

Article:  
**Insurance risk transfer and  
categorization of reinsurance contracts**

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# Executive summaries

## **Insurance risk transfer and categorization of reinsurance contracts**

by **Eugene N. Gurenko**, Lead Insurance specialist, World Bank Capital Markets and Non-Bank Finance Practice, World Bank, **Alexander Itigin**, Consultant, World Bank, and Senior Actuary at a global reinsurance company, and **Renate Wiechert**, Consultant, World Bank, and Accounting Policy Consultant at a global reinsurance company

Despite the existence of numerous quantitative approaches to the categorization of financial reinsurance contracts, insurance regulators may often find the practical implementation of the task to be technically challenging. This paper develops a simple, affordable and robust regulatory method that can help insurance regulators categorize whether financial reinsurance contracts classify as reinsurance. By reviewing real examples of different categorization methods, this paper explains how the proposed method, the Standardized Expected Reinsurer's Deficit (SERD), standardizes such categorization. It also summarizes the existing pertinent literature on the subject with the view to helping insurance regulators to first apply some simple indicators to flag the main issues with financial reinsurance contracts that may need further reviews.

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# Insurance risk transfer and categorization of reinsurance contracts

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### **Abstract**

Despite the existence of numerous quantitative approaches to the categorization of financial reinsurance contracts, insurance regulators may often find the practical implementation of the task to be technically challenging. This paper develops a simple, affordable and robust regulatory method that can help insurance regulators categorize whether financial reinsurance contracts classify as reinsurance. By reviewing real examples of different categorization methods, this paper explains how the proposed method standardizes such categorization. It also summarizes the existing pertinent literature on the subject with the view to help insurance regulators to first apply some simple indicators to flag the main issues with financial reinsurance contracts that may need further reviews.

Having identified the suspicious reinsurance contracts, supervisors may consider several solutions provided by the authors and, in some cases, requiring further quantitative testing of risk transfer contracts for categorization purposes; supervisors may also consider adopting the Standardized Expected Reinsurer's Deficit (SERD) approach to contract testing presented in this paper. The approach advocates the use of a simple standardized stochastic method that would allow market participants and regulators to perform robust quantitative tests quickly, and at an affordable cost. Besides addressing the obvious drawbacks of the "10-10" test, the proposed alternative method makes it possible to greatly reduce the technical challenges posed to the users of the Expected Reinsurer's Deficit approach based on full stochastic models with only a minimum loss of predictive accuracy.

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<sup>1</sup> We are very grateful for useful comments provided by our colleagues Charles Michael Grist, Senior Insurance Specialist, World Bank, and John Daniel Pollner, Lead Financial Officer, World Bank. The comments made in this article are those of the authors and are in no way representative of the views of the World Bank, or any of their associate organizations.

## Introduction

Financial reinsurance, often referred to as “finite risk reinsurance” or just “finite reinsurance,”<sup>2</sup> is a form of transaction between a reinsurance company and its client, which focuses mainly on purely financial effects such as capital management, solvency relief, influencing financial and earnings position, etc. rather than on the transfer of insurance risk, as is the case in traditional reinsurance. Very often financial reinsurance contracts combine features of both, a financial effect oriented financial instrument and a risk transfer oriented traditional reinsurance transaction. Categorization of such mixed financial reinsurance contracts and their eventual acceptance for supervisory purposes often becomes rather challenging and technically complex.

Despite the existence of several approaches to categorize financial reinsurance contracts, their technical complexity makes them practically unusable for insurance supervision purposes, particularly in developing countries. As a consequence, proper categorization of reinsurance contracts continues to remain a major challenge for many market players and insurance regulators, leaving ample room for mistakes, potential abuses and malpractice.

The paper aims to address this problem by first providing a thorough overview of the existing categorization methods, and then, presenting a simple and easy-to-implement quantitative regulatory method. The proposed method is much simpler and less costly than the current ones used in the market.

### Why a correct categorization of reinsurance contracts matters

Besides transferring insurance risk, usually to a limited extent, financial reinsurance contracts also address other objectives, like financing or smoothing the profit and loss results. Consequently, from the outset, one has to determine whether the contract is transferring insurance risk at all, or only deals with financial risks. For example, a contract that protects only the investment results of a client does not transfer any insurance risk. In addition, loans, even if written as reinsurance contracts, by their economic nature will still remain financial instruments despite their disguise.

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2 Financial reinsurance is also known as ‘non-traditional reinsurance,’ ‘limited risk reinsurance,’ or ‘structured reinsurance.’ Historically, the term “financial reinsurance” was used; however, as some fraudulent transactions took place in the past, the term “financial reinsurance” got a negative reputation. Consequently, the industry had established the new term “finite risk” or just “finite” to make clear that these contracts have sufficient risk transfer.

While the existing common international accounting guidelines, like International Financial Reporting Standards (IFRS) or the U.S. Generally Accepted Accounting Principles (US-GAAP), already provide guidance on how to distinguish between financial and insurance contracts, sometimes a contract may contain both elements, i.e., financial and insurance risks, thus making the application of existing guidance more difficult. In such cases, the contract may have to be separated into individual elements (so-called “unbundling”) to enable the application of the guidelines.

If it can be demonstrated that a contract transfers insurance risk, then an assessment has to be made of the amount of insurance risk transferred to a reinsurer. Depending on the contractual content and the accounting environment, those contracts that fail to provide enough risk transfer are categorized as financial instruments or accounted for under “deposit accounting”<sup>3</sup> with no effect on underwriting results.

In most countries with well-developed insurance regulatory regimes, insurance companies are required by law to differentiate between traditional and financial reinsurance contracts in their statutory financial reporting.<sup>4</sup> Those contracts that do not transfer enough risk to a reinsurer disqualify the cedant from obtaining solvency capital relief. Such adverse practical implications of regulatory categorization decisions underscore the importance of developing an accurate and easy to administer categorization method.

As has been already mentioned, in the use of financial reinsurance there might be cases of malpractice. The most common are the attempts to disguise self-financing (or borrowings) as a legitimate risk transfer for obtaining solvency relief or for smoothing the underwriting results. For regulatory purposes, therefore, it is important to define methods which would provide for adequate categorization of such contracts as either reinsurance or financial instrument/deposit accounting.

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3 An U.S.-GAAP accounting method for the recognition of (re)insurance contracts without significant insurance risk transfer. Only the reinsurer’s margin is reported in the profit and loss statement, such that no premiums, commissions, or incurred losses are recorded. In the balance sheet also only a net asset or liability is reported.

4 For example, the E.U. Directive 2005/68/EC on reinsurance established a definition and some general criteria for financial reinsurance. It allows home member states to lay down specific provisions concerning the pursuit of financial reinsurance activities, like mandatory contract components, administrative and accounting procedures, internal control mechanisms, risk management requirements, accounting, prudential, and statistical information requirements, or rules relating to the available solvency margin [E.U. Council of Ministers (2005)].

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The key to the categorization of reinsurance contracts lies in estimating the proportion of risk transfer obtained by a cedant through a given reinsurance transaction. To determine the extent of risk transfer in a reinsurance treaty, regulators may need to conduct quantitative tests. The main problem with the application of quantitative tests is their technical complexity, which considerably impairs their wide-spread use by the market and insurance regulators. Often, (re)insurance companies and regulatory bodies cannot perform quantitative tests on their own due to the lack of specialized technical resources. As a result, they may have to employ specialized actuarial consulting companies, which may be expensive or, in the case of developing countries, simply not available.

According to the International Association of Insurance Supervisors (IAIS), reinsurance is a key instrument for insurers and supervisors to conduct risk management [IAIS (2006)]. The insurance industry has significantly benefited from many product innovations. However, these innovations often bring along complex definitions of reinsurance contracts that not only affects insurers' risk management practices and capital management but also their economic solvency and the regulatory treatment of solvency relief typically sought by insurers under reinsurance contracts [IAIS (2006)].

To date, there is no globally accepted definition of financial reinsurance. However, a typical transaction in many cases would include risk-limiting features like a self-retention of some risk by the insurer structured as a loss corridor, loss cap, or an aggregate limit of liability. Adjustable commissions, like sliding scale or profit commissions, or experience refunds in case of a positive or negative performance are also often used for aligning the interests of insurers and reinsurers. Financial reinsurance contracts are also often set up for multiple years and/or multiple lines of business to reduce volatility and aggregate risk. Although the IAIS lists these and some other characteristics of financial reinsurance contracts<sup>5</sup>, it also points

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5 The IAIS list of most common features of risk financing instruments versus reinsurance contains the following characteristics: a) insurance risk transfer and financing are combined, b) assumption of limited risk by the reinsurer (e.g., aggregate limit of liability, blended cover, sliding scale and other adjustable commissions, loss corridors, and limits or caps), c) transfer of volatility (e.g., multiple lines of business, multiple years of account, and multiple year contract terms), d) inclusion of future investment income in price of contract (recognition of time value of money with funds withheld), e) potential profit sharing between parties (e.g., profit-sharing formulas, experience accounts), f) pricing determined by ceding insurers' results and not reinsurance pricing cycle, and g) terms and pricing are typically determined in advance for the whole a block of new or in-force business (i.e., administration of reinsurance is done on a bulk basis rather than on a traditional seriatim policy-by-policy basis).[IAIS (2006)]

out that these could also be present in traditional reinsurance, thus rendering this guidance impractical in some cases [IAIS (2006)].

Under the E.U. directive 2005/68/EC Article 2, paragraph 1 (q) financial reinsurance is defined as follows: "'finite reinsurance' means reinsurance under which the explicit maximum loss potential, expressed as the maximum economic risk transferred, arising both from a significant underwriting risk and timing risk transfer, exceeds the premium over the lifetime of the contract by a limited but significant amount, together with at least one of the following two features: (i) explicit and material consideration of the time value of money; (ii) contractual provisions to moderate the balance of economic experience between the parties over time to achieve the target risk transfer" [E.U. Council of Ministers (2005)].

As there can never be an exclusive list that defines the contract's categorization, risk transfer assessments should always be conducted on a case by case basis. In the absence of a standardized approach there is ample room for misinterpretations, misrepresentations, and abuses (e.g., avoiding ratings downgrades by employing financial smoothing instruments, saving taxes, circumventing creditor lending conditions by disguising new borrowings as reinsurance, or avoiding or delaying supervisory intervention to prevent breaches of solvency) [IAIS (2006)]. As a result, there is an urgent need for a standardized practical approach to a robust regulatory classification of risk transfer contracts.

### How to categorize contracts as reinsurance

As a first step, it has to be determined whether the reinsurance contract transfers insurance risk (e.g. a book of motor or liability insurance policies is reinsured) or financial risks.<sup>6</sup> If under the relevant local statutory and accounting provisions, a contract can be seen as transferring financial risk only, then no further categorization is required. Such a contract cannot be considered as reinsurance and has to be accounted for under the investment result.

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6 For example IFRS 4 Appendix A defines financial risks as: "The risk of a possible future change in one or more of a specified interest rate, financial instrument price, commodity price, foreign exchange rate, index of prices or rates, credit rating or credit index or other variable, provided in the case of a non-financial variable that the variable is not specific to a party to the contract." [IASB (2004)]

If the contract transfers insurance risk it has to be determined whether the risks transferred are sufficient to allow for reinsurance accounting. However, not every reinsurance contract must be tested. Under U.S.-GAAP and the NAIC<sup>7</sup> regulations, the so-called “reasonably self-evident exception” or “safe harbor exception” has become common practice. It says that reinsurance contracts that contain only traditional contractual components do not have to be tested for a sufficient amount of risk transfer. Only in cases where a contract includes some characteristic risk transfer limiting features will a quantitative testing have to be performed.

### Reasonably self-evident contracts

While the notion of “reasonably self-evident” is often not explicitly referenced in the accounting standards, it has become common practice. In essence, “reasonable self-evident” means that the given reinsurance contract can be seen as traditional reinsurance. For such contracts an explicit evaluation of risk transfer is not required. They are seen as “per definition” transferring a sufficient amount of risk. Obviously, evaluating risk transfer for each contract, irrespective of whether it is classified as traditional or financial reinsurance, would be costly and time consuming. “Reasonably self-evident” only requires a minimum level of technical analysis and documentation to demonstrate compliance with the accounting standards. This opinion is widely shared by the insurance industry, auditors, and regulatory authorities.

Currently, there are no uniform criteria for categorizing a reinsurance contract as “reasonable self-evident” or, in other words, for distinguishing between traditional and financial reinsurance. Usually, the regulators or accounting standards only stipulate some minimum criteria and the companies have to apply their own more detailed list of internal criteria. However, this also gives companies some room for abuse.

Besides the criteria of the IAIS [IAIS (2006)] and the E.U. directive [E.U. Council of Ministers (2005)], the document “Reinsurance Attestation Supplement 20-1: Risk Transfer Testing Practice Note” prepared by the American Academy of Actuaries’ Committee on Property and Liability Financial Reporting [AAA (2007)], provides some more detailed examples on how a checklist for financial reinsurance could look like. EIOPA has also recently published a draft paper on the Solvency II treatment of financial reinsurance, which also includes a list of eligibility criteria<sup>8</sup> [CEIOPS (2009)].

There are several important characteristics of such contracts where risk transfer is “reasonably self-evident.” According to the AAA (2007), there are reinsurance contracts that, in effect, comply with the “reasonably self-evident” principle by virtue of their belonging to a particular classification of reinsurance contracts. For example, risk transfer is reasonably self-evident for straight quota shares with fixed terms, e.g., no risk-limiting or any other variable terms like sharing positive or negative contract experience and with a fixed reinsurance commission that adequately compensates the ceding company for all acquisition costs.<sup>9</sup> For most traditional per-risk or per-occurrence excess of loss reinsurance contracts (both treaty and facultative), risk transfer is reasonably self-evident if for a predetermined amount of premium the reinsurer assumes all or nearly all of the potential variability in the underlying losses, and it is evident from reading

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- 8 The CEIOPS’ Advice for Level 2 Implementing Measures on Solvency II: SCR standard formula - Article 111f Allowance of Reinsurance Mitigation Techniques includes a list of possible criteria: “Some of the following characteristics may be present within reinsurance contracts: ▶ Insurance risk transfer, for example: - excess of loss reinsurance, which provides indemnification to the ceding insurer for each covered risk up to a predetermined limit. The ceding insurer is required to meet the obligations of the claim up to a preset amount before the reinsurer becomes liable; or - the insurer and the reinsurer share in an agreed ratio, all premiums, losses, and loss expenses arising out of the original business covered under the reinsurance agreement. There are two forms of proportional reinsurance: quota share and surplus share; or - catastrophe bonds issued to manage peak risks and embedded value securitization to help undertakings manage their capital more efficiently. ▶ assumption of significant but limited risk by the reinsurer (e.g., aggregate limit of liability, blended cover, sliding scale and other adjustable commissions, loss corridors and limits or caps); ▶ transfer of volatility (e.g., multiple lines of business, multiple years of account and multiple year contract terms); ▶ inclusion of future investment income in price of contract (recognition of time value of money); ▶ potential profit sharing between parties (e.g., profit-sharing formulas, experience accounts); ▶ bulk reinsurance or treaty reinsurance (i.e., administration of reinsurance is done on a bulk basis rather than on a traditional policy-by-policy basis, for a block of new or in-force business). Certain features can sometimes reduce the effective risk transfer considerably under the reinsurance contract. For example, this may be the case for certain finite reinsurance arrangements.” [CEIOPS (2009)]
- 9 A less restrictive, but generally accepted exception is the case of a straight quota share reinsurance contract with no risk-limiting features, other than a very high loss ratio cap with negligible effect on the economics of the transaction.

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7 The concept of “reasonably self-evident” was codified by the NAIC in 2005 as part of the Reinsurance Attestation Supplement 20-1. It addresses contracts for which a risk transfer test has to be carried out and also where detailed risk transfer testing is not required in order to conclude that the contract allows for reinsurance accounting (“For each such reinsurance contract entered into, renewed, or amended on or after January 1, 1994, for which risk transfer is not reasonably considered to be self-evident, documentation concerning the economic intent of the transaction and the risk transfer analysis evidencing the proper accounting treatment, as required by SSAP No. 62–Property and Casualty Reinsurance, is available for review”).

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the basic terms of the contract that the reinsurer can incur a significant loss.<sup>10</sup> In addition, for single year property catastrophe and casualty clash covers it can be demonstrated that these contracts fall under “reasonably self-evident” if no risk limiting features, like sub-limits, retrospective premium adjustments or other exclusions apply.

In general, it is less likely that risk transfer is reasonably self-evident, when most risk is retained by the ceding company and if certain experience-based contractual features, such as experience accounts, variable commissions, or premium adjustments, are included in the contract. When considering whether non-proportional contracts fall under the “reasonably self-evident” exemption it is also worth mentioning the “rate-on-line-criterion.”<sup>11</sup> Even if no risk limiting features are included in the contract, a high premium (rate on line) can disqualify the contract from meeting the exemption rule. If the premium approaches the present value of the limit of coverage, risk transfer is usually no longer deemed to be reasonably self-evident, even if a contract has no risk-limiting features [AAA (2007)]. However, these kinds of contracts usually have other characteristic features like contingent commissions (to allow the ceding company to participate in the positive experience of the contract) and which would violate “reasonably self-evident” anyway.

Even though the topic has been in discussion for several decades, the definition of risk transfer still remains ambiguous. This discovery only underscores the importance of formulating a simple standardized approach to categorize financial reinsurance contracts.

### **Not-reasonably self-evident contracts**

In case a contract does not meet the criteria of “reasonably self-evident” exemption, the contract falls into the “not-reasonably self-evident” category. For such contracts there are some commonly used quantitative criteria that help determine the amount of insurance risk transferred under a reinsurance contract. Below, we will describe the most relevant of such quantitative criteria.

It is important to note that a failure to satisfy the “reasonably self-evident” standard does not necessarily mean that a contract does not qualify as reinsurance contract. It simply means that more analysis, usually a quantitative risk transfer test, may be required to arrive at a contract categorization. The categorization approach under these quantitative methods can be summarized as follows. For a given reinsurance transaction to be categorized, each method calculates the value of a specific parameter that provides a quantitative measure for the amount of risk transferred by the reinsurance transaction. The resulting value is then compared with a specific parameter threshold value, which corresponds to the minimum level of risk transfer required by the method. If the parameter value is higher than the threshold, i.e., the transaction is transferring more risk than minimally required, then the transaction is categorized as reinsurance and accounted for as such.

Although there may be exceptions, contracts that falls under “not-reasonably self-evident”, (i.e., not automatically qualify for reinsurance) would typically have the following characteristics [AAA (2007)]: (a) non-proportional per risk, per occurrence or aggregate excess of loss contracts if the premium approaches the present value of the coverage provided and/or the contracts contain significant risk-limiting features or other variable features (e.g., profit commission); (b) contracts with experience accounts, i.e., sharing positive or negative experience of the contract, or similar provisions with a significant impact on the contract's economics; (c) multi-year contracts with such provisions and/or provisions that adjust the contractual terms in later years, based on contractual experience in earlier years; and (d) proportional quota share contracts with risk-limiting features such as loss ratio caps, loss participations/corridors, or sub-limits or other variable features sharing positive or negative contract experience, like sliding scale commissions.

In such cases, for accounting and regulatory purposes, the company will need to evaluate the amount of risk transferred by the underlying contract. Risk transfer analyses may range from very simple premium to limit approaches, to highly sophisticated stochastic methods. In most cases, the rigor of the analysis is likely to be inversely correlated with the amount of risk transferred under the contract (e.g., the less risk that is transferred the more technical effort is required to determine the true extent of such transfer). In addition, internal processes

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<sup>10</sup> In many cases, there is no aggregate limit on the reinsurer's loss. However, few practitioners would feel the need for a detailed probabilistic cash flow analysis to reach the conclusion that risk transfer is reasonably self-evident.

<sup>11</sup> “Rate on line” is defined as the premium paid to reinsurer divided by the amount of reinsurance coverage.

have to be established as the regulator would usually request the company to present supporting documentation for the business rationale of the contract categorization.

### Contracts which meet “virtually equivalent” condition

Under some regulatory regimes, contract categorization is entirely driven by the quantitative methods mentioned above. However, some more advanced accounting or regulatory regimes practice a more nuanced approach, which maintains that if the economic positions of the cedant (before risk transfer) and reinsurer (after risk transfer) are virtually equivalent for the ceded part of the underlying risk exposure, then the contract can be accounted for as reinsurance even if a quantitative risk transfer test is not fulfilled. In essence, virtual equivalence means that substantially all insurance risk relating to the reinsured portions of the underlying contracts has been assumed by the reinsurer. This condition is met only if some insignificant amount of insurance risk remains with the ceding enterprise on the reinsured portions of the underlying insurance contracts and the economic position of the reinsurer is equivalent to having written the underlying policies directly.<sup>12</sup> In such contracts, the reinsurer de facto acts as the original insurer. For example, this exception can be found under U.S.-GAAP and U.S.-Statutory.<sup>13</sup>

Consequently, even if the chosen quantitative methods fail to provide the sufficient level of risk transfer, the contract can be accounted for as reinsurance given the economic positions of

the reinsurer and the cedant are virtually equivalent. In this case, the low level of risk transfer provided just means that the original cedant’s risk for the ceded part of the underlying exposure had been already low before the transfer to a reinsurer.

The virtual equivalence-based categorization analysis is typically supplemented with a transaction study to establish whether the contract includes some specific features aimed at limiting the extent of risk transfer to reinsurers, such as loss caps, loss participations, loss corridors, sliding scale commissions, experience accounts, etc. Proving virtual equivalence for “not-reasonably self-evident” contracts is a challenging task, which mainly entails comparing the risk retained by the cedant with the risk transferred to the reinsurance company. An approach is suggested in the Casualty Actuarial Society Research Working Party paper on risk transfer testing [CAS (2005)].<sup>14</sup> Further to comparing the risk exposure, the profit position of the cedant and the reinsurance company under the reinsurance contract also needs to be compared as well. For this, an analysis needs to be performed if significant positive contract experience is shared with the cedant, as mentioned in the Risk Transfer Practice Note by AAA’s COPFLER [AAA (2007)] or in the AICPA document “Evaluating Risk Transfer in Reinsurance of Short-Duration Contracts” [AICPA (2003)]. For some reinsurance contracts, such as non-proportional contracts, virtual equivalence is difficult to demonstrate. If the virtual equivalence cannot be demonstrated, the contract would not qualify under this exception.<sup>15</sup>

### Summary of relevant reinsurance contracts categorization steps:

1. **Reasonably self-evident:** the first step in the categorization approach is to determine whether the contract belongs to the “reasonably self-evident” category. For contracts from this category, no quantitative risk transfer test is required. Such contracts are considered to transfer a sufficient amount of insurance risk by virtue of the class and/or individual contract characteristics. Such contracts are classified as “traditional reinsurance.”<sup>16</sup>

12 However, note that the introduction of risk limiting features to a quota-share contract, such as a loss ratio cap (other than one that is so high its effect on the economics of the contract is de minimis), a loss retention corridor, or a sliding scale commission, often prevents the contract from qualifying for the exception.

13 FAS 113 par. 11 and 67 states [FASB (1992)]: **11.** If, based on this comparison, the reinsurer is **not exposed to the reasonable possibility of significant loss**, the ceding enterprise shall be considered indemnified against loss or liability relating to insurance risk only if **substantially all of the insurance risk** relating to the reinsured portions of the underlying insurance contracts has been assumed by the reinsurer.<sup>4</sup> Footnote 4: This condition is met only if **insignificant insurance risk is retained** by the ceding enterprise on the reinsured portions of the underlying insurance contracts. **67.** Under very limited circumstances, the reinsure need not be exposed to the reasonable possibility of significant loss for a contract to meet the conditions for reinsurance accounting. For example, applying the “reasonable possibility of significant loss” condition is problematic when the underlying insurance contracts themselves do not result in the reasonable possibility of significant loss to the ceding enterprise. The Board concluded that, when the reinsurer has assumed **substantially all of the insurance risk** in the reinsured portions of the underlying policies, even if that risk does not result in the reasonable possibility of significant loss, the transaction meets the conditions for reinsurance accounting. In this narrow circumstance, **the reinsurer’s economic position is virtually equivalent to having written the insurance contract directly.** The risks retained by the ceding enterprise are insignificant, so that the reinsurer’s exposure to loss is essentially the same as the insurer’s. For easier reference the new FASB Accounting Standard Codification is not mentioned. FAS 113 par. 11 and 67 can now be found under FASB ASC 944-20-15-51 through 15-53 and FASB ASC 944-20-55-55.

14 “Because “substantially all” is less than “all,” if the EUD faced by the reinsurer is within a small tolerance of the expected underwriting deficit faced by the cedant, say, within 0.1%, then we would also say the “substantially all” test is met.” [CAS (2005)]

15 See U.S.-GAAP: EITF D-34 Q&A 24; FASB ASC 944-20-55-56.

16 Depending on the local accounting or regulatory bodies, companies might have to implement internal criteria for defining “reasonably self-evident.” Some examples can be found in the appendix of the Risk Transfer Practice Note by AAA’s COPFLER [AAA (2007)].

2. **Not reasonably self-evident:** some type of quantitative cash flow analysis must be performed to assess the extent of risk transfer.
3. **Substantially all/virtually equivalent:** even if not reasonably self-evident or a significant risk transfer test is met, reinsurance accounting might be applicable depending on the economic impact of the contractual features.<sup>17</sup>

By placing contracts in one of these three categories one can considerably reduce the amount of technical work by focusing only on those contracts that require further testing.

#### **Existing quantitative risk transfer methods**

While most reinsurance contracts are designed to protect the ceding company from adverse financial effects of one or more insured events by transferring the risk to a reinsurer, there are situations when the positive economic effect of a reinsurance contract on the ceding company cannot be easily determined. In such cases, a quantitative testing of a reinsurance contract must be performed to prove the existence and the extent of risk transfer, assuming relevant data is available.

Quota share reinsurance with its characteristic risk transfer limiting elements, such as sliding scale commission, loss participation, loss ratio cap, experience refund, etc., is an example of a financial reinsurance contract that needs to be subjected to further quantitative testing for the purposes of categorization. Computer models that perform scenario testing may be required in such cases to perform the tests. Relevant data are either based on historical results of the business in question or similar businesses. Scenario testing can either be deterministic or stochastic. Stochastic approaches might comprise a comprehensive set of possible stochastic scenarios (often called stochastic models) or its subsets.

Risk transfer testing is essentially a discounted cash flow test for the assumed scenarios [Vendetti and Freihaut (2008)].

Most of the risk transfer testing approaches can be broken down into the following three steps:

**Step 1. Analysis of the underlying risk exposure and defining the loss scenarios:** in this step, the underlying risk exposure needs to be analyzed with the objective to define the characteristic loss scenarios.

**Step 2. Analysis of the reinsurance transaction and modeling the resulting cash flows:** all terms and conditions of the contract relevant for the cash flow between the cedant and the reinsurer should be taken into account. Based on this analysis and scenarios defined in Step 1, all cash flows between the cedant and the reinsurer, as defined by the reinsurance contract, should be modeled for each scenario. These include claims, premiums, commissions, loss participations, experience based premium provisions, etc. The timing of any cash flow should be taken into account as well. In addition, all amounts should be deemed to be paid, i.e., the analysis should be performed irrespective of whether funds are transferred or not (so-called deposit retained or funds withheld).

**Step 3. Cash flow analysis and deriving a quantitative measure of risk transfer:** in this step, the cash flow modeled under Step 2 should be analyzed. This analysis includes discounting with suitable interest rates, often risk-free rates for different maturities depending on the timing of each cash flow. Alternatively, one single risk free rate can be used instead of different rates for different maturities. In this case, the duration of the interest rate should be chosen approximately equal to that of the net cash flows. Then, for each scenario, all considered cash flows should be summed up to the total discounted positive and negative cash flows from the reinsurer's perspective. Finally, through taking into account all considered scenarios with their total positive and negative cash flows, each method will determine whether there is a reasonable possibility of significant loss to the reinsurer based on the method's specific underlying quantitative risk transfer parameter and threshold.

Below, we describe the most common quantitative methods used by reinsurance practitioners to assess the extent of risk transfer in a financial reinsurance contract.

#### **Most common quantitative risk transfer methods**

The most common quantitative risk transfer testing methods are the "10-10" rule and the expected reinsurer's deficit (ERD). Both have been well described in the pertinent literature [CAS (2002),

<sup>17</sup> Depending on the local accounting or regulatory bodies, companies might have to implement internal thresholds for defining "substantially all risks" and "virtually equivalent."

AAA (2005), Vendetti and Freihaut (2008)]. These are briefly summarized below. Another, less common method is the “premium to limit of coverage ratio.”

**Premium to limit of coverage ratio:** under this criterion, the contract is unlikely to be a risk transfer, if the value of the ratio approaches or exceeds 1. This easy-to-apply method, which is not scenario-based and therefore does not require an in-depth analysis of the underlying exposure, might be used as a quick first test. However, in many cases the method may generate inaccurate results when the ratio is slightly below 1, indicating that the degree of risk transfer is insufficient. Also, where the premium to limit of coverage ratio is substantially under 1, the objective of the contract might still be purely financial even though according to the method the contract should be categorized as reinsurance.

**The “10-10” rule:** this rule was loosely derived from the accounting standard language that required that a reinsurer faced a “reasonable possibility of a significant loss.”<sup>18</sup> According to the “10-10” rule, a reinsurance contract exhibits significant risk transfer characteristics if there is at least a 10% probability of an at least 10% loss relative to the cash inflows of the reinsurer (usually reinsurance premiums).<sup>19</sup> Even though the rule does translate risk transfer into an easy-to-apply benchmark, its potential to be applied in practice has substantial shortcomings [as described in CAS (2005); AAA (2005)]. For instance, some conventional reinsurance contracts that normally would be classified by regulators and reinsurance practitioners as traditional reinsurance do not pass the “10-10” rule. This is, for example, the case with excess of loss property catastrophe contracts which fail to pass the rule because the frequency of major catastrophes is so low that there may not be a 10% chance

of a loss for a reinsurer. Yet, despite much lower odds of the loss, the reinsurer may potentially end up paying the full amount of the treaty limit. Moreover, even ordinary quota share reinsurance treaties designed for transferring high frequency but low severity losses from insurers’ portfolios may also fail the “10-10” test. However, it was common practice not to disqualify catastrophe excess of loss contracts or favorable quota share treaties as reinsurance because “10-10” was not met. For low severity-high frequency contracts the aforementioned “substantially all/virtually equivalent” criterion was applied. For high severity-low frequency contracts, however, no accounting guidance was applicable.

Furthermore, we must mention at least two other major shortcomings of the “10-10” rule. First, the “10-10” rule ignores the risk in the tail of distribution beyond the 90th percentile. Only the present value loss at the 90th percentile (VaR) is taken into account. However, in the right tail of the distribution the loss potential for catastrophe covers can be significant. Second, we must point out that the selected parameters for frequency and severity in the “10-10” test are completely arbitrary and can be replaced by a “5-20” test or a “1-100” test. Because of these shortcomings a new test, the so-called “product rule,” was developed. Every combination that would lead to an at least 1% (10%\*10%) threshold could also be applied for testing sufficient risk transfer. This “product test” was shortly replaced by the ERD, although the “product test” did solve the shortcomings for high severity-low frequency or high severity-low frequency contracts. However, in fairness to the “10-10” rule or the “product rule,” we must point out that these tests were never intended to become universally applicable risk transfer tests. These tests had emerged as informal quantitative methods of experienced practitioners to determine whether reinsurance contracts contained sufficient risk transfer.

**Expected reinsurer’s deficit method (ERD):** another common measure of risk transfer that has gained acceptance among regulators and reinsurance practitioners is the ERD. In 2002, the CAS Valuation, Finance, and Investments Committee published the paper “Accounting rule guidance statement of Financial Accounting Standards No. 113 – considerations in risk transfer testing,” which discussed the shortcomings of the “10-10” rule and introduced the ERD [CAS (2002)]. The ERD overcomes the shortcomings of the “10-10” rule by including the right tail of

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18 Also known as 9a/b-test under US-GAAP. FAS 113 par 9a/ b states: “a. The reinsurer assumes significant insurance risk under the reinsured portions of the underlying insurance contracts. b. It is reasonably possible that the reinsurer may realize a significant loss from the transaction.” Guidance also available under FASB ASC 944-20-15-41.

19 FAS 113 par. 10 states: “The ceding enterprise’s evaluation of whether it is reasonably possible for a reinsurer to realize a significant loss from the transaction shall be based on the present value of all cash flows between the ceding and assuming enterprises under reasonably possible outcomes, without regard to how the individual cash flows are characterized. The same interest rate shall be used to compute the present value of cash flows for each reasonably possible outcome tested.” FAS 113 par 11 states: “Significance of loss shall be evaluated by comparing the present value of all cash flows, determined as described in paragraph 10, with the present value of the amounts paid or deemed to have been paid to the reinsurer.” Guidance also available under FASB ASC 944-20-15-49 through 15-54.

the distribution in the risk transfer test. In addition, one single measure was developed that allowed the same treatment for low frequency-high severity, high frequency-low severity, and moderate frequency-moderate severity contracts. However, conducting an ERD test represents a considerable technical challenge due to the need to generate a realistic distribution of reinsured losses that are likely to be incurred by the cedant during the life-time of the reinsurance contract. In the case of reinsurance contracts that provide coverage for more than one line of business, the technical challenge of drawing numerous loss distributions and combining them into one single loss distribution at the portfolio level can be even more daunting.

Mathematically, the ERD test can be defined as follows [see Ruhm and Brehm (2007); CAS (2005); AAA (2005) for more details]:

$$ERD = p \cdot T / P \geq A$$

Where,  $p$  = probability of net economic loss;  $T$  = expected (average) severity of net economic loss (present value), when it occurs;  $P$  = expected reinsurance premium (present value) or, more general, the cash inflows to the reinsurer; and  $A$  = a threshold above which a contract is considered to have provisionally "passed" the "significant" risk transfer test and below which it is considered to have "failed"; usually,  $A$  is set at 1%, which has become an international best practice standard.

Since the ERD incorporates information about both the frequency and severity of the reinsurer's downside risk into one single measure, it allows utilizing a combined numeric threshold for significant risk transfer ( $A$ ) rather than defining it separately in terms of frequency and severity.

Although the above definition of ERD test provides a good intuitive understanding of the motivation behind the ERD test, in the scenario-based ERD calculation framework, it is often more convenient to rephrase the definition in the form of the following equation:

$$ERD = (\sum_{i=1}^N p_i \cdot S_i) / P \geq A$$

Where, the expression in brackets calculates the expected severity of the net economic loss to the reinsurer among all considered scenarios 1 to  $N$ . The probability  $p_i$  denotes the

Probability of net result (p)	Present value of net result (m)	Severity of net economic loss (m)
96.0%	5	0
2.5%	-30	30
1.0%	-72	72
0.5%	-200	200

**Table 1: Example results of a reinsurance contract**

occurrence probability of the scenario  $i$ , and  $S_i$  the severity of the net economic loss to the reinsurer in the corresponding scenario (present value). If, for a given scenario, net economic result of the reinsurer is positive, i.e., this scenario produces a net economic profit, then for this scenario  $S_i$  is equal to zero. Obviously, for  $S_i$  we can state:

$$S_i = -\min(0; \text{Present value of the reinsurer's net result})$$

Please notice that in the above definitions the severity of net economic loss, and therefore also ERD, is always positive or zero. In the last formula, this is achieved by setting the minus sign before the min function. Further, please note that each contract that qualifies as risk transfer under the "10-10" rule also fulfills the ERD test at 1% threshold of ERD (a 10% loss multiplied by a 10% probability is a 1% ERD). However, not every contract which fulfills the ERD test (say, a 100% loss multiplied by 1% probability is also a 1% ERD) would also meet the "10-10" rule, cf. the discussion of the shortcomings of the "10-10" rule presented above.

A simple example below illustrates the use of ERD test (Table 1). Assume, for a reinsurance contract, the following holds: Reinsurance premium  $P = 10$  million. The aggregate probability of net economic loss is calculated as:  $p = 2.5\% + 1\% + 0.5\% = 4\%$ . The expected severity of net economic loss under the condition that it occurs:  $T = (2.5\% \cdot 30 + 1\% \cdot 72 + 0.5\% \cdot 200) / 4\% = 61.8\text{m}$ . Then, according to the first variant of the calculation formula given above, we obtain  $ERD = p \cdot T / P = 4\% \cdot 61.8 / 10 = 24.7\%$ . We also could apply the second variant of the calculation formula which of course leads to the same result:

$$ERD = (\sum_{i=1}^4 p_i \cdot S_i) / P = (96\% \cdot 0 + 2.5\% \cdot 30 + 1\% \cdot 72 + 0.5\% \cdot 200) / 10 = 24.7\%$$

Obviously, in this example the resulting ERD is well above

the threshold of 1% and thus according to the ERD test, the reinsurance contract transfers enough risk to be classified as a reinsurance transaction.

The simplified example above only uses premium in the denominator as a fixed variable. However, in practice, premiums sometimes are not fixed upfront but depend on the contract's loss experience or result. In such cases, the premiums in the ERD calculation should be considered at their expected values for which different approaches are possible and used by the industry. Among other aspects, the choice of an approach may also depend on contract conditions, especially if with the increasing contract loss the premium increases or decreases (the latter case is rather rare but can be seen in practice as well; such contracts are often called contracts with inverse character).

In developed markets, market participants utilize either full or partial stochastic models of the underlying loss exposure for calculating the ERD. Both the partial and full stochastic models are based on the loss scenarios, with occurrence probability assigned to each scenario. While a full stochastic model tries to capture a possibly comprehensive set of loss scenarios, a partial stochastic model works with its suitable subset. Obviously deriving a partial stochastic model is easier. However, in practice, often partial stochastic models may be insufficient for proving the desired ERD threshold, thus necessitating the use of a full stochastic method.

A full stochastic model of the underlying loss exposure will usually differentiate between the basic loss exposure (losses below a certain threshold), individual large loss exposure and event-based catastrophe loss exposure. If, for a reinsurance transaction, one of the three loss categories does not seem relevant, then the loss exposure model can be abandoned. The full stochastic method, nevertheless, must still account for the total annual, individual or per event loss scenarios with the probabilities assigned to each loss scenario. These loss scenarios are then tested through a mathematical model of the underlying reinsurance transaction that produces a stochastically generated set of cash flows between the reinsurer and the cedant resulting from the underlying reinsurance transaction. These cash flows are then discounted to the present point in time, and recalculated into the values of the discounted reinsurer's deficit per each scenario.

To illustrate how this method works, we provide a more detailed numeric illustration of the ERD method for a typical quota share reinsurance treaty with elements of finite risk transfer in Appendix 1.

In addition to the "10-10" rule and the ERD, other risk transfer methods have been developed; however none of them has become as well accepted as the 10-10 rule and later the ERD test. For more details on these other methods please refer to Wang (2008), Vendetti and Freihaut (2008), and Ruhm (2001).

To summarize, despite the existence of numerous approaches to categorization of reinsurance contracts, including ERD, which is currently viewed as best practice, none of them can be easily performed. Even for international (re)insurers, performing the quantitative risk transfer tests represents a substantial technical burden, let alone small insurance companies and regulatory bodies in developing markets. This creates room for mistakes, misuse, and malpractice. Hence, the need for a simple but robust risk transfer categorization method still remains.

#### **SERD method: standardized ERD test**

As described in the previous section, the main drawback of the ERD is the technical complexity of its application. To address this problem, we developed a method that can be followed by insurance regulators to carry out the ERD test without employing complex actuarial techniques.

The proposed *Standardized ERD (SERD) method* aims to help regulators and insurers in developing countries to apply the ERD method at an affordable cost. The SERD relies on the ERD method applied to proportional reinsurance contracts. In a nutshell, the SERD represents a simplified approach to exploiting a full stochastic model of the underlying risk exposure for calculating ERD. However, instead of developing an individual model for each given case, the SERD utilizes a standardized model template which needs to be fed with only a few relatively easy-to-obtain parameters, without imposing a significant technical burden on a user. With this approach, the SERD method follows the logic of the European Solvency II approach that allows an insurance company to apply a "simplified" approach by using the Standard Formula instead of a "full" or "partial internal model," if the latter represents a heavy technical (and cost) burden for the company. Hence, the SERD can be seen as the "standard formula" method of the ERD calculation framework.

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The level of method customization can be adjusted depending on how much information about the individual risk exposure to be modeled is available to the user. For example, the volatility parameters of the chosen probabilistic loss distributions or the loss development patterns can either be used at their default values, which will be suggested by the SERD method, or, if available, at their unique values for a given individual case. The default parameter values have been taken from the Solvency II (QIS5) and Swiss Solvency Test frameworks (see Appendix 2 for more details).

On the basis of the user inputs as well as the default values of risk exposure parameters, the SERD method then provides a comprehensive set of probabilistic scenarios (stochastic model) for the severity of the reinsurer's net economic loss (similar to the format of Table A2 in Appendix 1) and finally automatically calculates the ERD based on the obtained probabilistic scenarios.

The SERD method comprises the following four modules:

1. **Loss modeling module** - The user will be given the possibility of choosing the line of business covered by the contract from the list comprising the main standard non-life lines of business. Following the approach of Solvency II and Swiss Solvency Test [European Commission (2010); Federal Office of Private Insurance (2006)], the SERD method allows us to assume some correlation between basic losses in different lines of business. However, no correlation is assumed between basic, large and catastrophe loss exposures.

In the loss modeling module, the SERD tool allows us to differentiate between basic, large and cat loss burdens. The basic loss modeling is based on the assumption that the annual basic loss ratio is distributed according to the lognorm distribution. With this choice we follow the Solvency II (QIS5) approach [European Commission (2010)]. The user will be asked to enter the expected ultimate loss ratios<sup>20</sup> for all lines of business covered by the contract. Further, the user will be given the choice to use the individual user defined values of the volatility per line of business or to use the default

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<sup>20</sup> The term "ultimate loss ratio" is used to describe the ratio between the ultimate loss attached to an annual contract term period after its full development and the insurance premium belonging to this annual term period.

values imported by the SERD method from the Solvency II framework.

The modeling of the individual large loss burden is based on the recognized international best practice assumption that the number of individual large losses per line of business is distributed according to the Poisson distribution and the loss severity according to the Pareto distribution. The user will be asked to provide the expected number of individual large losses per annum as well as lower and upper loss thresholds for each line of business covered by the contract. For the shape parameter of the loss severity distribution (Pareto alpha), the user will be given the option to provide its own unique value, if available, or to use a standard default value. The default values can be derived from the industry experience in other more mature markets. The choices used in the SERD method draw on the values of Pareto alpha suggested in the Swiss Solvency Test Standard Model [Federal Office of Private Insurance (2006)].

If there is a catastrophe loss exposure, the user will be asked to provide a loss exceedance curve describing the exposure. At a later stage, the SERD method can be supplemented with catastrophe risk modeling modules for various natural catastrophe scenarios, which will undertake assessments of natural catastrophe risk based on sum insured aggregates (to be provided by the user) instead of a loss exceedance curve. This will further reduce the technical burden on the user while improving the accuracy of calculations.

2. **Reinsurance transaction module** - this module captures the risk transfer effect of the reinsurance transaction, taking into account its main features, such as reinsurance and profit commissions, loss participations and loss corridors, loss caps, etc. For each value of the underlying exposure's loss ratio, this module encapsulates the corresponding value of the reinsurance result as a percentage of the reinsurance premium. Together with modules 1 and 3, module 2 will be the basis for obtaining stochastic scenarios for the severity of the reinsurer's net economic loss and finally for calculating the ERD in module 4.
3. **Loss developments patterns module** - on the basis of the loss development patterns for each line of business covered

by the contract, the SERD method calculates the discounting adjustments in the present value of the reinsurer's net economic loss required for calculating ERD. The user will be asked to provide loss development patterns for each line of business. In those cases where the patterns are not available, the SERD method will provide default market patterns for each line of business. For the reinsurance premium and all kinds of commissions, the SERD method assumes the full payment within one year (no development after the first year).

4. **Scenario generating and the ERD calculating module** - in this module, the SERD method generates probabilistic scenarios for the severity of the reinsurer's net economic loss and then, based on these scenarios, calculates ERD and cumulative probabilities for different severity values in the same manner as shown in Appendix 1 for the example of "financial quota share." Behind the scenario generating module is a stochastic Monte Carlo simulation which is carried out automatically based on the user specific and default parameters as defined in modules 1, 2 and 3. This automatic simulation engine represents one of the main strengths of the suggested method. In a conventional ERD calculation framework, stochastic Monte Carlo simulation is usually one of the most technically challenging parts, which is often too heavy a burden for many market participants and regulators. The suggested SERD method fully automates the most difficult part of the calculation so that the user does not need to worry about it, the method does it automatically.

To illustrate our approach, we applied the suggested SERD method to the Financial Quota Share example shown in Appendix 1, where the full-fledged stochastic model was applied, and then compared the ERD results obtained with both methods.

As a more detailed description of the SERD method for this example has been provided in Appendix 2, below we provide only the results of the SERD Module 4 – the probabilistic scenarios for the severity of the reinsurer's net economic loss and the resulting ERD. Table 2 shows the results of the SERD method in the same format as the results of the conventional ERD calculation.

ERD calculates to

$$ERD = \sum_{i=1}^{26} A_i \cdot B_i = 1.4\%$$

Scenario N (aggregated scenarios)	A. Realization probability	B. Severity of reinsurer's net economic loss
1	78.6%	0%
2	3.0%	1%
3	2.6%	2%
4	2.3%	3%
5	2.1%	4%
6	1.8%	5%
7	1.4%	6%
8	1.4%	7%
9	1.2%	8%
10	0.9%	9%
11	0.8%	10%
12	0.7%	11%
13	0.6%	12%
14	0.4%	13%
15	0.4%	14%
16	0.3%	15%
17	0.3%	16%
18	0.2%	17%
19	0.2%	18%
20	0.1%	19%
21	0.1%	20%
22	0.1%	21%
23	0.1%	22%
24	0.1%	23%
25	0.3%	24%
26	0.0%	>=25%

Table 2: SERD method, results for the Financial Quota Share example

As we can see, with the ERD value of 1.4% resulting from the SERD method, while the contract still fulfills the ERD test, this value deviates from the value obtained with a full stochastic model (1.9%) (Table A2 in Appendix 1). The reason for this deviation is that the default value for the standard deviation of the basic loss ratio deviates from the specific value used when deriving the full stochastic model. Default value is 10% and in the full model we worked with 12%. Also, for the shape parameter of the severity distribution for the individual large loss exposure (Pareto alpha) there has been a difference between the value used in the full stochastic model (2.4) and the default value in the SERD method (2.5). The observed differences in results demonstrate that with the default values selected by the user under the SERD approach the contract shows less risk transfer. This can be seen from the higher probabilities of the lower loss severities in the Table 2, as compared to Table A2, and of

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course from the lower resulting ERD value of the SERD method compared to the full stochastic method. Obviously, this deviation in results is the price one has to pay for omitting the technical burden of the full stochastic model.

It is worth noting however, that if all unique distribution parameters were available, our proposed SERD method would produce the same result as the full stochastic ERD method. Consequently, we believe that the suggested SERD method is considerably less costly to implement, which makes it a robust alternative to the ERD, which relies on full-fledged unique stochastic models of the risk.

In conclusion, we would like to note that other quantitative risk transfer tests, such as, for example, the “10-10” rule, could also be automated in the same manner as the suggested SERD method automates the ERD test. The approach to calculating the ERD values proposed in this paper can, therefore, be also viewed as a methodological framework applicable to a wide range of risk transfer tests used by insurance regulators and the insurance industry.

### Summary

Despite the existence of numerous quantitative approaches to the categorization of financial reinsurance contracts, insurance regulators may often find the practical implementation of the task to be technically challenging. To simplify the categorization process, in this paper, we first conveniently summarize the existing pertinent literature on the subject with the view to help insurance regulators to first apply some simple indicators to flag the main issues with financial reinsurance contracts that may need further reviews.

Some of such obvious “red flags” are [IAIS (2006)]: contracts, including clauses, that change the nature of how risks are transferred; contracts including different and diverse lines of businesses, making it difficult to assess the risk and exposures of the transfer; contracts where cedants do not follow formal processes nor guidelines; signed contracts near financial year end covering past periods or earlier years; or, when contracts are backdated (i.e., replicating a retroactive coverage); and contracts combining financial reinsurance with traditional reinsurance contracts, making it difficult to assess the two contracts separately.

Having identified the suspicious reinsurance contracts, supervisors may consider (a) conducting on-site inspections of reinsurance programs and risk management practices, (b) requesting annual attestations from the management on risk transfers reporting accuracy, (c) further expanding actuaries’ responsibility to cover the analysis of risk transfer content in reinsurance contracts when submitting reinsurers’ system assessments, (d) reviewing companies’ annual reinsurance plans, and (e) implementing reinsurance “whistle blower” programs mainly focusing on actuaries and auditors [IAIS (2006)].

In some cases, requiring further quantitative testing of risk transfer contracts for categorization purposes, supervisors may also consider adopting the SERD approach to contract testing presented in this paper. The approach advocates the use of a simple standardized stochastic method that would allow market participants and regulators to perform robust quantitative tests quickly and at an affordable cost. Besides addressing the obvious drawbacks of the “10-10” test, the proposed alternative method allows the user to greatly reduce the technical challenges posed by the ERD approach based on full stochastic models with acceptable loss of predictive accuracy.

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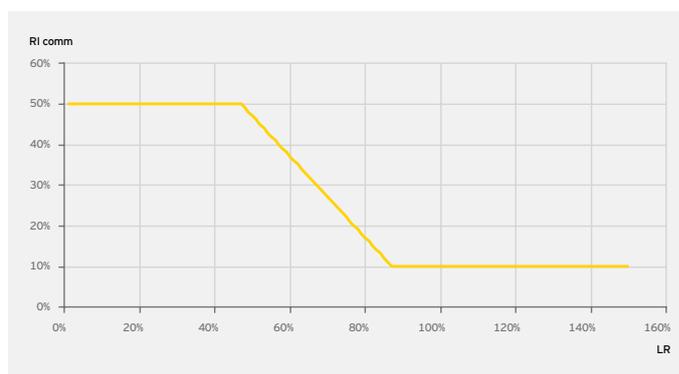
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**Appendix 1: ERD calculation for a financial quota share (FQS) reinsurance contract.**

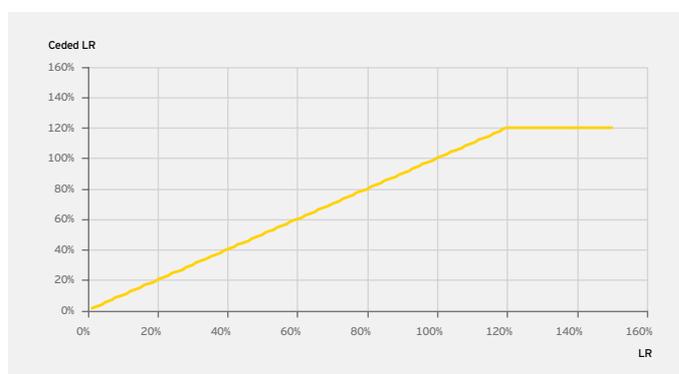
Contract details: proportional quota share contract for motor third party liability (MTPL) business; Ceded premium = € 100m; Sliding scale reinsurance commission:

Loss ratio (LR) <= 50% → Reinsurance commission (RI) = 47%  
 Loss ratio (LR) >= 87% → Reinsurance commission (RI) = 10%

For LRs between 50% and 87%, RI commission drops by 1% for any LR increase of 1% (Figure A1).



**Figure A1: Sliding scale reinsurance commission**



**Figure A2: Ceded loss ratio with loss cap**

- ▶ **Loss ratio is capped at 120%** – this feature means that the reinsurer does not accept any loss arising from the underlying contract beyond 120%. The original losses beyond this loss ratio are not ceded into the underlying reinsurance contract "ceded LR" = min (LR, LR cap) (Figure A2).
- ▶ **Cedant's loss participation of 20% between ceded LRs of 90% and 120%** – this means that the cedant will reimburse the reinsurer for 20% of the loss between the ceded LRs of 90% and 120%; "loss participation" = 20% \* min(30%; max("ceded LR" - 90%; 0)). For example, if the LR = 80%, then the Ceded LR = 80% and the loss participation is zero. If on the other hand, LR = 125%, Ceded LR = 120%, there will be some non-zero loss participation: "Loss participation" = 20% \* min(30%; max(120% - 90%; 0))= 6%. Please note that with this definition, the reinsurer's loss participation is always positive or zero.

When modeling the risk exposure for this contract, we differentiate between basic losses below certain threshold and individual large losses above this threshold. Whereas basic losses are modeled on the annual aggregate basis, large losses are modeled individually through a combination of loss frequency and loss severity probabilistic assumptions. For the sake of simplicity, we assume that there are no loss development patterns, i.e., losses are fully settled within one year. Hence, loss discounting effects do not play any role.

Let us assume that from the analysis of loss and premium statistics from the previous years, we can derive the following assumptions:

#### Basic losses

- ▶ Losses below the threshold of €3m
- ▶ Distribution assumption: ultimate LR follows a lognormal distribution
- ▶ Expected ultimate basis loss ratio = 80%
- ▶ Standard deviation of the ultimate basic loss ratio = 12%

#### Individual large losses

- ▶ Losses above the threshold of €3m
- ▶ Distribution assumptions: number of losses p.a. (loss frequency) follows a Poisson distribution, loss severity follows a truncated Pareto distribution
- ▶ Expected number of individual large losses above €3m (Poisson Lambda) = 0.5
- ▶ Shape parameter of Pareto Distribution (Pareto Alpha) = 2.4
- ▶ Lower threshold of Pareto distribution = €3m, upper threshold = €100m

To calculate ERD we carry out a Monte Carlo simulation which generates 100,000 scenarios for the total ultimate loss ratio. The realization probability for each scenario, is equal  $1/100,000 = 0.001\%$ . For each scenario we then apply the contract conditions to calculate the reinsurer's ultimate result and then the severity of reinsurer's net economic loss (if any).

First we calculate reinsurer's ultimate result which is the reinsurer's result after the insured loss has been settled, i.e., has achieved its ultimate value.

Reinsurer's ultimate result =  $100\% - \text{"ceded LR"} - \text{"RI comm"} + \text{"loss participation"}$

Now, we recalculate the ultimate result into its present value.

Present value of reinsurer's result =  $\text{"reinsurer's ultimate result"} + \text{"discounting adjustment"}$

Please note that according to our previous assumption, the loss will be fully settled within one year, i.e., there will be no loss development over the time and the resulting discounting adjustment can be assumed to be zero. However, for the sake of completeness we provide the formula for a general case.

Finally, we recalculate the present value of reinsurer's result into the severity of reinsurer's net economic loss

Severity of reinsurer's net economic loss (as percentage of the ceded premium) =  $-\min(0; \text{"Present value of reinsurance results"}); = -\min(0; 100\% - \text{"ceded LR"} - \text{"RI comm"} + \text{"loss participation"})$

The following example for both loss scenarios Ultimate LR = 80% and Ultimate LR = 125% will illustrate the above formula.

As explained above, for the Ultimate LR = 80% Ceded LR = 80%, RI Commission = 17% and loss participation = 0; and for the Ultimate LR = 125%, Ceded LR = 120%, RI Commission = 10% and loss participation = 6%. Then, for both scenarios, we calculate for the Reinsurer's deficit as follows:

Severity of reinsurer's net economic loss (as percentage of the ceded premium) for the loss scenario LR = 80% =  $-\min(0; 100\% - 80\% - 17\% + 0) = \min(0; 3\%) = 0$ .

Severity of reinsurer's net economic loss (as percentage of the ceded premium) for the loss scenario LR = 125% =  $-\min(0; 100\% - 120\% - 10\% + 6\%) = -\min(0; -24\%) = 24\%$ .

Out of the resulting scenario set for severities of reinsurer's net economic loss, we can easily calculate a reliable estimate for the expected reinsurer's deficit (ERD) (Table A1).

Scenario N	A. Realization probability	B. Loss ratio	C. Reinsurance commission	D. Ceded LR	E. Loss participation	F = 100% - B - C + D Reinsurer's result	G = - min(0; F) Severity of Reinsurer's net economic loss
1	0.001%	77.6%	19.4%	77.6%	0.0%	22.4%	0.0%
2	0.001%	69.0%	28.0%	69.0%	0.0%	3.0%	0.0%
3	0.001%	104.3%	10.0%	104.3%	2.9%	-11.4%	11.4%
4	0.001%	90.8%	10.0%	90.8%	0.2%	-0.7%	0.7%
5	0.001%	65.3%	31.7%	65.3%	0.0%	3.0%	0.0%
6	0.001%	102.1%	10.0%	102.1%	2.4%	-9.7%	9.7%
7	0.001%	79.4%	17.6%	79.4%	0.0%	3.0%	0.0%
8	0.001%	80.1%	16.9%	80.1%	0.0%	3.0%	0.0%
9	0.001%	109.8%	10.0%	109.8%	4.0%	-15.9%	15.9%
10	0.001%	74.7%	22.3%	74.7%	0.0%	3.0%	0.0%
11	0.001%	62.8%	34.2%	62.8%	0.0%	3.0%	0.0%
12	0.001%	78.7%	18.3%	78.7%	0.0%	3.0%	0.0%
13	0.001%	89.1%	10.0%	89.1%	0.0%	0.9%	0.0%
14	0.001%	61.2%	35.8%	61.2%	0.0%	3.0%	0.0%
...	...	...	...	...	...	...	...
99,999	0.001%	85.5%	11.5%	85.5%	0.0%	3.0%	0.0%
100,000	0.001%	89.9%	10.0%	89.9%	0.0%	0.1%	0.0%

Table A1: Stochastic model for calculating ERD, 100,000 scenarios

This stochastic model has been obtained from the Monte Carlo simulation for the underlying risk exposure (Column A) and applying the terms and conditions of the reinsurance contract (Columns C, D, and E). The reinsurance result for each scenario (Column F) is then recalculated into the severities of reinsurer's net economic loss (Column G).

Obviously, for calculating ERD we are only interested in the economic loss severities in Column G. Working with 100,000 scenarios might be somewhat inconvenient. To reduce the number of scenarios to be considered, we can now round up the severities to the full percentage digits and aggregate realization probabilities for the scenarios resulting in the same value of the (rounded) loss severity. The results can be found in Table A2.

Then, ERD can be calculated as the total of the row-wise products of the columns A and B

$$ERD = \sum_{i=1}^{26} A_i \cdot B_i = 1.9\%$$

Obviously, with this result the underlying contract successfully passed the ERD risk transfer test.

Scenario N (aggregated scenarios)	A. Realization probability	B. Severity of reinsurer's net economic loss
1	75.4%	0%
2	2.8%	1%
3	2.5%	2%
4	2.3%	3%
5	2.0%	4%
6	1.9%	5%
7	1.7%	6%
8	1.5%	7%
9	1.3%	8%
10	1.2%	9%
11	1.1%	10%
12	1.0%	11%
13	0.8%	12%
14	0.6%	13%
15	0.6%	14%
16	0.5%	15%
17	0.4%	16%
18	0.4%	17%
19	0.3%	18%
20	0.3%	19%
21	0.2%	20%
22	0.2%	21%
23	0.2%	22%
24	0.1%	23%
25	0.8%	24%
26	0.0%	>=25%

Table A2: Stochastic model for calculating ERD, aggregated scenarios

## Appendix 2: SERD method for the financial quota share example

In this Appendix, we provide details of the suggested SERD method and demonstrate its application to the financial reinsurance quota share example presented above, where the ERD was calculated conventionally with help of a full stochastic model. To carry out the calculations with the suggested SERD method, we applied a prototype SERD tool which was developed by the authors. The figures provided in this Appendix show the input and output interfaces of this tool. Furthermore, we provide the explanation on how to work with these interfaces.

The starting point of the SERD method is to choose one or more line of business contributing to the overall risk exposure covered by the contract (Figure A3). With this set, we follow the Solvency II QIS5 approach for Non-life and non-SLT Health [European Commission (2010)]. For the financial quota share example, we choose the line of business “motor vehicle liability” by marking the corresponding line in the dark grey area (in this and all following figures depicting the tool interfaces, dark grey marks the input fields).

The SERD method consists of the following four modules:<sup>21</sup> (1) loss modeling module; (2) reinsurance transaction module; (3) loss development patterns module; and (4) scenario generating and ERD calculating module. Modules (1) and (3) assess the overall contract risk exposure, module (2) examines the risk transfer effect of the reinsurance transaction, and finally module (4) calculates the ERD value. In modules (1), (2), and (3), the SERD tool requests the user to enter some parameters and specific characteristics of the underlying risk exposure and the reinsurance contract (please see the detailed description of the modules provided below).

### 1. Loss modeling module

**Basic loss** - In the loss modeling module, the method allows for differentiating between basic, large and cat loss burdens. The basic loss modeling is based on the assumption that the loss ratio of the basic loss, aggregated over the annual contract term, is distributed according to the lognorm distribution.

<sup>21</sup> Please note that the approach described below applies for proportional reinsurance contracts. As non-proportional contract usually do not provide any substantial solvency capital relief, their regulatory treatment and categorization as reinsurance or financial instruments usually do not include any solvency capital requirements related aspects.

Line of business	
Motor vehicle liability	<input checked="" type="checkbox"/>
Motor, other classes	<input type="checkbox"/>
Marine, aviation, transport (MAT)	<input type="checkbox"/>
Fire and other property damage	<input type="checkbox"/>
Third-party liability	<input type="checkbox"/>
Credit and suretyship	<input type="checkbox"/>
Legal expenses	<input type="checkbox"/>
Assistance	<input type="checkbox"/>
Miscellaneous	<input type="checkbox"/>
Medical expense	<input type="checkbox"/>
Income protection	<input type="checkbox"/>
Workers' compensation	<input type="checkbox"/>

Figure A3: SERD tool: line of business interface

Line of business	Loss ratio std dev.
Motor vehicle liability	10.0%
Motor, other classes	7.0%
Marine, aviation, transport (MAT)	17.0%
Fire and other property damage	10.0%
Third-party liability	15.0%
Credit and suretyship	21.5%
Legal expenses	6.50%
Assistance	5.0%
Miscellaneous	13.0%
Medical expense	4.0%
Income protection	8.5%
Workers' compensation	5.5%

Table A3: Default values of the ultimate LR standard deviation by line of business

Chosen LoB's	Expected LR	Use USP for LR Std Dev?	USP	LR Std Dev
Motor vehicle liability	80%	NO		10.0%

Figure A4: SERD tool: basic loss interface

With this choice, we follow the Solvency II (QIS5) approach [European Commission (2010)]. The user is asked to enter the expected ultimate loss ratios for all lines of business covered by the contract. Figure A4 shows the basic loss interface of the ERD tool for the financial quota share example. In the first dark grey column, the user provides the expected ultimate loss ratio of 80% as valid for this example.

In the second input column, the user specifies whether they would use unique parameters of the insurance undertaking (following Solvency II framework we call these parameters USP – Undertaking Specific Parameters) for the standard deviation of the ultimate loss ratio or standard default values. If the USP values are used, these values are provided in the third dark grey column. Otherwise, the tool will use the default standard deviation values, as shown in Table A3. These values are taken from Solvency II QIS5 (QIS5 Technical Specification, Par. SCR.9.25, SCR.8.72) [European Commission (2010)].

Even though, in the financial quota share example presented above, the value of 12% was available for the standard deviation, in the SERD calculation example this USP value was omitted and the default value for the underlying line of business was used instead (Figure A4). This was done to demonstrate the approach for a case when USP values were not available, and also to examine the effect of using default values instead of the USP values on the resulting ERD later on.

Following Solvency II and Swiss Solvency Test [European Commission (2010); Federal Office of Private Insurance (2006)], the SERD method assumes some embedded correlations among different lines of business covered by the contract in their basic loss exposure. However, no correlation is assumed among the loss categories basic, large and catastrophe losses.

**Large loss** - following the inputs in the basic loss section, the user proceeds to the next large loss section. The user will be asked to provide the expected number of the individual large losses per annum as well as the lower and upper loss thresholds for each line of business covered by the contract. Figure A5 shows these data inputs for the financial quota share example (first, second and third dark grey columns). The modeling of the individual large loss burden is based on the recognized international best practice assumption that the number of

Line of business	Lower loss threshold = CHF 1m	Lower loss threshold = CHF 5m
MVL (motor vehicle liability)	2.5	2.8
MVC-hail (motor vehicle comprehensive hail)	1.85	1.85
Property	1.4	1.5
Liability	1.8	2
UVG including UVGZ	2	2
Health collective and individual	3	3
Transport	1.5	1.5
Finance and surety	0.75	0.75
Others	1.5	1.5

Table A4: Pareto alpha by lines of business (Swiss solvency test standard model)

Chosen LoB's	Expected number of large losses p.a.	Lower loss threshold	Upper loss threshold	Use USP for Pareto alpha?	USP	Pareto alpha
Motor vehicle liability	0.5	3000000	100000000	NO		2.5

Figure A5: SERD tool: large loss interface

Line of business	Pareto alpha
Motor vehicle liability	2.5
Motor, other classes	1.8
Marine, aviation, transport (MAT)	1.5
Fire and other property damage	1.4
Third-party liability	2
Credit and suretyship	0.75
Legal expenses	1.8
Assistance	1.5
Miscellaneous	1.5
Medical expense	3
Income protection	0.75
Workers' compensation	2

Table A5: Default values of Pareto alpha by line of business

individual large losses per line of business is distributed according to the Poisson distribution and the loss severity according to the Pareto distribution. The parameter "Pareto alpha" describes the shape of the loss severity distribution.

Similar to the loss ratio standard deviation in the basic loss section, the user is given an option to provide the USP values for Pareto alpha when available or to use the standard default values.

These default values can be derived from the industry experience in other more mature markets. The choices used in our tool draw on the values of Pareto alpha suggested in the Swiss Solvency Test Standard Model [Federal Office of Private Insurance (2006)]. Also for Pareto alpha, we omitted providing the USP value and worked with the default value instead. The reason is the same as in case of the standard deviation – to demonstrate the approach in the case when USP value were not available and to examine the effect of using default values instead of the USP values on the resulting ERD later on. With this reference from the Swiss solvency test at hand, we selected the following parameters for our line of business classification (Table A5). Please note, that the lower the parameter alpha the more prone the distribution is to higher losses as illustrated by Figure A6.

**Catastrophe loss** - If there is a catastrophe loss exposure, the user is asked to provide the loss exceedance curve describing the exposure. The corresponding tool interface is shown in Figure A7. For the financial quota share example, we assumed that there is no exposure to natural catastrophe losses. Hence the input field is left empty.

At a later stage, the SERD method can be supplemented with catastrophe risk modeling capabilities to carry out assessments of natural catastrophe risk based on the sum insured aggregates instead of substituting them with a loss exceedance curve. This will further reduce the technical burden of the calculation when using the SERD method.

## 2. Reinsurance transaction module

This module captures the risk transfer effect of the reinsurance transaction taking into account its main features such as reinsurance and profit commissions, loss participations and loss corridors, loss caps, etc. For each value of the underlying risk exposure loss ratio, the user is asked to provide the corresponding value of the transaction result from the reinsurer's perspective (as percentage of reinsurance premium), see the first dark grey column in Figure A8.

Further, the user will be asked to provide the value of reinsurance premium, the second dark grey column in Figure A8.

For the financial quota share example, the calculation of the reinsurer's result depending on the ultimate loss ratio has been

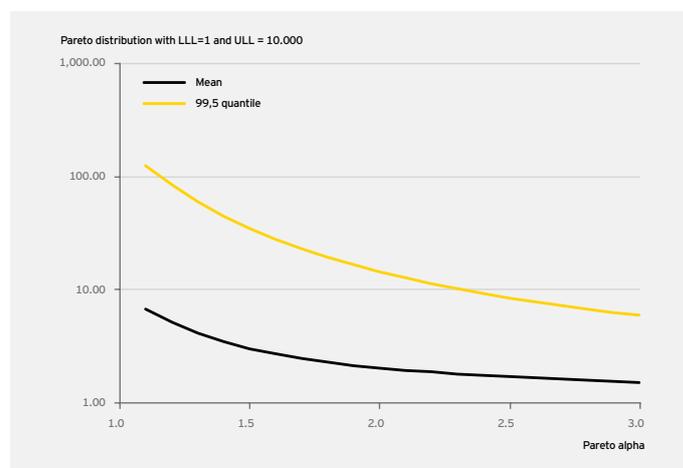


Figure A6: 99.5-Quantile of Pareto distribution for different values of alpha parameter

Return period, yrs	PML
5	
10	
20	
30	
40	
50	
100	
200	
300	
400	
500	
600	
700	
800	
900	
1000	

Figure A7: SERD tool. Natural catastrophe loss interface

already explained above, when the example was introduced. Hence, here we only repeat the calculation formula:

Reinsurer's ultimate result (as [%] of the reinsurance premium) = 100% - "ceded LR" - "RI comm." + "loss particip." + "discounting adjustment", where "ceded LR", "RI comm." and "loss particip" are to be calculated according to the formulae provided above.

With help of the above formula, the present values of the reinsurer's result can be easily calculated for different values of the ultimate loss ratio, cf. the first dark grey column in Figure A8.

Together with Modules 1 and 3, Module 2 will form the basis for obtaining stochastic scenarios for the severity of the reinsurer's net economic loss and ultimately for calculating ERD in Module 4.

### 3. Loss development patterns module

In this module, the user is asked to provide loss development patterns for each chosen line of business (on the cumulative paid basis). In cases when the USP patterns are not available, the SERD method will provide default market patterns for each line of business. For the reinsurance premium and all kinds of commission, we assume the full payment within one year.

Based on the development patterns, the SERD tool calculates the discounting adjustment factors for each line of business. These adjustment factors are used to calculate the present value of the reinsurer's net economic loss required for calculating ERD.

For the financial quota share example, we assume that the loss is fully developed, i.e., reaches its ultimate value within one year and hence there is no discounting adjustment. According to our assumption, 100% is entered for the first year and zeros for all following years (Figure A9).

### 4. Scenario generating and ERD calculating module

In this module, the SERD method generates the probabilistic scenarios for the severity of the reinsurer's net economic loss and then, based on these scenarios, finally calculates ERD and cumulative probabilities for different possible severities of the net economic loss. Behind this calculation is a stochastic Monte Carlo simulation that is carried out automatically based on the user specific and default parameters provided in Modules 1, 2 and 3. This automatic simulation engine represents one of the main strengths of the suggested method. In a conventional ERD calculation framework, a stochastic Monte Carlo simulation usually represents one the most technically challenging parts that is often too heavy a burden for many market participants and regulators. The suggested SERD method eliminates the need for having the user perform this most difficult part of the calculation by running it automatically. For example, in the case of the Financial Quota share, the result shown in Figure A10 was obtained automatically from the tool.

Loss ratio	Reinsurer's ultimate result as % of the reinsurance premium	Reinsurance premium
1%	49%	100,000,000
2%	48%	
...	...	
46%	4%	
47%	3%	
48%	3%	
...	...	
87%	3%	
88%	2%	
89%	1%	
90%	0%	
91%	-0.8%	
92%	-1.6%	
...	...	
120%	-24%	
...	...	
200%	-24%	

Figure A8: SERD tool. Reinsurance transaction interface

Chosen LoB's	Use UP for loss development pattern	YR 1	YR 2	YR 3	YR 4	YR 5	YR 6	YR 7	YR 8
Motor vehicle liability	NO	100%	0%	0%	0%	0%	0%	0%	0%
Default pattern		40%	30%	20%	5%	2%	1%	1%	1%

Figure A9: SERD tool. Loss development patterns interface

As explained above, due to our previous assumption on the development patterns for the Financial Quota Share example, no discounting adjustment has been made. In a generic case, the discounting adjustment, based on the loss development pattern, as calculated in Module 2, would be taken into account when calculating the reinsurer's net economic loss in Module 4. In this example, the estimated ERD is 1.4%.

In conclusion, Figure A11 provides a flow chart which summarizes all the intermediate steps of the SERD method as implemented in the above described prototype tool.

A. Realization probability	B. Severity of reinsurer's net economic loss (as [%] of the RI premium)	ERD = sumproduct (Col A, Col B)
78.6%	0%	1.4%
3.0%	1%	
2.6%	2%	
2.3%	3%	
2.1%	4%	
1.8%	5%	
1.4%	6%	
1.4%	7%	
1.2%	8%	
0.9%	9%	
0.8%	10%	
0.7%	11%	
0.6%	12%	
0.4%	13%	
0.4%	14%	
0.3%	15%	
0.3%	16%	
0.2%	17%	
0.2%	18%	
0.1%	19%	
0.1%	20%	
0.1%	21%	
0.1%	22%	
0.1%	23%	
0.3%	24%	
0.0%	25%	
0.0%	26%	
0.0%	27%	
0.0%	28%	
0.0%	29%	
0.0%	30%	

Figure A10: SERD Tool. ERD Output Tableau

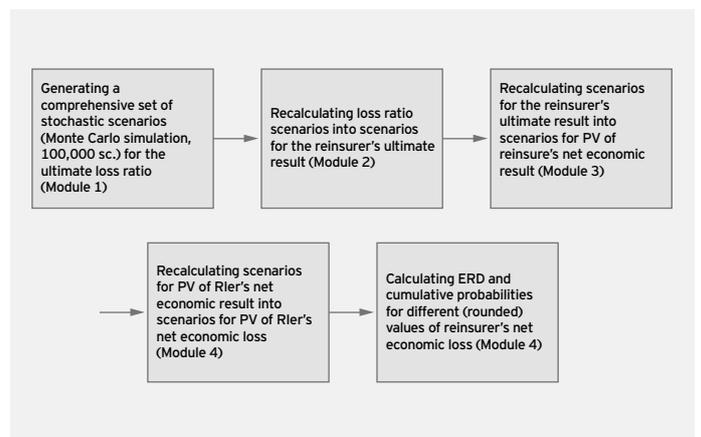


Figure A11: Flow chart SERD method with the prototype tool

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