Risk Transfer Testing of Reinsurance Contracts

A Summary of the Report by the CAS Research Working Party on Risk Transfer Testing

by David L. Ruhm and Paul J. Brehm

ABSTRACT

This paper summarizes key results from the Report of the Casualty Actuarial Society (CAS) Research Working Party on Risk Transfer Testing. The Working Party defined and described a structured process of elimination to narrow down the field of reinsurance contracts that have to be tested for risk transfer. Perhaps more importantly, the Working Party offered two metrics for gauging risk transfer that are superior to the standard "10-10" Value-at-risk (VaR) test commonly used: the expected reinsurer deficit (ERD) and right-tailed deviation (RTD). These metrics are described, with examples. A related metric, the risk coverage ratio (RCR), is also described.

KEYWORDS

Conditional tail expectation (CTE), expected reinsurer deficit (ERD), FAS 113, parameter risk, risk coverage ratio (RCR), risk transfer testing, value-at-risk (VaR)

1. Introduction

In the summer of 2005, the CAS formed a Working Party to address the topic of risk transfer testing for reinsurance contracts. The Working Party was established in response to a request from the American Academy of Actuaries Committee on Property and Liability Financial Reporting (COPLFR). The COPLFR request was multifaceted, but the gist of the request was to identify effective tests for risk transfer along with threshold criteria to establish whether transfer exists.

The Working Party addressed COPLFR's questions in a 60-plus page report [2], issued in the late summer of 2005. This paper summarizes the Working Party report, primarily focusing on the recommended risk metrics for risk transfer tests. We will briefly describe and illustrate two risk measurement methods, expected reinsurer deficit (ERD) and right-tailed deviation (RTD). A third method that is related to ERD, risk coverage ratio (RCR), also will be described.

This paper is organized into four subsequent sections: Section 2 describes the testing process, Section 3 describes the expected deficit risk measures (ERD and RCR), Section 4 covers RTD, and the final section is the conclusion and summary.

2. Risk measurement and the risk transfer testing process

Risk measurement has several practical uses. It is essential to risk management because risk can be controlled more effectively if it is measured. Accurate risk measurement is also useful in pricing, to ensure that the expected profit from a deal is sufficient to compensate for the risk being assumed. Another closely related use is risk-based capital allocation. If capital is allocated in proportion to risk, then pricing for risk will correspond to earning an adequate return on risk-based capital.

Another need for risk transfer testing—and the genesis of the CAS Working Party—stems from accounting regulations. Accounting systems treat insurance contracts differently than noninsurance financial contracts, with the transfer of risk being a key determinant of the contract's status. If a contract transfers risk, the contract is accounted for as (re)insurance. For example, if an insurer purchases a reinsurance contract, ceded premiums are treated as a reduction to income and ceded incurred losses are treated as a benefit to income, with the net effect of the two passing to the company's bottom line earnings in the current period. If this contract does not transfer risk, funds paid as premiums are considered a deposit and the net costs/benefits (typically benefits for the contracts in question) are amortized into earnings over time (treatment varies between Generally Accepted Accounting Principles [GAAP] and Statutory accounting). To ascertain whether a contract transfers risk, one needs a credible, reliable, and robust measure of risk, as well as some standard for what constitutes enough risk transfer to qualify as "insurance."

Financial Accounting Standard (FAS) 113 for GAAP accounting and Statement of Statutory Accounting Principle (SSAP) 62 for Statutory accounting define the risk transfer requirements. The GAAP and Statutory requirements are very similar. In order to receive reinsurance accounting, a contract must satisfy at least one of two conditions:

1. The reinsurer must assume "substantially all" of the underlying insurance risk, or
2. The reinsurer must assume "significant" risk; that is, it must be "reasonably possible" that the reinsurer can suffer a "significant loss."

The terms in quotes above are critical but also undefined in the accounting regulations. The regulations do provide broad guidance for the required elements of a test of risk transfer. For a further description of FAS 113, SSAP 62, and

testing considerations, see, for example, CAS Valuation, Finance, and Investment Committee (VFIC) [3].

The Working Party report, like the VFIC paper before it, took FAS 113 and SSAP 62 as given. The focus was on risk transfer testing given the existing regulations, not debating the existing regulations.

The Working Party proposed a testing framework that can be characterized as a three-step process:

1. Determine if the contract transfers "substantially all the risk." If so, stop. If not, continue to step 2.
2. Determine whether or not the risk transfer is "reasonably self-evident." If so, stop. If not, continue to step 3.
3. Calculate recommended risk metrics and compare the values to critical threshold values.

To evaluate "substantially all the risk" the Working Party recommended that "if the downside risk assumed by the reinsurer is essentially the same as that faced by the cedant with respect to the original unreinsured portfolio, then the contract transfers 'substantially all the insurance risk.'" It was suggested that this could be proven by a review of the downside scenarios or by a comparison of downside risk metrics.

If a contract does not transfer "substantially all risk," the Working Party recommended a second step to exclude from testing those contracts where the risk transfer is "reasonably self-evident." This is not a concept introduced by the accounting rules, but rather a real-world convenience to relieve cedants from the burden of testing every contract, especially those where the risks are obvious or the accounting statement impact immaterial. Examples of contracts in this category include

1. Standard individual risk and catastrophe excess of loss contracts,
2. Excess of loss contracts without any loss-sensitive features, and
3. Contracts with an immaterial premium, say less than or equal to $1 million or 1% of primary premium.

The original Working Party report discusses these sorts of contracts in more detail, provides examples, and offers in-depth rationale for said treatment.

If a contract does not transfer substantially all the risk or the risk transfer is not reasonably self-evident, it must be tested further. For this category of contracts, the Working Party made two key points. First, in developing a parameterized model of a distribution for the purpose of computing risk metrics, care must be taken to reflect both process risk and parameter risk. Second, given a distribution of contract results, risk metrics must be computed and compared to a critical threshold value. The Working Party made the point that the long-standing industry practice of evaluating risk transfer with the "10-10" rule (a 10% chance of a 10% loss) was insufficient. An alternative measure—the ERD—was recommended instead, along with a threshold value.

Since the recommendation of ERD is central to the Working Party's report, it is treated in more detail in the next section.

3. Expected reinsurer deficit

The ERD is defined as follows:

$$\text{ERD} = pT/P, \tag{3.1}$$

where

p = probability of net income loss;

T = average severity of net economic loss, when it occurs; and

P = expected premium.

The ERD measure is derived from the probability distribution of net economic outcomes. The critical point in the distribution is economic breakeven, where net gain is exactly zero. The

part of the distribution below breakeven, where net economic loss occurs, is the risk zone. ERD is based on defining "risk" as the probability of net economic loss times the average loss severity, measured against expected premium as the base.

The term "economic" as used here means

- Total return basis: all economic components of the business are captured (not only premiums and losses), and
- Net present value, to include time value of money in the calculation.

The loss distribution alone is not sufficient to calculate ERD. Losses are usually a major component of the total return distribution. Premium, expense, and investment income as well as any loss-sensitive, variable contract terms, and other financials relevant to the total return are also included, at net present value.

The rates used for calculating net present value should be risk-free, with maturities reflecting timing of cash flows. If a risk-adjusted rate is used, then the economic gain distribution will already be risk-adjusted, before using ERD to measure the risk. Applying an ERD measurement to such a risk-adjusted distribution will result in an overestimate of the risk, from what amounts to "double counting." After-tax or pre-tax rates can be used, depending on the model structure context, with after-tax rates generally used to discount after-tax cash flows and pre-tax rates generally used to discount pre-tax cash flows.

For example, suppose an excess catastrophe reinsurance contract has the following terms and parameters (simplified for illustration, all figures hypothetical):

Loss layer:	$250 million excess of $500 million
Settlement:	One year after inception
After-tax investment yield:	4.00% (1-year U.S. Treasury, at inception)
Premium:	$10 million, payable at inception (fixed)

Loss distribution for the 250 excess of 500 layer:

Layer loss amount	Probability	Net gain/(loss), net present value
0	96%	10,000,000
50,000,000	2%	(38,077,000)
150,000,000	1%	(134,231,000)
250,000,000	1%	(230,385,000)

Expected = 5,000,000

The net gain amounts are calculated using the following formula:

$$G = \text{Net gain} = \text{Premium} - \text{Loss}/1.04. \tag{3.2}$$

This formula puts all cash flows on the same net present value (NPV) basis. The ERD is then calculated as follows (dollars in thousands, rounded):

p = probability of net loss

$= 2\% + 1\% + 1\% = 4\%$

T = average severity of net loss ($ in thousands)

$= (38{,}077 \times 2\% + 134{,}231 \times 1\% + 230{,}385 \times 1\%)/4\%$

$= 110{,}193$

$\text{ERD} = pT/P = (4\%)(110{,}193)/10{,}000 = 44.1\%.$

This ERD level is relatively large. For comparison, the 10-10 rule that had been commonly used as the threshold for risk transfer requires a 10% chance of a 10% net loss (relative to premium). This would correspond to an ERD threshold of $10\% \times 10\% = 1\%$, in the sense that a contract that narrowly passed both parts of the 10-10 rule would have an ERD slightly above 1%. The relationship between ERD and the 10-10 rule is explored in further detail below ("ERD and the 10-10 rule").

The contract in this example would not pass the 10-10 rule, since there is only a 4% chance of net loss, which is less than the required 10% chance. But the risk transfer in ERD terms is 44 times that of a contract narrowly passing the 10-10 rule. This illustrates a weakness of the 10-10

rule: it fails to recognize low-probability, high-severity risk transfer. ERD corrects this problem.

This example, being a catastrophe cover, would qualify as insurance in any case since it is a type of contract for which risk transfer is considered "self-evident," as discussed above. It is shown in order to clearly demonstrate the ERD math and to demonstrate the robustness of the ERD measure, particularly in comparison with the 10-10 rule. Theoretically, if risk transfer is self-evident then we should be able to measure it. The ERD measurement recognizes the "self-evident" risk transfer in the catastrophe category, providing a method for quantifying the intuitive assessment.

Actual examples have more details that need to be modeled in order to produce the net gain distribution, yet the procedure is the same:

1. Produce the probability distribution of net present value ("economic") gain, including all components;
2. Identify the part of the distribution containing net losses;
3. Measure the probability of loss and its average severity when it occurs;
4. Apply the ERD formula [3.1].

3.1. ERD's relationships to other risk metrics and methods

Every risk metric is based on an implicit definition of what "risk" is. As discussed above, ERD defines risk as the product of frequency and severity of net economic loss, which is intuitively appealing. The critical point where risk begins is economic breakeven, which defines risk on more of an economic than a statistical basis.

Probability of ruin is concerned with the ruin point in the distribution, often using a distribution with a one-year time horizon. Non-ruin loss possibilities (some of which are substantial) are not measured, although several years of large losses in a row might precipitate ruin. The possibilities of loss beyond ruin are also not measured for their potential severity and resulting impact on policyholders, an issue that Butsic [1] addressed with his Expected Policyholder Deficit (EPD) methodology.

Value-at-risk (VaR) defines risk by a percentile, such as the 95th percentile of annual loss. This definition is statistical, rather than economic, in nature. VaR addresses the question, "What level of loss is unlikely to occur over the next year, at a particular level of confidence?" VaR has the same single-point-focus limitation as probability of ruin—values above and below the critical value aren't measured. The 10-10 rule that had been in common use for risk transfer testing required at least a 10% probability of at least a 10% loss, or VaR(90%) > 10% of premium.

Tail value-at-risk (TVaR), also known as conditional tail expectation (CTE), is the average severity of the worst outcomes. Like probability of ruin and VaR, the TVaR measure uses a percentile; the average outcome in the worst 10% of cases would be called "TVaR(90%)." TVaR is also statistical, since specifying a fixed percentile parameterizes it. Unlike probability-of-ruin and VaR, TVaR captures the entire tail beyond the specified percentile rather than one point.

TVaR is generally used to measure the average capital that would be consumed by an unusual, adverse event. The percentile specifies what is considered "unusual." A drawback to TVaR is that it is usually based on a fixed percentile (such as the 95th) and often does not capture all of the economic loss outcomes. Also, TVaR does not measure the probability of economic loss.

TVaR is related to ERD. The variable "T" in ERD's formula [3.1] is the TVaR of the total return distribution at the percentile where breakeven occurs $(1 - p)$. In the example above, the calculation of ERD uses $p = 4\%$, and TVaR(96%) = 110,193,000, which is the average tail severity T.

3.2. ERD and the 10-10 rule

The 10-10 rule has been, and still is, commonly used to test for risk transfer. The rule requires that there be at least a 10% probability of at least a 10% loss, relative to premium. Assuming that the loss used in the 10-10 rule is on an economic basis, a contract that passes the 10-10 rule has an ERD of at least 1%:

$$\text{ERD} = pT/P = p(T/P) > 10\%(10\%) = 1\%.$$

In this way, the 10-10 rule corresponds to a 1% ERD rule. A 1% ERD rule will admit all contracts that pass the 10-10 rule. However, a 1% ERD rule will also admit some contracts that do not meet the 10-10 rule, but that do transfer risk. These generally fall into two categories:

- Low-frequency, high-severity risks, such as catastrophe covers;
- High-frequency, low-severity risks, such as some quota share deals.

The example given above illustrates the first type. An example of the second type would be a simple quota share of a stable, primary line of business having a 40% probability of net loss, where the average loss is 4% of premium (104 combined ratio, net present value basis) and the likelihood of a 10% loss is very remote, say 2%. The 10-10 rule is not met because a 10% loss has less than a 10% probability. The ERD is $40\% \times 4\% = 1.6\%$, which would pass a 1% ERD risk transfer test.

In their report, the Working Party specifically stated that they were not endorsing any particular model or framework. The report also stated, "…if the 1% ERD method were adopted as a de facto standard replacing the '10-10,' we would consider that a good outcome" [2].

3.3. Risk coverage ratio (RCR)

A risk metric that is closely related to ERD is the RCR, which measures risk relative to expected return, instead of premium. RCR is defined by several equivalent formulas, one of which is

$$\text{Risk Coverage Ratio (RCR)} = \text{E}[G]/(pT), \tag{3.3}$$

where

$\text{E}[G]$ = expected economic gain across all possibilities,

p = probability of net economic loss, and

T = average severity of net economic loss, when it occurs.

As with ERD, the distribution of net economic outcomes is the basis for RCR. The denominator of RCR is the same tail risk that is used in the numerator of ERD, namely the product of the tail's frequency and severity.

RCR is the amount of expected profit per unit of risk assumed. The name derives from an analogy to debt "coverage" ratios used in financial analysis. RCR measures how many times the risk of losing money is "covered" by expected return. RCR is similar to the Sharpe ratio used in finance, with the downside-tail measure of risk below breakeven used in place of the Sharpe ratio's standard deviation.

RCR can also be expressed in reciprocal form as risk per dollar of return, which makes its relationship to ERD even clearer:

$$\text{RCR, \% form} = pT/\text{E}[G]. \tag{3.4}$$

For example, if a contract or line of business has an RCR of 8.0, the percentage form of RCR would be 12.5%.

ERD measures the tail risk as a percentage of premium, while RCR compares the tail risk to expected gain. In short, ERD is a risk/premium measure, while RCR is the corresponding risk/return measure. This can be shown by writing RCR's formula in terms of ERD, with expected return on expected premium in the denominator:

$$\text{RCR, \% form} = \text{ERD}/(\text{E}[G]/P). \tag{3.5}$$

3.4. RCR example

Continuing with the example above, we can calculate the RCR and compare the results to the ERD measure. From above, $p = 4\%$ and $T = 110{,}193{,}000$. We can calculate $\mathrm{E}[G]$ using the right-hand column of net gain in the example's table:

$$\mathrm{E}[G] = 10{,}000 \times 96\% - 38{,}077 \times 2\% - 134{,}231 \times 1\% - 230{,}385 \times 1\%$$

$$\mathrm{E}[G] = 5{,}192{,}000.$$

Then,

$$\mathrm{RCR} = \mathrm{E}[G]/(pT) = 5{,}192{,}000/[(4\%)(110{,}193{,}000)] = 1.178$$

$$\text{RCR, \% form} = 1/1.178 = 84.9\%.$$

The risk/return ratio is 84.9%. In essence, the expected return has an 84.9% "risk concentration." This number is about double the 44.1% ERD, because the expected gain, which is the base for RCR, is about half of the premium.

RCR's formula does not explicitly use premium volume. As a result, RCR is unaffected by the presence of "traded dollars" in premium that have no net impact on risk or return. Premium-based measures such as ERD respond to premium size and are affected by traded dollars, which is useful since a preponderance of traded dollars would indicate that a deal may be more financing than insurance in nature.

Applications of RCR include pricing and capital allocation [4].

3.5. Advantages of ERD and RCR versus other risk metrics

There are two main features of ERD and RCR that distinguish them from other risk metrics:

- The cutoff point for risk is economic breakeven, rather than a statistical percentile,
- Frequency and severity of potential loss are incorporated.

An economic definition of risk could be considered more meaningful than a statistical definition based on a percentile, because the impact of risk on a company is in economic terms. For example, a net loss of $10 million leaves the company $10 million weaker, regardless of whether it is a 5th percentile event or a 10th percentile event. The ERD and RCR metrics capture all capital-destroying loss events, while statistically based metrics generally do not.

4. Right-tailed deviation measure

Members of the Working Party were unanimous in their belief that ERD was a superior risk measure to VaR. However, the Working Party was not unanimous in the selection of ERD as the best measure. A number of members preferred a class of risk measures based on distributional transforms (see, for example, Wang [5]). In the end it was agreed that distributional transforms do have benefits that ERD does not, but at the added cost of complexity. The final Working Party recommendation reflected the members' differing views on the trade-off between information and complexity.

Right-tailed deviation (RTD), proposed by Shaun Wang, is a member of the distributional transform family of measures. For a given cumulative distribution function, $\mathrm{F}(x)$, define $\mathrm{F}^*(x)$ as

$$\mathrm{F}^*(x) = 1 - [1 - \mathrm{F}(x)]^{0.5} \qquad (4.1)$$

Wang considers other distributional transforms, some of which are generalizations of [4.1], with exponents other than 0.5 on the right-hand side of the equation.

Since $\mathrm{F}(x)$ is a number in $[0,1]$, $\mathrm{F}^*(x) < \mathrm{F}(x)$ for all x. That is, the transformed distribution is shifted to the right. This, in turn, implies

$$\mathrm{E}^*[x] \geq \mathrm{E}[x]. \qquad (4.2)$$

One can think of $E^*[x]$ as the mean of a distribution that has been loaded for risk. Thus the difference between $E^*[x]$ and $E[x]$ is the risk load. This risk load is Wang's RTD risk metric:

$$RTD(x) = E^*(x) - E(x). \qquad (4.3)$$

It is easy to see the application of distributional transforms to pricing applications. In fact, one of the appeals of RTD (or transforms in general) is that $F^*(x)$ is simply a new loss distribution, so all of the usual math and metrics apply.

Wang proposes a risk transfer test called the "maximum qualified premium," which is a multiple of the RTD, say $\alpha RTD(x)$. If $\alpha RTD(x)$ is greater than the contract premium, one concludes that risk transfer exists.[1] Wang recommends α in a range from 3 to 5, though the Working Party observed that $\alpha = 4$ was perhaps too low. The topic of threshold values needs further research.

Following is a sample calculation of RTD using the same example from Section 3.

Layer loss amount	$F(x)$	$F^*(x)$
0	96%	80% (= 1 – [1 – .96]$^{1/2}$)
50,000,000	98%	86%
150,000,000	99%	90%
250,000,000	100%	100%
Expected =	5,000,000	34,000,000

Then from [4.3],

$$RTD = 34{,}000{,}000 - 5{,}000{,}000 = 29{,}000{,}000.$$

If an α of 5 is used, $\alpha RTD = 145{,}000{,}000$. In this test, any contract with premium equal to or less than $145,000,000 would presumably pass risk transfer.

5. Conclusion

The CAS Working Party on Risk Transfer Testing made a significant, thorough contribution to the literature on risk transfer. This paper has simply summarized some main points from that work for the CAS membership, with additional examples.

The Working Party offered two metrics for gauging risk transfer that are superior to the standard 10-10 (VaR) test commonly used: the expected reinsurer deficit (ERD) and the right-tailed deviation (RTD). Furthermore, an ERD threshold value of 1% was suggested as one possible threshold for risk transfer. In addition, the Working Party defined a structured process of elimination to narrow down the field of reinsurance contracts that have to be tested, describing the concepts of "substantially all the risk" and "reasonably self-evident."

The Working Party concluded their report with two recommendations for further study: "Level 1"—research on consensus thresholds, and "Level 2"—research on other methods, including ways of determining that "substantially all the risk" has been transferred, methods of determining a "reasonably possible" chance of "significant loss," and methods for incorporating parameter uncertainty into the testing.

In the end, the Working Party report, like other efforts before it, was written within the confines of FAS 113 and SSAP 62. Perhaps another area of research could encompass an actuarial perspective on risk transfer that is not constrained by current accounting rules.

[1] Note that the test of $\alpha RTD(x) \geq$ premium is equivalent to saying that the ratio of indicated risk load to actual premium is greater than $1/\alpha$.

References

[1] Butsic, Robert P., "Solvency Measurement for Property-Liability Risk Based Capital Applications," Casualty Actuarial Society *Discussion Paper Program* 1, 1992, pp. 311–354.

[2] CAS Research Working Party on Risk Transfer Testing, "Risk Transfer Testing of Reinsurance Contracts: Analysis and Recommendations," Casualty Actuarial Society *Forum*, Winter 2006, pp. 281–347.

[3] CAS Valuation, Finance, and Investment Committee, "Accounting Rule Guidance Statement of Financial Accounting Standards No. 113—Considerations in Risk Transfer Testing," Casualty Actuarial Society *Forum*, Fall 2002, pp. 305–338.

[4] Ruhm, David L., "Risk Coverage Ratio: A Leverage-Independent Method of Pricing Based on Distribution of Return," presented at ASTIN Colloquium, 2001.

[5] Wang, Shaun, "A Universal Framework for Pricing Financial and Insurance Risks," *ASTIN Bulletin* 32:2, 2002, pp. 213–234.