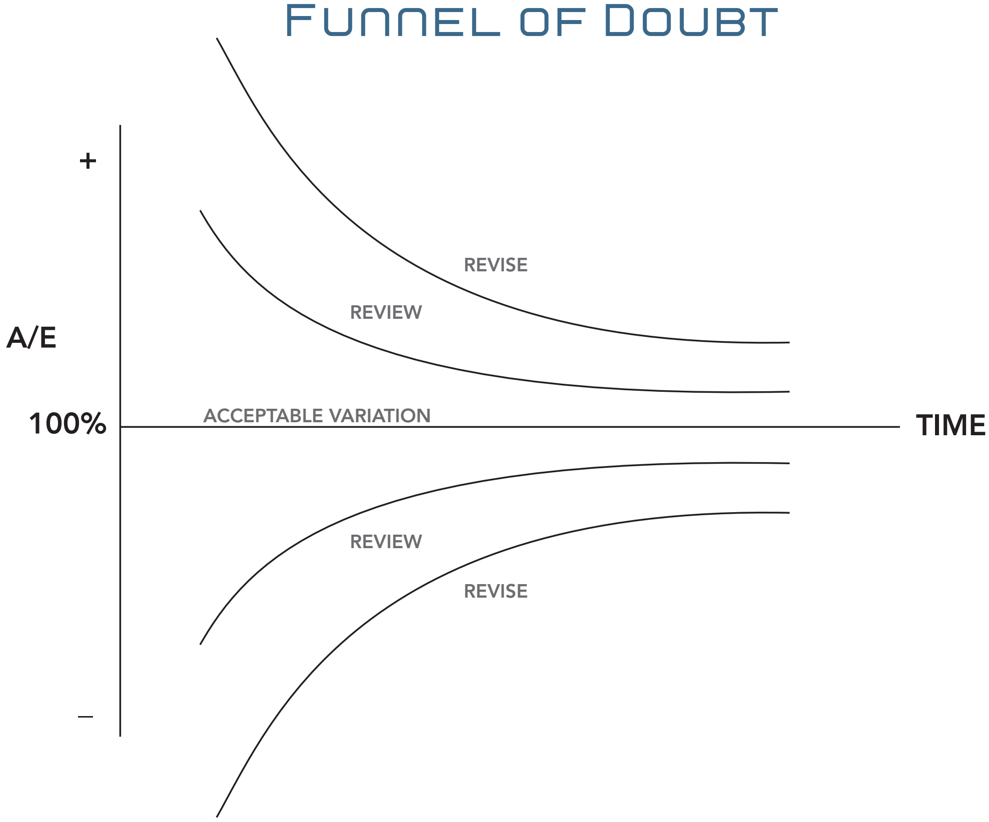
HORIZON	EXPECTED RESERVES RELEASE ($M)	ST. DEV. OF RESERVES RELEASE ($M)	COEFFICIENT OF VARIATION (%)
1 MONTH	0.59	0.33	57%
3 MONTHS	1.78	0.58	33%
12 MONTHS	7.00	1.14	16%
36 MONTHS	20.83	1.91	9%

The form of nervous system and assumptions policy outlined can easily be applied to annuitant mortality experience in a block of payout annuities. As an example, we modeled a hypothetical portfolio of 5,000 payout annuity policies, paying $1,000 per month, all age 65, single life. Using reserves as the "amount at risk" in the formula, the hypothetical portfolio produces the results shown in Chart II.

The same analytics can be applied to a defined-benefit pension plan.

Repeating the analysis for age 75 produces a much higher expected reserve release, a marginally higher standard deviation (in this case the "severity" of a death is the reserve release, not a relatively fixed dollar amount as in the term example), resulting in coefficients of variation reduced by roughly a third.

THE DIMINISHING FUNNEL OF DOUBT



As shown in both examples, for a particular vintage of policies, the dollar standard deviation will go up over short periods of time, while the coefficient of variation will go down, both roughly in proportion to the square root of time.

The standard deviation approach can be applied consistently to low- and high-frequency risks. It is not necessarily an indicator that the next "black swan" is around the corner, but it is a disciplined approach to the data that has been observed.

SEVERITY

For mortality and withdrawal decrements, severity tends to be known, and we are therefore concerned only with measuring the expected variation in frequency. In many insurance situations, assumptions must be made with respect to frequency and severity. In these situations, one approach would be to apply the same analytics and process to frequency and severity assumptions separately. As part of the same pragmatic approach, narrower "review" and "revise" thresholds might be applied to the sum of the frequency standard deviation and the severity standard deviation.

VERSUS PRAYER

Historically, the question of whether experience that varies from the assumption constitutes noise has been handled in two ways. In many situations, the question is hand-waved away for as long as possible in the hopes that it will subsequently disappear. As described earlier, this "pray silently for reversion" approach can eventually lead to large and sudden reserve increases, and a reduction of trust from the capital markets in the opaque processes within an insurance company,

THE TERM INSURANCE EXAMPLE provides insight into how such a tool could be used by a direct life writer to assess different mortality retention strategies. Measures of variation are invaluable to reinsurers for pricing portfolio stop-loss treaties, and for differentiating between noise and valuable experience resulting from treaties.

not to mention the relationship between the company's finance department and actuarial areas.

VERSUS CREDIBILITY

Credibility theory is often used by actuaries to set pricing assumptions and has also been used to assess what constitutes noise. Credibility thresholds tend to be calculated at a high confidence level and over long, fixed time horizons in order to translate into a "rule of thumb." As an example, the rule of thumb that 1,000 claims are necessary for full credibility originated in a 1962 paper by Longley-Cook.[1] The conclusion is only appropriate in the set of circumstances described in the paper, although it is often used without awareness of the context in which it was derived. (As an aside, perhaps all rules of thumb developed before the age of computing power should be reassessed.) It is interesting to note that in response to the approach of a principle-based environment and other developments listed at the beginning of the article, the scope of the actuarial standard of practice (ASOP) on credibility has been recently expanded to include life and pensions.

Credibility theory is not broadly understood. Wikipedia currently defines it as a branch of actuarial science. Also, actuaries use the word credibility itself in a different way than the general population, adding obfuscation. One of the two methods of credibility theory, Bühlmann-Straub, uses the standard deviation of the "population" as an input.

Both a standard deviation approach and a credibility approach are subjective. As the Federal Reserve states in its Bulletin on Model Risk Management:

> *Statistical tests cannot unambiguously reject false hypotheses or accept true ones based on sample information.*

Relative to the credibility approach, a standard deviation approach is easily applied at different confidence intervals and time horizons, making it a more effective nervous system to differentiate between noise and important variation. Also, the broader understanding of the standard deviation trigger mechanism (effectively the "front end" of an assumptions policy) by an audience well beyond statistically trained actuaries and risk managers is critical to wider adoption and ultimate success.

QUARTERLY RESULTS

As examples of the need for standards of practice in this area, the recently completed quarterly public insurance company investor calls have included:

- A CEO assuring analysts that the weaker mortality result was not systemic
- A very large reserve increase resulting from an assumption change
- A CEO describing the reserving discipline his actuaries will have going forward.

GOING FURTHER

A thorough assumptions policy (as an element of model governance) should extend beyond the early warning system outlined in this short article. As an example, a natural sequel would be a disciplined and consistent process to change an assumption, once the nervous system indicates the need. Going even deeper, the topic of parameter uncertainty (we do not know the decrements absolutely) should be addressed within reserving and/or economic capital models.

The analytics described here, while simple, represent a confluence between risk management, finance and product development into a properly controlled and transparent principle-based environment, a challenge many of us will face. A

END NOTE

[1] L. H. Longley-Cook, "An Introduction to Credibility Theory," PCAS, XLIX (1962), 194.

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