MILLIMAN RESEARCH REPORT

Optimising non-life reinsurance strategy under risk-based capital measures

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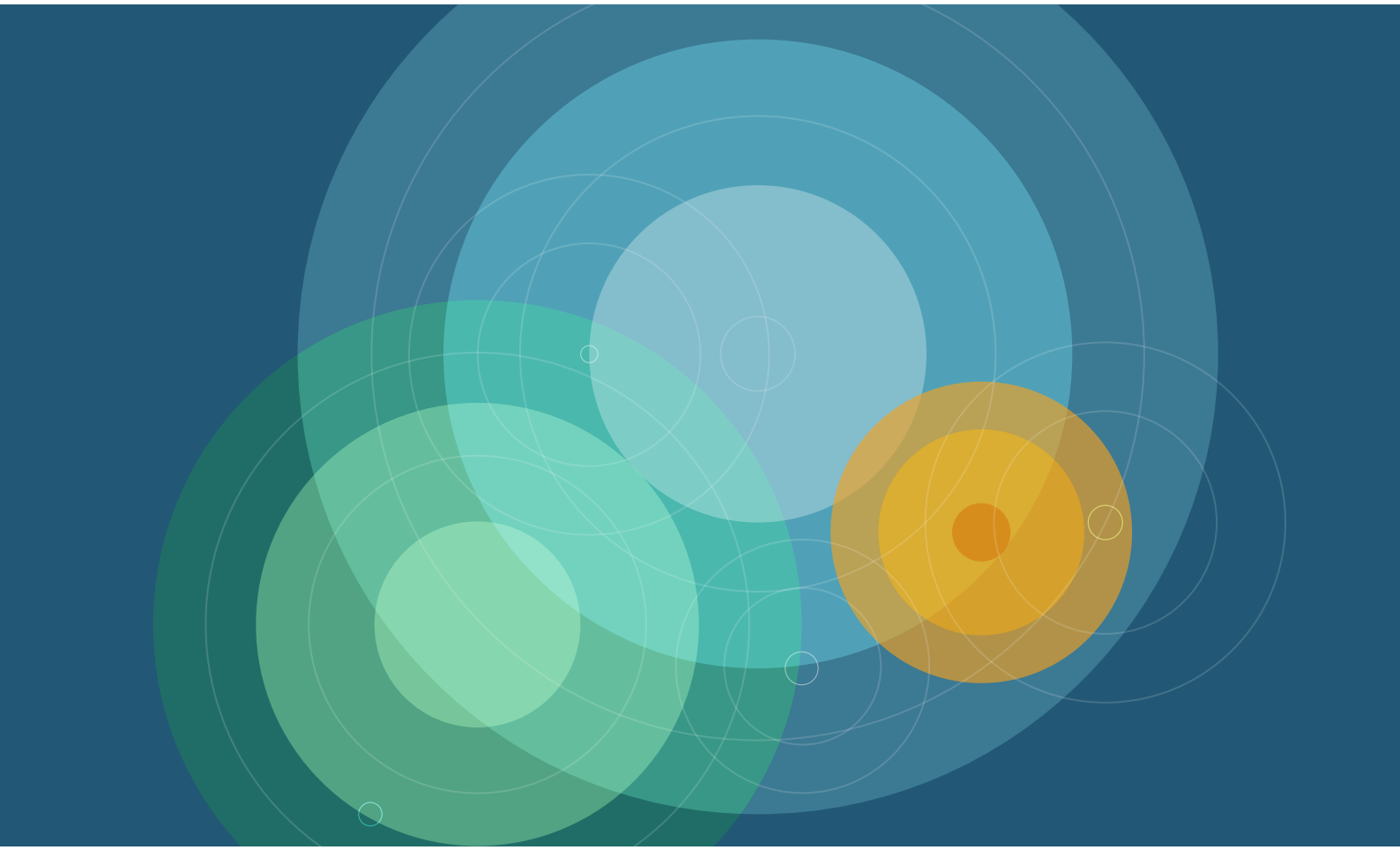

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1. Introduction

BACKGROUND AND OBJECTIVES

The recent introduction of new economic- and risk-based reporting and solvency frameworks across the insurance industry is encouraging non-life insurers to focus much more than previously on risk, value, and the capital management of their portfolios. These new frameworks include Solvency II, the Swiss Solvency Test (SST), and other internal economic and rating agency capital measures. Even in markets where risk-based solvency frameworks have existed for a while, such as the United States, additional requirements are being introduced to raise the bar in the industry with respect to enterprise risk management (ERM).

Risk-based frameworks offer more incentive to develop risk management strategies that align with risk tolerance and optimise economic value on a risk-adjusted basis. Such frameworks can lead to a significant shift in perspective for many insurers, often challenging the conclusions of traditional management decisions.

As non-life insurers adapt their business models to modern risk management frameworks, which can include customised reinsurance solutions of increasing complexity, reinsurers are also adapting their offerings to meet the evolving needs of their non-life insurance clients, within a very challenging reinsurance environment characterised by intense competition fuelled by new sources of reinsurance capacity, changing considerations around catastrophe events, and low interest rates. Of course, adjustments in the structure of reinsurance solutions to meet evolving needs can introduce administration and pricing challenges for the purchaser of reinsurance solutions.

Typical proportional and non-proportional non-life reinsurance coverage, such as quota share or excess-of-loss, are not designed for modern-day capital frameworks and are therefore not necessarily optimal for non-life insurers. For example, quota share treaties can, in some markets, reduce significant potential profit generated by smaller claim sizes, thus reducing balance sheet value and solvency ratios under economic-based frameworks.[1] Further, excess-of-loss treaties continue to mitigate large losses, but only have a limited impact on the reduction of required capital under the Solvency II standard formula.

Increasingly, insurers are seeking bespoke reinsurance solutions to address a range of issues, including property risk accumulations and capital efficiencies. With changing regulation and a shift to ERM by insurers, many firms are seeking to enhance earnings and deliver on corporate strategies through the use of innovative capital management and reinsurance frameworks.

Many large multinational insurance groups are centralising their reinsurance purchasing, taking more sophisticated and global approaches. Typically, these groups use dedicated entities to manage more effectively risk and capital across the group, through internal reinsurance agreements. They also use such entities to leverage their purchasing power, consolidating their reinsurance purchasing globally.

In this paper, we explore the possible impact of risk-based economic capital and ERM frameworks on a non-life insurer's reinsurance strategy.

Structure of this paper

In Section 2, we provide a brief overview of various common types of non-life reinsurance coverage currently available.

In Section 3, we describe the broad context in which reinsurance decisions are made, including key decision factors and the implications for risk, capital, and value management.

In Section 4, we highlight the importance of aligning reinsurance decisions with risk appetite.

1 We note however that, in some situations, reinsurance is sometimes priced more aggressively than the direct insurer's own assessment of the risk rates and can therefore enhance the value of the insurer's portfolio.

In Section 5, we describe an economic perspective for optimising the reinsurance strategy.[2] We formulate a simple theoretical optimisation problem for assessing alternative reinsurance strategies, as well as considering how to manage the real-world practical constraints.

In Section 6, we offer some conclusions.

2. Common types of non-life reinsurance coverage

To provide further context, in this section of the paper we provide a high-level overview of common types of traditional non-life reinsurance coverage. Our intention is not to provide a comprehensive description of reinsurance available to non-life insurers; we have assumed that most readers are generally familiar with typically available reinsurance structures.

PROPORTIONAL REINSURANCE

Under proportional reinsurance treaties, the reinsurer accepts a defined percentage of each policy written and covered by the treaty. The reinsurer will receive the defined portion of premiums and pay the defined portion of claims.[3]

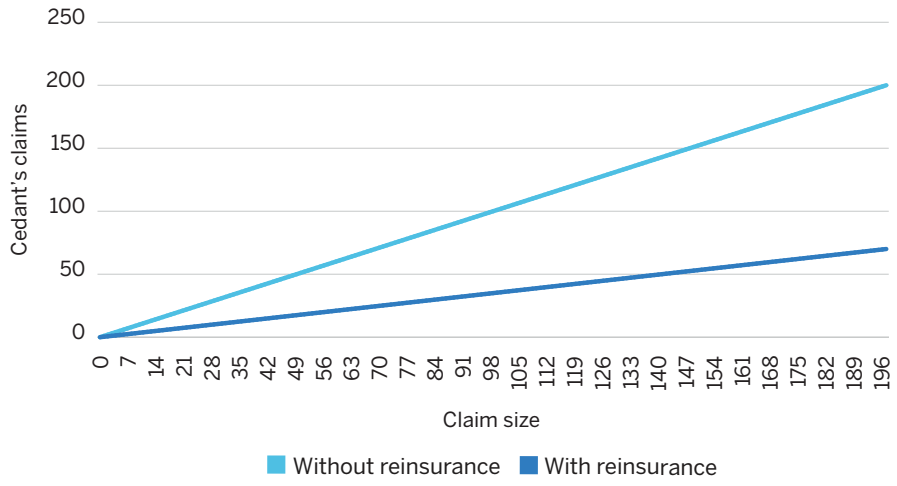
Additionally, a reinsurance commission may be paid to the cedant, which can help to reduce the insurer's new business strain, for example relating to underwriting, administration, marketing, acquisition, and other costs associated with writing business.

Quota share

A typical proportional reinsurance structure is quota share. Under quota share, the reinsurer accepts the same percentage of all policies written by the cedant that fall within the scope of the treaty. In the context of non-life insurance, quota share contracts can cede to the reinsurer up to 90% or more of the risk (a 100% quota share would be assimilated as 'fronting' which is not unusual, particularly within the captive insurance market).

Figure 1 illustrates the cedant's claim profile with and without quota share cover.

FIGURE 1 : CEDANT'S CLAIM PROFILE UNDER QUOTA SHARE



Quota share coverage is commonly seen with features that add complexity to the agreement in order to equitably share the underlying risk, taking the form of loss corridors, loss-sensitive commission structures (e.g., sliding scale), and profit sharing agreements.

2 Reinsurance strategy here refers to the type of cover and appropriate parameters of this cover, e.g., a mixture of common forms of reinsurance (quota share and excess-of-loss).

3 A distinction should be made regarding proportional reinsurance and coinsurance arrangements. Coinsurance is increasingly seen as a potentially useful arrangement, offering benefits similar to proportional reinsurance while alleviating some of the distorting effects of risk-based solvency frameworks such as Solvency II. Under coinsurance, for example, the lapse risk charge and Type 2 counterparty default risk charge generated by a policy would be shared between the coinsurers, while under a proportional reinsurance treaty the primary entity would retain all of the lapse risk and Type 2 counterparty default risk as well as incurring Type 1 counterparty default risk.

Surplus share

Surplus share reinsurance is another type of proportional reinsurance coverage, commonly secured for large property and engineering risks where the underlying maximum loss size can be reasonably estimated in terms of the value of the property. Under surplus share arrangements, the cedant retains the full amount of each policy up to a defined exposure retention limit, with higher layers of risk above this limit (i.e., lines) being reinsured proportionally. The design of such treaties allows an insurance company to write larger risks while staying within the constraints of its risks limits and risk appetite.

Figure 2 illustrates an example of the additional capacity provided by purchasing 10 lines of surplus share cover above a desired retention level, fully ceded at 100%. Note that, with such protection, the cedant is able to write risks up to €55 million, while limiting their retained risk to €5 million.

FIGURE 2 : CAPACITY UNDER 100% SURPLUS SHARE (€)

	CAPACITY (INDIVIDUAL LINES)		TREATY CAPACITY		MAXIMUM
	RETENTION	SURPLUS	RETENTION	SURPLUS	CAPACITY
10TH SS LINE		5,000,000		50,000,000	55,000,000
9TH SS LINE		5,000,000		45,000,000	
8TH SS LINE		5,000,000		40,000,000	
7TH SS LINE		5,000,000		35,000,000	
6TH SS LINE		5,000,000		30,000,000	
5TH SS LINE		5,000,000		25,000,000	
4TH SS LINE		5,000,000		20,000,000	
3RD SS LINE		5,000,000		15,000,000	
2ND SS LINE		5,000,000		10,000,000	
1ST SS LINE		5,000,000		5,000,000	
RETENTION	5,000,000		5,000,000		

Within this construct, the premium ceded and the losses shared are proportional within each line of the surplus share treaty, so a policy with an exposure limit of €50 million would cede 90% of the total written exposure to the reinsurance company. In case of a €50 million reported claim, 90% (€45 million) would be recovered. In case of a €25 million reported claim, 80% (€20 million) would be recovered. If a reported claim was less than €5 million, then nothing would be recovered.

We have used a 100% cession for the example shown in Figure 2. A more common solution would be for the cedant to retain a percentage of the risk below the first surplus share line (by combining the surplus share with a quota share treaty) and a percentage of the risk within each of the surplus share lines, as shown in Figure 3 on page 4. Using an example of a 50% surplus share above a 28% quota share, a policy with an exposure limit of €50 million would cede 48% of the total written exposure to the reinsurance company.

FIGURE 3 : CAPACITY UNDER 50% SURPLUS SHARE ABOVE A 28% QUOTA SHARE (€)

	CAPACITY (INDIVIDUAL LINES)		TREATY CAPACITY		MAXIMUM	LARGE CLAIM EXAMPLES	
	RETENTION	SURPLUS	RETENTION	SURPLUS	CAPACITY	50,000,000	25,000,000
10TH SS LINE		5,000,000	25,000,000	25,000,000	55,000,000		
9TH SS LINE		5,000,000	22,500,000	22,500,000		2,500,000	
8TH SS LINE		5,000,000	20,000,000	20,000,000		2,500,000	
7TH SS LINE		5,000,000	17,500,000	17,500,000		2,500,000	
6TH SS LINE		5,000,000	15,000,000	15,000,000		2,500,000	
5TH SS LINE		5,000,000	12,500,000	12,500,000		2,500,000	
4TH SS LINE		5,000,000	10,000,000	10,000,000		2,500,000	2,500,000
3RD SS LINE		5,000,000	7,500,000	7,500,000		2,500,000	2,500,000
2ND SS LINE		5,000,000	5,000,000	5,000,000		2,500,000	2,500,000
1ST SS LINE		5,000,000	2,500,000	2,500,000		2,500,000	2,500,000
RETENTION	5,000,000		3,600,000			1,400,000	1,400,000
					TOTAL RECOVERY	23,900,000	11,400,000
					IN PERCENTAGE OF THE LARGE CLAIM	47.8%	45.6%

As shown in Figure 3, in the case of a €50 million reported claim, 47.8% (€23.9 million) of the large claim would be recovered. In the case of a €25 million reported claim, 45.6% (€11.4 million) of the large claim would be recovered. If a reported claim was less than €5 million, then the quota share would partially mitigate the loss but nothing would be recovered from the surplus lines.

NON-PROPORTIONAL REINSURANCE

Under non-proportional coverage, the reinsurer meets the cost of claims above a defined claim retention limit. Such coverage is commonly secured for risks where the maximum loss size cannot be reasonably estimated (e.g., because of unlimited bodily injury awards).

Excess-of-loss

Under an excess-of-loss treaty, coverage is either negotiated to cover all accidents occurring during a contract period, i.e., loss occurring during (LOD), or all accidents associated with policies incepting during a contract period, i.e., risk attaching during (RAD). In all cases, the reinsurance company provides coverage in excess of an 'attachment point' (or 'priority'), subject to a 'layer limit,' for the large occurrence (or event).

As a simple example, a treaty providing €8 million (the layer limit) excess of €2 million (the attachment point) would not reimburse anything for claims smaller than €2 million, and would reimburse the difference between the claim size and €2 million (up to €8 million in total) for claims larger than €2 million. More commonly for longer-tailed lines of business in Europe (where it can take years for large claims to be settled or adjudicated), an indexation clause is used to increase the attachment point and layer limit over time, such that the non-life insurance company and the reinsurance company share in the claim cost inflation between the coverage period and the settlement of the claim.

A working layer excess-of-loss treaty is a treaty where a sizeable number of claims are expected to breach the attachment point. In order to limit its risk to such accumulation, reinsurance companies use features that add complexity, such as an annual aggregate deductible (AAD), an annual aggregate limit (AAL), and limitations in the number of reinstatements of the limit.

Annual aggregate deductible (AAD)

The reinsurance company uses an AAD to limit the number of claims reimbursed. Continuing the example from above, an AAD of €5 million would mean that one or more large losses would, in aggregate, need to exceed the €5 million attachment point (and exhaust a €5 million deductible) before the reinsurer would cover a large loss.

Annual aggregate limit (AAL)

The reinsurance company can also use an AAL to limit the number of claims reimbursed. Continuing the example from above, an AAL of €5 million would mean the total reimbursable loss would be €5 million, regardless of the number (or size) of large losses that breach an attachment point.

Reinstatements

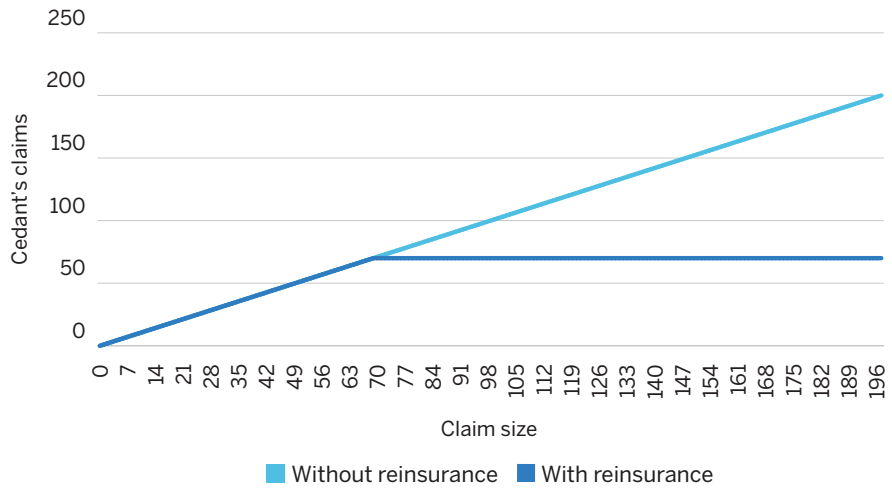
Even though most reinsurance treaties offer annual coverage, the number of reinstatements determines whether reinsurance coverage exists after an occurrence (or event) that breaches the attachment point of the excess-of-loss treaty. In some cases, treaties have unlimited (and free) reinstatements, which implies that every large claim that exceeds an attachment point would be reimbursed. In other cases, treaties include both a limit on the number of layer reinstatements and an additional premium cost ('reinstatement premium') in order to continue to benefit from the treaty coverage. Such reinstatement premium is most often determined by formula on a pro rata temporis basis (i.e., the number of days remaining in the treaty period divided by the number of total days of the treaty).

Stop-loss

Stop-loss coverage, and similarly excess-of-loss written on a 'per event' basis, applies to the aggregate claim amount of a portfolio within a defined time period. It is often referred to as aggregate excess-of-loss and mitigates the costs to insurers of events such as pandemics and extreme weather.

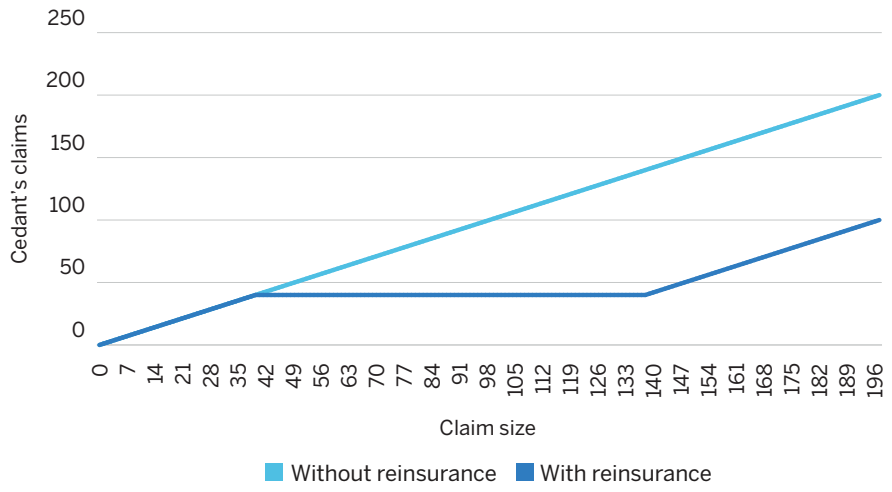
Figure 4 illustrates the cedant's claim profile with and without stop-loss cover.

FIGURE 4 : CEDANT'S CLAIM PROFILE UNDER STOP-LOSS



A standard stop-loss contract covers the full tail risk of the ceded portfolio, thus exposing the reinsurer to extreme events. Standard stop-loss contracts seldom provide unlimited coverage, and they can be expensive. Reinsurers often introduce upper limits in order to avoid excessive tail-risk exposure, as illustrated in Figure 5 on page 6.

FIGURE 5 : CEDANT'S CLAIM PROFILE UNDER STOP-LOSS WITH UPPER LIMIT



RETROSPECTIVE REINSURANCE

Sometimes non-life insurers may decide to buy retrospective reinsurance. One example of such protection is an adverse development cover (ADC), which might be purchased for legacy business (i.e., portfolios in runoff) whereby the insurer is protected against excessive adverse development of its prior years' liabilities, enabling management to focus on ongoing business. Another example of such protection is a loss portfolio transfer (LPT) whereby the insurer cedes a fixed percentage share of its prior years' liabilities (sometimes as much as 100%).

The capital benefit from such solutions is not only dependent on the solvency regime in the cedant's jurisdiction, but also the approved approach for solvency measurement. In particular, the Solvency II standard formula calculates reserve risk by multiplying the net reserve by a factor, meaning that an 'out-of-the-money' ADC has no impact on the required capital for reserving risk, an 'in-the-money' ADC has a limited impact on the required capital for reserving risk, and a LPT has the intended (i.e., proportional) impact.

FACULTATIVE REINSURANCE

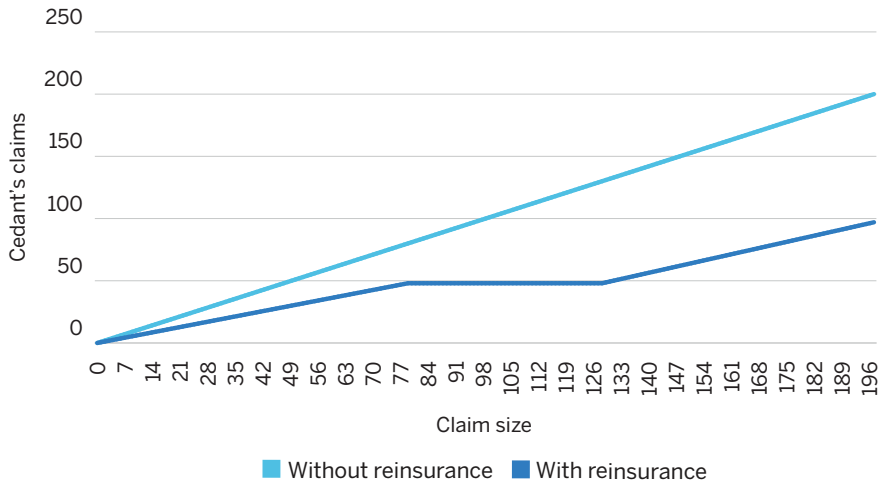
Facultative reinsurance is a popular form of reinsurance for insurers writing very large or complex individual risks. Individual risk facultative covers are written and priced on a risk-by-risk basis (and there is no obligation on reinsurers to accept the risk). Facultative/obligatory contracts introduce an element of compulsion into the arrangement—either the cedant may choose to cede risks that fall into the agreed classes and the reinsurer must accept them, or the cedant must offer to cede risks that fall into the agreed classes and the reinsurer can choose whether to accept them.

COMBINED STRUCTURES

Classical proportional and non-proportional reinsurance structures are not always adequate in isolation to meet certain risk profiles and may not take into account the value perspective under particular risk appetites.

Alternative reinsurance forms can be achieved via a combination of proportional and non-proportional coverage, for example combined quota share and stop-loss contracts, as illustrated in Figure 6 on page 7. However, as mentioned above, increased complexity in structure can introduce administration and pricing challenges.

FIGURE 6 : CEDANT'S CLAIM PROFILE UNDER COMBINED QUOTA SHARE AND STOP-LOSS WITH UPPER LIMIT



COLLATERALISED REINSURANCE

Collateralised reinsurance refers to a reinsurance contract which is fully collateralised by investors or third-party capital. The collateral is provided to cover the potential claims that could arise from the reinsurance contract. Normally the collateral posted is equal to the full reinsurance contract limit, less the net reinsurance premium.

As the contracts are fully collateralised, such reinsurance allows insurance-linked security (ILS) funds, hedge funds, pension funds, and unrated, third-party capitalised reinsurance vehicles to participate in major reinsurance programmes. By participating in collateralised reinsurance activities such investors are able to provide capital to underwrite insurance risk without requiring a rating, enabling such investors to collect premium as a return on their invested collateral.

The market in collateralised reinsurance enables these institutional investors to directly participate in the reinsurance market and provide a source of risk capital to cedants in the market. Collateralised reinsurance is increasingly popular, as it enhances the diversification effect of reinsurance protection with minimum credit default risk, which is due to the fully collateralised arrangement.

ALTERNATIVE SOLUTIONS

We also note in passing the availability to non-life insurers of risk mitigation solutions other than reinsurance, such as those provided by capital markets. For example, insurance-linked securities (e.g., catastrophe bonds and catastrophe swaps) have become increasingly popular for the large/multinational non-life insurers. They can be used by both direct writers and reinsurers to provide funds against catastrophes such as European wind storms, Californian earthquakes, etc.

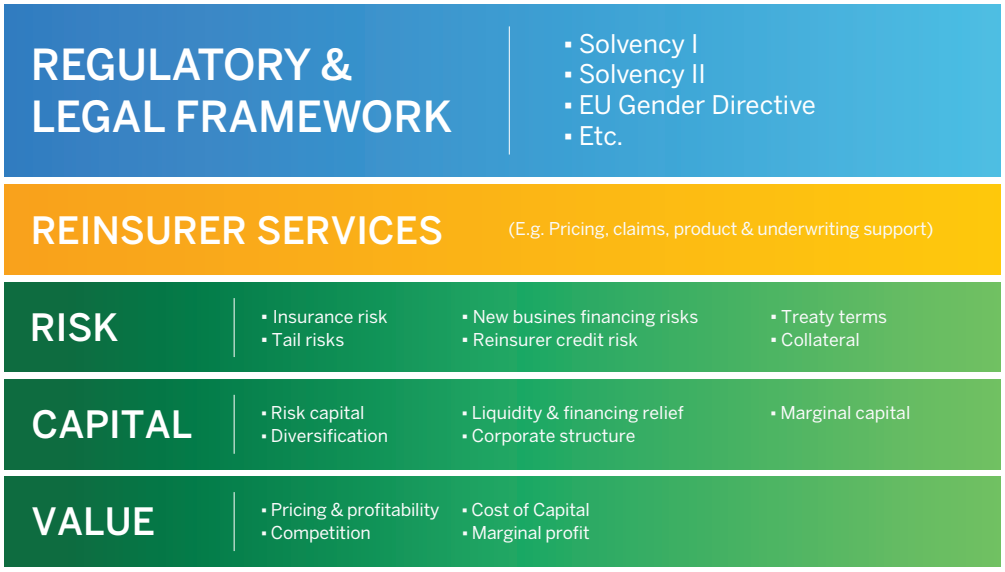
Under a catastrophe bond arrangement, capital market investors receive coupon payments from a special purpose vehicle, indirectly from the (re)insurer, so long as a specified 'trigger event' does not occur. If a trigger event occurs, then the investors start losing their principal investments, as this would be used by the (re)insurer to help it to pay its liabilities following the trigger event. Such a 'trigger event' requires an extremely precise definition and transparent calibration for capital markets to be willing to purchase such solutions. Further, the 'trigger event' may not be directly related to the (re)insurer's own experience, meaning that the size of the payout from the bond will not necessarily depend on the claims paid out by the (re)insurer.

3. The context of reinsurance decision-making

THE BROAD ENVIRONMENT

The reinsurance strategies of non-life insurers are typically considered within a broad economic, operating, and regulatory environment, such as that illustrated in Figure 7.

FIGURE 7 : ECONOMIC AND OPERATING ENVIRONMENT SUPPORTING REINSURANCE DECISIONS



Reinsurance has clear implications for risk, capital, and value management, all of which are themselves closely interrelated in an economic context. Additionally, other reinsurer services offered by the reinsurer are an important consideration when making reinsurance decisions.

In this section of the paper, we elaborate on certain key aspects of each of these main areas.

REGULATORY AND LEGAL FRAMEWORK

In this paper we focus on the economic- and risk-related factors which support reinsurance decisions. However, other regulatory and legal considerations must also be considered, especially as they may restrict decisions based purely on economic principles.

RISK MANAGEMENT

Below we describe key aspects of an ERM framework (e.g., Pillar 2 of Solvency II) which are impacted by reinsurance decision-making:

Underwriting risk: Reinsurance is a primary tool for managing the underwriting risk of a non-life insurer. This might include protection against:

- Individual claims above a certain size (e.g., large personal injury claims, major industrial property losses).
- Aggregate claims above a certain level, including the effects of:
  - Extreme insurance events such as natural catastrophe events (e.g., earthquakes, storms) or terrorist events.
  - Concentration risk, for example if many policyholders are located in the same location and/or are exposed to similar risks.
- Volatile claim experience, especially within a smaller portfolio.

New business risk: Reinsurance is effective for managing uncertainties associated with writing new business. In particular, an appropriate reinsurance commission structure can relieve the insurer's financing strain associated with the costs of underwriting, sales, and initial administration, which is why quota share reinsurance is a commonly chosen solution.

Counterparty default risk: While reinsurance typically reduces certain risks on the insurer's balance sheet, it does introduce additional credit risk. The insurer must therefore assess and quantify the counterparty default risk, typically based on the credit rating of alternative reinsurers.

Treaty terms: The terms and conditions of the reinsurance treaty should be designed to provide the appropriate legal and financial protection, as intended by the objectives of the insurer when deciding to purchase reinsurance coverage (e.g., the insurer's objective may no longer be met if an indexation clause is added to a treaty covering a line of business with an expectation that the adjudication of some large claims will take the form of a periodic payment order (PPO) claim).

Collateral: Collateral arrangements can play an important role in reducing counterparty default risk and protecting policyholders. A wide range of options is available for structuring these arrangements, and it is important to understand their impact on required capital, as they can influence the economics of a reinsurance transaction.

CAPITAL MANAGEMENT

Below we describe key aspects of a capital management framework which are impacted by reinsurance decision-making:

Corporate structure: The corporate structure of the insurer is an important consideration, especially when the insurer consists of multiple entities.

Corporate structure is often driven by capital optimisation. Reinsurance can act as a mechanism to support an enhanced capital structure, for example by transferring risk capital from one entity to another and allowing improved diversification within a group of companies.

It is also important to make allowance for any implications of the corporate structure when assessing alternative reinsurance options. For example, considering the impact of reinsurance at a local entity level may offer different conclusions to the impact at group level.

Diversification profile: Insurers can gain advantages through a diversified mix of risk types and an appropriate corporate structure. For example, multinational insurers will often benefit from geographical diversification and a balanced portfolio. In contrast, monoline domestic insurers might be limited in the diversification they can achieve and thus might be more vulnerable to risk aggregation and systemic risks, although this will often be offset by a competitive advantage through a specialised offering.

A holistic view across all risk categories should therefore be adopted in order to achieve the desired risk and capital objectives.

Counterparty default risk capital: We discussed earlier the need to consider the counterparty default risk associated with using particular reinsurers. The purchase of reinsurance naturally has implications for required capital to reflect the additional counterparty default risk associated with the reinsurance. Under risk-based solvency frameworks, the calibration of counterparty default risk considers the strength of the reinsurance partner. As such, an insurer has the ability to assess and quantify the marginal added default risk, based on the credit ratings of alternative reinsurers.

Marginal capital: A key metric when assessing alternative reinsurance structures is the marginal capital impact, as measured on either an economic or regulatory basis.

VALUE MANAGEMENT

Below we describe key aspects of a value management framework which are impacted by reinsurance decision-making:

Pricing and profitability: The expected profitability of an insurer's portfolio, in particular the relative balance of costs and benefits between the insurer and reinsurer, can influence the relative attractiveness of certain types of reinsurance.

Competition: The market for non-life reinsurance is not always efficient. For some lines of business, there is low capacity with relatively few providers and market share is dominated by a few large reinsurers. As mentioned above, the counterparty default risk also varies by reinsurer. As with any

inefficient market, the level of pricing can vary widely and some types of coverage can be difficult to obtain at a reasonable price, if at all.

Price is not the only competitive factor—levels of service, expertise, or knowledge support are also key decision drivers which underscore decisions, leading to a preference for a long-term partnership with a reinsurance provider. Further, the presence of a prominent reinsurer among the participants in a treaty may provide an implicit endorsement to the cedant's underwriting and business management.

Cost of capital: An insurer requires capital to write insurance business, in order to support minimum (and target) capital requirements, and to meet up-front costs such as underwriting, acquisition of business, and initial administration efforts. Capital comes at a cost, which will vary by insurer depending on specific circumstances.

The cost of capital will influence the economic impact of an insurer's management of its risk profile. For example, if an insurer increases its risk exposure to certain risks, its capital requirements under a risk-based regime will increase and the additional cost of that capital will impact profitability.

An insurer's capital costs can therefore influence the attractiveness of reinsurance and other risk management strategies. There may be a 'tipping point' at which a certain level of reinsurance coverage is not worth the cost, for example if the insurer is instead willing to accept the risk and hold the associated risk capital on its own balance sheet or avoid the risk altogether.

An insurer's capital costs will depend on a number of factors. They might include capital structure, credit rating, size of company, financial position, market conditions, and market perception.

Marginal profit: A key metric when assessing the alternative reinsurance structures is the marginal profitability impact, as measured on either an economic or accounting basis. Combined with the marginal capital impact, the marginal return on capital can be assessed.

REINSURER SERVICES

In addition to providing reinsurance coverage, reinsurers (and reinsurance brokers) offer valuable services such as knowledge support, underwriting, pricing, and product and claim management. They are key offerings to non-life insurers and can be major drivers of the decision to buy reinsurance coverage. It is therefore unlikely in the current environment that insurers will make reinsurance decisions based purely on financial and risk factors.

OTHER FACTORS INFLUENCING REINSURANCE STRATEGY

In addition to the aspects mentioned above, reinsurance decisions can be influenced by a wide range of other factors, including:

Line of business mix: The line of business mix of an insurer's portfolio determines the relative focus on various types of risk.

Potential diversification benefits are also a key consideration. Well diversified insurers may have the ability to offset different types of risk before considering the need for external reinsurance. Indeed, some large insurance groups have an internal reinsurance department which seeks to aggregate risks across the group in order to optimise diversification, subject to capital fungibility constraints.[4] Any excess risk above the company's risk appetite is then transferred, either via reinsurance or capital markets.

Size of insurer and financial position: Smaller insurers, or insurers with limited financial resources, will typically have less ability and/or less appetite to absorb claim fluctuations. In contrast, larger insurers may focus more on retaining profits and diversification benefits associated with underwriting risks.

Some insurers may have limited excess solvency or liquidity to absorb new business strain, resulting in a greater need for financing arrangements (e.g., reinsurance commission or financial reinsurance).

Reinsurance can also offer solvency relief, although this varies by solvency regime.

4 Capital fungibility refers to the extent to which capital can flow freely around a group structure, given the constraints of such aspects as corporate structure, solvency requirements of local subsidiaries, dividend restrictions, tax impacts of capital transfers, etc.

Risk appetite: Different insurers will have different appetites for different types and levels of risk, often related to the above factors. Excess risk above an insurer's risk appetite should be considered for external risk transfer, for example via reinsurance. The counterparty default risk of the reinsurer is also a key consideration, as well as the associated impact on risk-based capital. We discuss the importance of risk appetite in Section 4 below.

4. Aligning strategy with risk appetite

With the introduction of Solvency II, European insurance companies have focussed much effort on understanding and defining risk appetite and aligning risk limits with that appetite. This includes risks that are typically mitigated through reinsurance. However, insurers have not always aligned reinsurance decisions with their internal risk appetites.

At the very core of risk management is a statement about how much risk an entity is prepared to take around the delivery of its objectives and the types of risk which it finds acceptable or unacceptable. This then sets the tone for how the entity does business. Many, if not most, people find it challenging to think in a structured way about uncertainty. For this to work effectively, there needs to be an appreciation among those setting, monitoring, and managing the risk appetite of the nature of probability and statistics, and for them to be generally comfortable thinking about ranges of potential outcomes.

DEFINING THE RISK APPETITE

The first challenge here is for the management of an insurance company to define risk appetite in an objective and quantifiable way. Consider a non-life insurer with the simple risk appetite to withstand a 1-in-200-year event (i.e., the Solvency II risk tolerance level).[5] To help meet this particular appetite, non-proportional coverage, such as excess-of-loss or stop-loss, might be more suitable than proportional coverage, such as quota share.

In this simple example, it is theoretically rational for the insurer to cede only excess risk at or above the 1-in-200-year event. Otherwise we potentially observe either of the following scenarios:

- The insurer retains less risk than it has appetite for, potentially sacrificing the associated profit and resulting in suboptimal management of economic capital.
- The insurer is exposed to a higher level of risk than it can tolerate, thus risking its future financial health to an unacceptable level.

In practice, however, there may be barriers which prevent an ideal alignment of reinsurance coverage with risk appetite, for example:

- Defining with any level of accuracy the events which correspond to the risk appetite is not always easy, especially for extreme risk events that occur, by their very nature, rarely (e.g., earthquakes).
- It may not be possible to define the risk tolerance limit for an entire portfolio across multiple risk exposures, allowing for diversification effects, and then formulate that into a practical reinsurance structure.
- Reinsurance pricing may justify ceding a higher portion than risk tolerance alone might suggest.
- There might be other drivers for taking reinsurance coverage which are less easy to quantify, such as underwriting or pricing support.
- There may be limitations in the availability of certain types of coverage, either absolutely or at an acceptable price.

5 We note that insurers may hold capital to withstand an event which is more remote than the 1-in-200-year event, for example 1-in-1,000-year, in order to meet internal target capital or rating agency requirements.

ENHANCING THE ORSA

The optimisation of the reinsurance strategy can be seen as an ERM process. As such, there are several elements of the process that should find its way into the Own Risk and Solvency Assessment (ORSA) report, for example:

Risk identification:

- For reinsurance decision-making to be effective, it is necessary not only to imagine possible future events but also to assess the likelihood and the corresponding possible consequences of them. In this context, risks are the subset of these situations where the possible outcome is less desirable than the expected one.

Risk assessment:

- Once the existence of a risk is identified, the next challenge is to assess it and find out its consequences, likelihood, and features. This involves a second wave of analysis, involving the modelling of the multivariate dynamics of the gross exposure.

Risk management:

- The management of risk involves a trade-off. Only very rarely can risk be reduced without expending some form of effort. The decision to retain more or less of the gross exposure includes a cost element (e.g., ceded premium) and a multivariate impact for the reduction of the underlying risk. Reinsurance decision-making affects several elements of the future results, the corresponding Solvency Capital Requirements (SCRs), including the non-life underwriting risk charge, the counterparty default risk charge, market risk charge (to the extent less premium is retained to be invested), and the diversification effect, as shown in Figure 8, as well the available capital.
- Further, a choice between alternative reinsurance programmes may involve reinsurance companies with different 'credit quality step' levels and collateral obligations, leading to very different counterparty default risk charges.

Risk monitoring:

- Risk monitoring activity involves a number of tasks: looking for signals that a 'known' risk may be getting more, or less, likely; looking for signs that the nature of an identified risk's impact is changing; and detecting the signs that something 'unknown' is happening and triggering the entity to learn more and prepare itself (emerging risks).

FIGURE 8 : ORSA PROJECTIONS BASED ON ALTERNATIVE REINSURANCE SCENARIO

SCR AND AVAILABLE CAPITAL							
	2015 CENTRAL	2015 SCENARIO	2016	2017	2018	2019	2020
SCR	**11,256**	**10,891**	**10,466**	**10,763**	**10,941**	**11,093**	**11,985**
MARKET RISK	2,354	2,362	2,417	2,395	2,393	2,367	2,384
COUNTERPARTY RISK	1,173	1,181	1,327	1,398	1,402	1,412	1,381
NON LIFE INSURANCE RISK	9,157	8,772	8,099	8,340	8,509	8,661	9,622
INTANGIBLE RISK							
DIVERSIFICATION EFFECT	-2,023	-2,018	-2,079	-2,105	-2,111	-2,107	-2,136
OPERATIONAL RISK	594	594	702	735	749	761	734
AVAILABLE SOLVENCY CAPITAL	**18,264**	**18,264**	**19,297**	**19,157**	**19,305**	**19,472**	**19,654**
SOLVENCY RATIO	162%	168%	184%	178%	176%	176%	164%
SURPLUS OVER TARGET SOLVENCY	52%	58%	74%	68%	51%	51%	39%

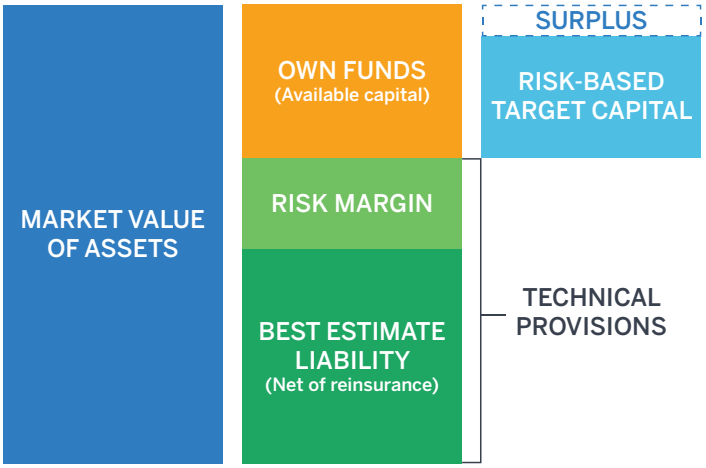
In Section 5, we consider further the role of risk appetite in a broad optimisation framework.

5. Optimising the reinsurance strategy

MEASURING THE INTERACTION OF RISK, CAPITAL, AND VALUE

As indicated in Section 3, the concepts of risk, capital, and value are closely interrelated. This is well demonstrated by an economic capital framework, such as Solvency II. Under such frameworks, the economic balance sheet represents economic- and risk-adjusted value, while the risk-based target capital[6] reflects the risk profile of the insurer. Figure 9 illustrates the basic structure of an economic capital framework.

FIGURE 9 : ECONOMIC BALANCE SHEET AND RISK-BASED TARGET CAPITAL[7]



A key prerequisite for non-life insurers to quantify alternative reinsurance structures within an economic capital framework is a reliable and robust cash flow projection model. Model results can then be used to support objective decision-making.

Under Solvency II, insurers based in the European Union are required to implement a market-consistent approach for the valuation of assets and liabilities. The standard formula methodology under Solvency II, which is a stress- and scenario-based regime for assessing solvency capital requirements, offers an effective and adequate platform for many insurers to assess reinsurance decisions.

Some insurers have chosen to implement an internal capital model to gain a more sophisticated view of their risks, often adopting a distribution-based approach. When the internal model is used for regulatory risk capital purposes, such as Solvency II or the SST, the internal model must satisfy 'Use Test' requirements. This requires insurers to demonstrate that management decisions are supported by the results of the internal model.

Insurance groups can also adopt a group model to assess the relative advantages of introducing capital and risk transfer instruments across the group.[8] A well-developed group model can support a holistic assessment of intragroup transactions and internal diversification before consideration of external transfer of residual risk to reinsurers or capital markets.

6 We use the term 'target capital' to highlight that the context is broader than Solvency II. Under Solvency II, target capital is referred to as the Solvency Capital Requirement (SCR).

7 Note that, for presentational purposes, we illustrate the technical provisions net of reinsurance. Under the Solvency II technical specifications, the reinsurance asset is presented separately on the asset side of the balance sheet. However, the net effect on value of the available capital is the same.

8 The SST requires insurance groups to adopt a group model which explicitly models the intragroup transactions. Solvency II offers insurers a number of options on how to capture the intragroup interactions, some more complex than others, which are outside the scope of this paper.

OPTIMISATION PROBLEM: A SIMPLE THEORETICAL VIEW

At a conceptual level, reinsurance strategy can be formulated as a mathematical optimisation problem under Solvency II or any other economic capital framework.

Consider the following optimisation objectives, subject to constraints of risk tolerance and availability of certain types of reinsurance coverage:

1. Maximise economic (balance sheet) value.
2. Minimise technical provisions[9] (net of reinsurance).
3. Minimise the risk-based target capital in order to improve the cost of economic capital.

Alternative formulations of the problem might also consider additional practical constraints (see below) or more complexly defined objectives, such as reducing the expected earnings volatility to an acceptable level.

Figure 9 on page 13 illustrates the components of the economic capital framework that are influenced by a change in reinsurance structure:

- Changing the retention levels and reinsurance structure will change the risk profile and risk-based target capital.
- This subsequently changes the risk margin component of the economic balance sheet.
- Changing the reinsurance structure will also change the reinsurance asset (illustrated in Figure 9 on page 13 as a component of technical provisions).

While this construction is an elegant framework within which to consider the reinsurance strategy, numerous complexities arise in applying the numerical calculation in practice, as described in the following paragraphs.

PRACTICAL CONSTRAINTS

In the real world, insurers face a complex operating environment. The basic formulation described above is complicated by numerous factors, including:

- Knowledge of reinsurance pricing for every type of coverage is not generally available.
- Certain reinsurance coverage may not be available.
- Corporate structures can introduce complexity, such as tax issues or restrictions on risk and capital transfer, as well as offering the possibility to diversify risks internally before ceding excess risks to an external reinsurer.
- Local regulatory capital regimes may restrict the optimal capital structure implied by a pure economic framework.
- Other regulatory requirements may restrict certain structural features of the treaty.
- Ancillary services from a reinsurer (e.g., underwriting or pricing) have a clear value which is not captured by the quantitative framework described.
- Estimating claim distribution may not always be reliable, which is an important assumption when risk capital and economic value are being assessed on a distribution basis.[10]

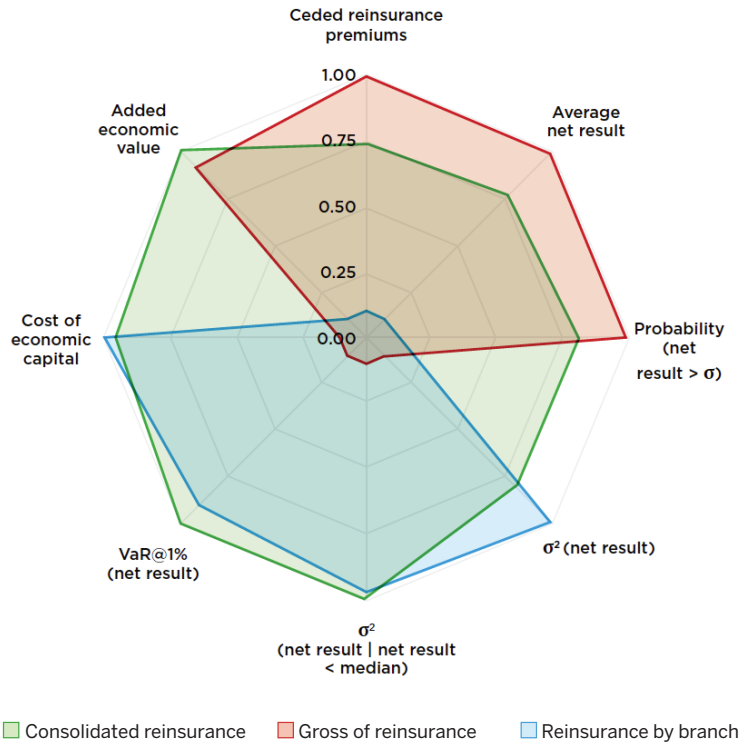
9 Technical provisions under Solvency II, or alternatively reserve liabilities or provisions under other regimes.

10 Risk capital is typically assessed on either a 'stress and scenario basis' (e.g., the Solvency II standard formula), where the scenarios represent the risk event at the designated tolerance level; or a 'distribution basis' (e.g., an internal capital model based on distributions), where the risk capital reflects a risk measure, such as the Value at Risk or Tail Value at Risk associated with the designated risk tolerance.

In short, the 'closed-form' formulation of the reinsurance optimisation problem is not normally feasible. There are a number of key metrics that need to be monitored simultaneously to ensure that the reinsurance decision is consistent with risk limits and risk appetite, protecting the net result while reducing the uncertainty of the result. A collection of metrics is often used to evaluate reinsurance alternatives (as shown in Figure 10), and can be categorised as value, capital, and volatility of cash flows:

1. **Value:** The expected net result and amount of premium ceded
2. **Capital:** The expected added economic value and the cost of economic capital
3. **Volatility of cash flows:** Tail risk, as measured by the Value at Risk (VaR) or Tail Value at Risk (TVaR) at predefined levels, and variance or conditional variance of the distribution of net result outcomes. Conditional variance would measure the volatility from a subset of the distribution of net result outcomes.

FIGURE 10 : COMPARISON OF REINSURANCE ALTERNATIVES



Source: Reinsurance: Optimising your strategy. Impact magazine (April 2016).

Below we describe a practical approach to the problem.

A PRACTICAL FRAMEWORK FOR TESTING REINSURANCE STRUCTURES

There is not a 'one-size-fits-all' reinsurance structure that would be optimal for all non-life insurers. Every insurer is faced with different circumstances, as determined by factors discussed above.

In practice, a trial-and-error approach is typically adopted for testing the impact of alternative reinsurance structures. However, for such an approach to be effective, some structure must be introduced into the decision process to maintain as much objectivity as possible.

Such a process might follow this framework:

Step 1: Define the objectives

Understanding the main objectives of the programme is critical to the design of the reinsurance structure and a successful outcome. The main objectives should complement the expectations and conclusions found in the ORSA. Areas of focus when setting objectives may include financial

reporting implications, capital release, maximum acceptable loss, transfer of risks and rewards, volatility management, and/or liquidity enhancements.

Step 2: Identify the candidate portfolio(s)
For a diversified insurer with a varied and segmented portfolio, the possibilities for implementing reinsurance solutions will be broad, possibly including the use of internal reinsurance structures to optimise risk diversification and capital.

As an early step in the process, insurers might perform an assessment of their portfolios to identify which are strong candidates to meet key strategic objectives set by management.

For each candidate portfolio, more detailed assessment can be made of the scale of benefit which might be obtained from particular reinsurance options and the effort or cost associated with each.

At the same time, the nature and risk profile of the portfolio can influence the availability and perceived value of reinsurance coverage, because the appetite of different reinsurers towards different risk types can vary significantly.

Step 3: Identify and understand the constraints
As described above, there will likely be a number of constraints which will influence the outcome of a particular structure. It is important to understand these constraints and their implications when assessing alternative structures.

In some cases, for example when considering financial reinsurance solutions, it will be important to understand the regulator's view at an early stage in the process to ensure that the desired balance sheet or capital objectives are feasible under the current structure and regulation.[11] It may also be important to understand the auditor's opinion on the accounting implications of a particular structure.

Step 4: Short-list the candidate structures
As mentioned above, candidate structures should be considered in the context of the main objectives. Structures can be as simple or complex as the situation requires and will be tailored to the specific circumstances and needs. All other things being equal, insurers should (usually) opt for simple over complex, as structures would be easier to understand, easier to manage, easier to model, and easier to audit (and easier usually means direct cost benefits).

Certain structures should be short-listed for consideration in a detailed quantitative assessment. This requires a good working knowledge of the available solutions and their associated costs.

At this stage, the insurer will typically approach a reinsurance broker or reinsurers directly and request tenders for the structures being considered. This may or may not involve a competitive bidding process involving a number of reinsurers.

To aid this step, some insurers will have dedicated reinsurance managers who liaise directly with reinsurers on a regular basis. Equally, the reinsurers can advise on possible structures to fit the objectives and the costs of those structures.

Step 5: Quantitative and risk analysis
As mentioned earlier, a key prerequisite for non-life insurers to quantify alternative reinsurance structures is to have a reliable and robust cash flow projection model that can support objective decision-making.

For the candidate structures identified in the previous step, the insurer might evaluate a variety of retention levels, consistent with the risk appetite. The model should offer an impact assessment on the key metrics, e.g., value, capital, volatility of cash flows, costs, etc., to draw a reinsurance-efficient frontier.

11 For example, in some European countries the regulator has indicated that reinsurance should be used primarily as a means of transferring material risk and not primarily to reduce solvency capital requirements (even if those capital requirements would be unduly onerous without such mitigation). It follows that solutions that are aimed primarily at reducing the SCR are currently unwelcome.

Scenario testing, volatility analysis, and risk analysis are also key to ensure the robustness of a proposed structure and to avoid certain unintended consequences.

Apart from the underwriting risks associated with the defined portfolio, other risks will also arise, such as counterparty default, legal, or tax risks. Each structure considered should be subject to a risk analysis, including identification of appropriate mitigation options, if available.

Step 6: Sign-off and approval
On successful completion of the above steps, internal approvals and sign-off will be obtained, thus allowing the insurer to proceed with the purchasing process, ultimately resulting in the implementation of a new reinsurance structure.

Step 7: Reconciliation
The negotiated cost of reinsurance inevitably differs from modelled expectations. Cash flow projection models need to be recalibrated to reflect achieved terms and (potentially) reinsurance features that were not envisioned during the modelling stage (AAL, AAD, loss corridors, etc.). A variety of after-action exercises would be undertaken in order to improve the modelling process for future renewals.

Step 8: Documentation
Finally, the process and cash flow projection model output needs to be documented such that prospective experience can be assessed and the ORSA can be enhanced to reflect the exercise.

6. Conclusion

Reinsurance strategy and corresponding purchasing decisions are most definitely impacted by the recent introduction in various jurisdictions of economic- and risk-based reporting and solvency frameworks as well as an increased regulatory focus on ERM. These frameworks have led to a shift in perspective for many insurers, often challenging the conclusions of traditional management decisions.

Non-life insurers are adapting existing business models to the modern risk management frameworks. Simultaneously, reinsurers are adapting their offerings to meet the evolving needs of their non-life insurance clients. An increase in the complexity of reinsurance solutions to meet non-life insurers' evolving needs can introduce administration and pricing challenges.

There is generally better recognition of reinsurance in the calibration of solvency capital requirements under a risk-based regime (even if still limited within the Solvency II standard formula framework). This naturally leads to a need for quantitative reinsurance optimisation models. The increased focus on ERM leads to a need for qualitative documentation of the many variables which have an impact on reinsurance decisions, including a testing of alternative reinsurance strategies in the ORSA.

Reinsurance is one of many areas where an investment in additional in-house modelling, including the considerations of several metrics, can provide significant insight which is usable in the management of the business (and ultimately could bring a market advantage).

Milliman has developed a reinsurance tool, intended to help clients to perform a number of tasks associated with the design of appropriate reinsurance programmes. These tasks include projections of individual claims, curve fitting, simulations of statistical distributions, estimation of the financial benefits of reinsurance covers, and the optimisation of reinsurance programmes. We would be delighted to discuss with insurers how Milliman could assist them in optimising their insurance strategies within a risk-based environment.

Milliman is among the world's largest providers of actuarial and related products and services. The firm has consulting practices in life insurance and financial services, property & casualty insurance, healthcare, and employee benefits. Founded in 1947, Milliman is an independent firm with offices in major cities around the globe.

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