Discussion of Scalars in Reference to the US Developed Aggregation Method for Calculating Group Capital for Internationally Active Insurance Groups

Insurance Policy Advisory Committee
of the Federal Reserve Board of Governors

Report to the Board of Governors of the Federal Reserve

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Insurance Policy Advisory Committee of the Federal Reserve Board of Governors
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Executive Summary

The Insurance Policy Advisory Committee (IPAC) of the Federal Reserve Board (Board) was established by a 2018 act of Congress to provide information, advice and recommendations to the Board on international insurance capital standards and other insurance policy issues. In February 2023, the IPAC directed its Insurance Capital Standard Working Group to advance work on scalars, an integral component of the US developed Aggregation Method (AM). The AM is being developed as an outcome equivalent alternative to the group-wide International Association of Insurance Supervisors (IAIS) insurance capital standard (ICS).

Under the AM, scaling is applied to the available capital and required capital information from the underlying jurisdictional capital frameworks. Scaling aligns the capital measures under each jurisdictional regime in a practical and relevant way. Primarily, the scalar adjusts for the varying approaches to, and location of, prudence within regimes (e.g., reserves versus required capital).

This report outlines the purpose of scalars in the context of AM and considers various technical approaches for determining scalars. These approaches are further analyzed based on criteria to assess suitability. Two approaches, the Scalar Equal to One and the Excess Relative Ratio methods, were seen to satisfy these criteria although the Scalar Equal to One only minimally satisfied one of the criteria. Other approaches were evaluated but either failed one or more of these criteria or were not pursued due to lack of available data.

The Excess Relative Ratio method is seen to generate scalars in a viable, reasonable, reliable, and stable manner, enabling a group capital solvency measure derived using the Aggregation Method to further regulator understanding of the financial condition of internationally active insurance groups.

Introduction

This report discusses "scalars" in the context of the Aggregation Method (AM) that is being developed as an outcome equivalent alternative to the International Association of Insurance Supervisors (IAIS) insurance capital standard (ICS). By enabling the synthesis of various jurisdictional capital requirements into a coherent view of group-wide solvency, scalars are foundational to the AM. This report is intended to demystify scalars by providing insight into their purpose, function, design, and calibration.

The first section discusses the attributes of the AM, including the purpose of scalars in determining group-wide solvency. The report describes the important role of expert judgment in the design and calibration of scalars, which is consistent with the significance of expert judgment within the design of the ICS, such as in the calibration of cross-correlation assumptions that aggregate exposure across ICS risk types.

The following section discusses various technical approaches for determining scalars. This analysis is anchored in criteria for assessing the suitability of a particular form of scalar. For the more suitable approaches (in particular, the Excess Relative Ratio approach), the report provides an example of quantitative estimates across US/EU Solvency II jurisdictions and discusses underlying calibration assumptions.

While the development and implementation of scalars is integral to the AM methodology, the IAIS assessment of the comparability of AM relative to ICS encompasses several considerations, including but not limited to the role of scalars. This report focuses specifically on scalars and does not address these broader aspects of the comparability assessment. To contextualize the theoretical and practical application of scalars, this report begins with background on the AM.

Aggregation Method (AM): Background

The AM is a proposed solvency standard designed to further regulator understanding of the financial condition of an internationally active insurance group (IAIG), including risks assumed by the group, as well as the location, quality, and sources of capital across the group. As an "aggregation-based" approach to a group-wide measure of capital adequacy, the AM leverages and respects the existing jurisdictional capital regimes and underlying valuation that provide the basis for insurance entity capital management and regulatory action.

Supervisory approaches vary across jurisdictions, but all work in service of achieving the same paramount objective of protecting policyholders, while accounting for market specificities. All jurisdictions complement their capital regimes with additional supervisory tools and requirements (e.g., ORSA, Liquidity Risk Management, Supervisory Colleges, etc.) that work in concert with the capital regime to ensure comprehensive and rigorous supervision of insurers.

With respect to capital adequacy, some jurisdictional regimes capture uncertainty associated with insurance products primarily through required capital while others embed higher levels of prudence within reserving requirements.

The AM adheres to the logic that jurisdictional supervisors are best positioned to assess local insurance activity. In taking an aggregation-based or "bottom up" approach to developing a view of group capital adequacy, and anchoring to jurisdictional frameworks, the AM by design provides group-wide solvency signals tailored to local insurance markets and practices, including, among other aspects:

- **The types of products and protection that consumers purchase.** The types of insurance products tend to vary by jurisdiction and market. For example, the relative roles of the public and private sector in funding retirement income typically vary across jurisdictions, which in turn impacts the role and design of long-term guaranteed products. The scope and liquidity of asset markets also vary by jurisdiction, meaning that insurers' relative allocation to equities, sovereign bonds, corporate bonds, and structured finance investments will also vary globally. regulators are well positioned to tailor their approaches to reflect these idiosyncratic insurance and asset market features (*see **Regulatory adaptation to product evolution: a US example** text box below for examples of co-development of products and local regulatory systems*).

- **Regulatory evolution and judgment**: The AM is anchored to tried-and-tested regulatory regimes, which have not only evolved to meet the needs of the current market and product environment but will continue to adapt to future innovations and developments. The application of expert judgment is inherent to the design and implementation of all global regulatory regimes, to maintain reasonable, reliable, and pragmatic frameworks. By aligning with local regulatory regimes and their future evolution, the AM promotes continued consistency with relevant market practices and current expert judgment.

- **Limitations on fungibility of capital across the group:** The AM, by showing the location of capital relative to regulatory jurisdiction, reflects the reality that, during a stress event, the fungibility of capital across a global insurance group may be constrained. By comparison, a consolidated capital model treats risks and capital in a manner indifferent to location or jurisdiction and the potential for ringfencing.

Observation #1: The aggregation approach to group capital leverages the capital and reserve information from the underlying jurisdictional capital and valuation frameworks. Independent of applying a scaling method or specific scaling factors, an aggregation approach retains the entity- and jurisdictional-specific information in its building blocks.

Regulatory adaptation to product evolution: a US example

Statutory Reserves for Deferred Annuities in the US

In the US, reserves are used as one means to ensure sufficient capital. US regulations for deferred annuity contracts have developed as these products have grown more complex over time:

- The Commissioner's Annuity Reserve Valuation Method (CARVM) was first developed in the 1970s.
- As product innovations occurred in the 1990's, Actuarial Guidelines (AG) 33, 34, 35, and 39 were developed to address the need to hold sufficient reserves.
- As technology has advanced, principles-based methods have been developed with, for instance, AG43 leading to Section 21 of the Valuation Manual (VM-21), which enabled the use of stochastic methods to calculate reserves for guarantees included with variable annuities.
- Currently, VM-22 is being updated to similarly address reserves for fixed deferred annuities.

Statutory Reserves for Universal Life (UL) Insurance in the US

When UL products began to emerge in the 1980s, simplified reserving methods were used, such as simply holding the cash surrender value. More sophisticated methods were soon introduced in the Universal Life Model Regulation to ensure that sufficient reserves were held to cover benefits:

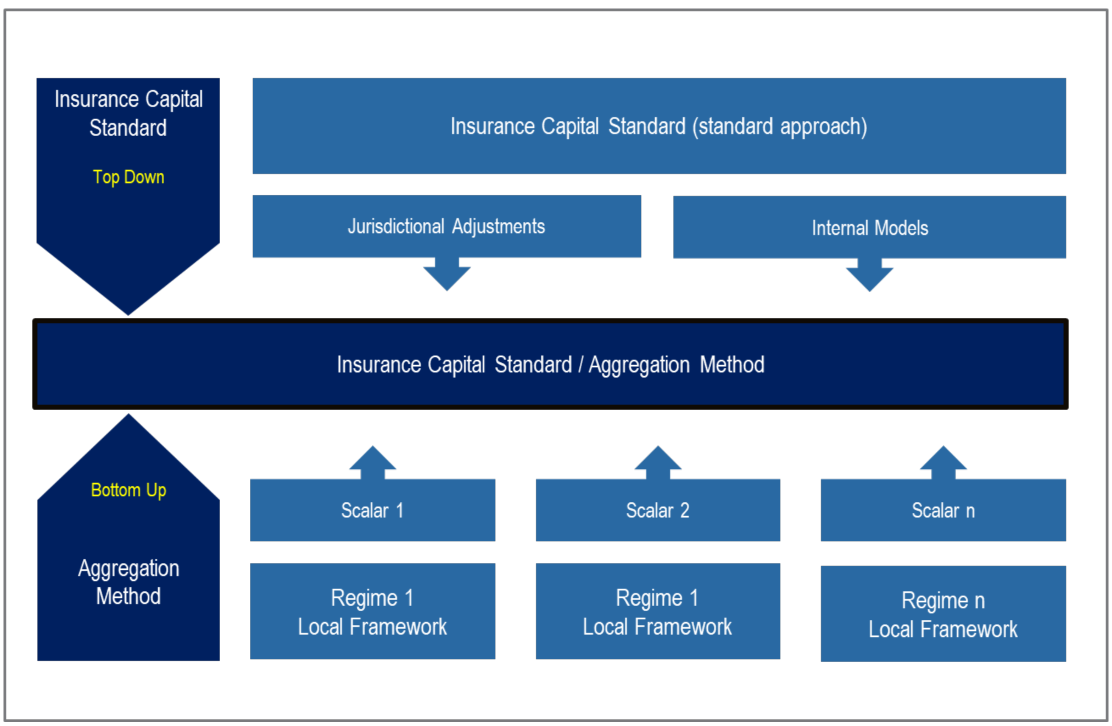
- When secondary guarantee products (ULSG) entered the market in the 1990s, Model Regulation 830 was issued to address reserve sufficiency for these products.
- As products rapidly innovated in the 2000s, AG38 was issued and quickly revised over time to ensure that appropriate reserves were being held for increasingly complex guarantees such as shadow accounts.
- Principles-based methods are now being applied for newly issued business, which can more appropriately capture guarantees embedded in life insurance contracts.

Observation #2: Changes in the underlying regime framework are automatically reflected in the AM. An inherent principle of the AM approach is anchoring to the underlying jurisdictional frameworks. This may necessitate a recalibration of scalars to the extent there are wholesale changes in a regime (e.g., moving from a moderately adverse to a best-estimate reserve standard). Yet, this anchoring ensures that AM is robust in reflecting evolving risk, and consequent changes in risk measurement, in the underlying jurisdictional framework.

AM and ICS: A comparison

The AM can be thought of as a "bottom-up" construct that builds a group view from the respective jurisdictional regimes. As noted, the foundations for the AM are the capital measures (required capital and available capital) in the local capital regimes and the underlying balance sheet valuation. These capital measures are then adjusted through the application of scalars to provide a consistent and comparable view of entity level capital that is then aggregated to provide the group capital ratio.[1]

By the same token, the ICS can be considered to be a "top-down" measure that is applied to a range of products and activities using a common methodology across all jurisdictions. The group capital ratio starts with a standard approach that may be adjusted to reflect local jurisdictional differences, either using explicit "jurisdictional adjustments" or implicitly through the use of internal models for calculating required capital. Conceptually, the "bottom-up" AM and the "top-down" ICS are simply alternative ways of deriving the group capital ratio *(as illustrated in the chart below).*



In terms of implementation, the AM has several notable attributes. For one, the AM provides clarity and predictability for stakeholders, given that the AM is anchored to jurisdictional regimes that are well understood and well established as the basis of capital management across the group.

[1] The choice of scalar methodology could influence both the scalar value as well as the mechanics of the AM calculation (i.e., the types of adjustments applied to required capital and/or available capital).

The AM enables alignment with local regimes, rather than the overlay of an alternative approach to valuation, capital, and risk quantification. This alignment with local regimes reduces the risk of conflicting solvency signals for the operating entities relative to the group level. For example, in terms of liability valuation, the ICS valuation approach attempts to measure liabilities using a market adjusted valuation method, while the US statutory reserving framework includes undiscounted non-life reserves and conservatism in assumptions and floors on the level of life reserves required. The IPAC's prior study on the impact of the ICS on US life products illustrates several examples of the inherent challenges of applying a global approach to the particular attributes of the US markets, including investment allocations, participating whole life product designs, and dynamic hedging programs.[2]

Moreover, the AM limits the potential for competitive distortions, since both domestic and foreign insurers are typically subject to the same underlying entity-level capital rules in a given jurisdiction. It also reflects evolution in underlying jurisdictional regimes over time. For example, in the US, the NAIC typically implements roughly 15 to 20 annual changes to Risk-Based Capital (RBC) calculations.[3] Additionally, the stakeholder knowledge base is already established under the AM's building blocks, and the AM might help to promote a deeper understanding of local capital approaches across jurisdictional regimes.

Observation #3: In contrast with the ICS, the AM is a "bottom-up" construct that builds a group view from the respective jurisdictional regimes. By aligning with local regimes, the AM provides stakeholders clarity and predictability and reduces the risk of conflicting solvency signals while limiting the potential for competitive distortions.

Purpose of Scalars

Scalars are a mechanism to enable aggregation of local results in a way that the sum of the parts (i.e., the aggregated result) also provides meaningful risk and solvency signals at the group level. As stated in the AM "Level 1" document, "The goal is to select a scaling methodology for the final AM that is meaningful from a prudential point of view, relevant for the monitoring of financial soundness and helps provide comparable outcomes to the ICS."[4] Scalars are generally derived from industry-level information and applied to entity-level capital measures. While scalars, theoretically, could be defined at a more detailed risk- or product-level (beyond Life/Health/P&C), implementation considerations limit the practical feasibility of these alternative approaches. In general, scaling aligns the entity-level capital measures under each jurisdictional regime in a practical and relevant way. Primarily, the scalar adjusts for the varying

[2] https://www.milliman.com/-/media/milliman/pdfs/2022-articles/IPAC-ICS-Paper-US-LT-Products.ashx
[3] https://content.naic.org/capital_adequacy_task_force.htm
[4] https://www.iaisweb.org/uploads/2022/01/191120-Level-1-Document-for-ICS-Version-2.0-for-the-monitoring-period1.pdf

approaches to, and location of, overall prudence within regimes (e.g., reserves versus required capital).

For example, in jurisdictions where the regulator has embedded higher levels of prudence within reserving requirements for certain risks or products (relative to applicable capital requirements), insurers typically operate with higher capital ratios; namely, they hold greater multiples of required capital. The US RBC statutory regime for Life insurance is an example, where reserves for mortality are calibrated to cover a provision for unexpected loss that supplements available capital. Therefore, all else equal, the amount of required capital for mortality risk is commensurately lower, since part of potential losses in a stress scenario would already be covered by conservatism embedded in reserves.

Conversely, in jurisdictions where valuation of certain risks or products is based on a "current estimate", or with relatively lower provisions for unexpected loss, required capital acts as the primary mechanism for capturing uncertainty associated with those risks. In these regimes, since reserves are not explicitly calibrated to cover a material portion of unexpected loss, the amount of required capital for these risks or products must be relatively higher when compared with a regime that embeds additional conservatism in reserving.

By scaling the results for each insurer within the group before aggregating, the AM generates a group level capital ratio that supervisors (group supervisor or members of the Supervisory College) can assess relative to the practices of the group's home jurisdiction. The AM, in turn, promotes insight into the level of excess capital over regulatory minimums across the group as a whole. The AM also enables an assessment of the group-wide ratio relative to intervention points for insurance subsidiaries, providing insight into the relative capitalization of the underlying insurance operating entities.

> **Observation #4: The AM recognizes the primary importance of a jurisdiction's own valuation and recognition principles.** As risks and accounting practices vary by jurisdiction, different levels of prudence in reserving requirements and different operating levels for capital can result. Yet, the degree of prudence embedded in total balance sheet requirements is generally consistent between jurisdictions that comply with ComFrame. The AM recognizes this principle and does not seek to override the relationship between reserving prudence and operating capital within a valuation regime at the jurisdictional level. Instead, it applies scalars that determine a comparable level of available capital relative to required capital that can subsequently be aggregated.

Precedents for Scalars and Aggregation

There are precedents within insurance group capital regimes to devise mechanisms for aggregating component jurisdictional requirements. The Federal Reserve's aggregation-based Building Block Approach scales insurance relative to bank capital regimes, using a methodology based on regression analysis between solvency ratios and historical probabilities of default for banks vs. insurers.[5]

Solvency II allows for aggregation of Solvency II requirements with jurisdictional regimes outside of the EU, including the US RBC statutory framework. Under the Solvency II approach to aggregation, group available capital consists of the sum of available capital from each subsidiary using the domestic capital framework of each subsidiary.[6] A similar approach also applies under the Hong Kong Group Wide Supervision (GWS) Framework implemented in March 2021. Group required capital is the sum of required capital from each subsidiary using the domestic capital framework of each subsidiary and essentially a scalar equal to one. Group level solvency is, in turn, measured as the ratio of group available capital over group required capital.

Observation #5: Existing insurance group capital regimes have integrated scaling and aggregation-based approaches into their standards and requirements. These regimes have recognized the necessity of combining capital levels in a thoughtful, relevant, and coherent manner.

Scalars: Role of expert judgment

Scalars are similar to cross-risk correlation matrices within ICS to the extent that both are mechanisms for synthesizing component risk calculations into a coherent group measure. The components of the ICS are the consolidated risk types, aggregated via correlation matrices. Likewise, the components of the AM are the insurance entity requirements, aggregated via scalars.

Scalars and pair-wise correlation assumptions are similar in that both are quantitative mechanisms, and both require an element of expert judgment in their design and calibration. For the parameterization of scalars and pair-wise correlation assumptions, expert judgment is necessary to account for data limitations related to the low historical incidence of, and definitional challenges in consistently measuring, insurance company defaults, as well as data limitations in estimating dependencies under stress events. Moreover, to be practicable, both correlations and scalars need to be assessed not just from a theoretical lens, but also in terms of their impact on ratio results.

As a frame of reference, several research studies and methodology papers illustrate the judgment involved in deriving cross-risk correlation matrices for insurance consolidated models, and by extension the ICS. A CRO Forum paper issued after the 2007 to 2009 Global Financial

[5] See full methodology at https://www.federalreserve.gov/newsevents/pressreleases/files/bcreg20190906a1.pdf
[6] Directive 2009/138/EC of the European Parliament and of the Council, Article 233, https://www.eiopa.europa.eu/rulebook/solvency-ii/article-2320_en.

Crisis (GFC) emphasized the importance of applying expert judgment in determining correlations.[7]

The CRO Forum highlights that correlations vary across cycles, as linear correlations (which are a constant scalar factor) cannot precisely capture the drastic changes in dependence structure between random variables during stress events like the GFC. Under stress, the implied correlations can significantly exceed historical observations. Given the inherent shortcomings of relying solely on historical data, the CRO Forum advocated for expert judgment to supplement models in a "structured – though not necessarily mathematical" manner. By the same token, the CRO Forum underscores the importance of ratio impact assessments as a complement to theoretical analysis, given both the opacity underlying quantitative correlation estimates as well as the potentially significant impact on modeled outcomes and, consequently, business decisions.

An Oliver Wyman study, which sought to establish a potential empirical basis for pair-wise correlation estimates across the forms of risk typically faced by insurance groups, reached similar conclusions about data limitations in reliably quantifying cross-risk correlation estimates (and in some cases relied on crude indicators or proxies to represent certain risk types that are challenging to measure on a cross-sectoral basis).[8]

Finally, a recent EIOPA study, "Comparative Study on Diversification in Internal Models" used in Solvency II[9] acknowledged the challenges associated with the lack of sufficient empirical data and the use of expert judgment in quantifying diversification benefits under stress scenarios. As a result, the study observed "a sizeable dispersion in the capital impact of aggregation modelling for undertakings with the same business profiles".

As part of the IAIS's assessment of the AM and scalars, the sensitivity of AM results to the choice of scalar methodology should be put into context with the ICS. Of note, both AM and ICS ratios are sensitive to several elements that are based on significant judgment, including: diversification of risks that are difficult to capture in the tails of risk distributions; the level of risk charges used to determine required capital, which are developed based on tail events and have little data on which to be calibrated; and the complicated role of tax offsets in assessing capital adequacy, particularly during stress scenarios when the loss-absorbing properties of deferred tax assets become more uncertain.

Observation #6: The development of scalars for the AM utilizes expert judgment, akin to the reliance on expert judgment in other group capital frameworks. Other frameworks, such as Solvency II and ICS, contain elements of an aggregation approach and make

[7] https://www.thecroforum.org/wp-content/uploads/2013/10/CRO-Forum-Diversification-paper-October-2013-final1-2.pdf
[8] https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2906129
[9] https://www.eiopa.europa.eu/publications/comparative-study-diversification-internal-models_en

assumptions about tail risks, which are challenging to calibrate on an empirical basis. Across these frameworks, expert judgment ensures that aggregated capital metrics provide appropriate solvency signals while acknowledging a degree of difference in expert opinion on specific methodologies and calibrations.

Scalar Considerations

Different Approaches to Scalars

A number of scaling options were considered for the purposes of this report, many of which have previously been explored in the American Academy of Actuaries paper "Aggregating Regulatory Capital Requirements Across Jurisdictions: Theoretical and Practical Considerations" and are under consideration during the development of the Aggregation Method. As of the date of this report, a scalar option has not yet been decided upon for use in the AM however, a "provisional" scalar equal to one is included in the assessment that the IAIS is undertaking to determine whether the AM produces comparable supervisory outcomes to the ICS.

For the following discussion on the different scalar methods, a "home" jurisdiction is defined as the jurisdiction of the IAIG, and a "local" jurisdiction is defined as the jurisdiction of the local entity that is to be "aggregated" with the home jurisdiction.

Scalar Equal to One

As noted above, the AM comparability assessment is based on a provisional scalar set to one. A scalar set equal to one (i.e., scalars not differentiated by jurisdiction) could, in certain instances, result in solvency signals that would not materially differ from those derived using differentiated scalars. Jurisdictional capital requirements are often calibrated to similar levels and the precision of a group capital measure may not necessarily be enhanced by attempting to adjust jurisdictional capital requirements to comparable levels via a more sophisticated scalar method. Implicitly, a scalar of one assumes comparability of reserves and required capital across jurisdictions. In contrast to the relative ratio methods described below, this method does not assume comparability in operating levels across jurisdictions. The report does not perform an analysis of the efficacy of this option, although it serves as an implicit alternative to the other, more refined methods explored in the report.

Simple Relative Ratio

The Simple Relative Ratio method, also referred to as the Pure Relative Ratio, scales required capital in the local jurisdiction using the ratio, between the home and local jurisdictions, of the average jurisdiction solvency ratio. This calculation assumes both comparability of reserves and similar operating levels between jurisdictions and compares the relative level of required capital between jurisdictions.

Excess Relative Ratio

The Excess Relative Ratio (ERR) method attempts to capture differences between jurisdictions in both required capital and available capital. Available capital may differ between jurisdictions, for example, due to the level of explicit or prescribed conservatism included in the valuation of insurance liabilities. This method is based on the measure of excess capital or free surplus which is the amount of capital held above the regulatory intervention point. Similar to a simple relative ratio, this method also assumes that insurers on average operate at similar levels of capital across jurisdictions. The ERR scalar is calculated by taking the jurisdictional average excess capital divided by the required capital level at the point of supervisory intervention in the local jurisdiction divided by a similarly calculated ratio in the home jurisdiction.

The method contains two possible options. In the first option, the scalar is simply applied to adjust the required capital. The other option includes an additional adjustment to available capital. In this second option, the difference between the required capital under the local jurisdiction and the scaled amount is subtracted from the original local jurisdictional available capital thereby ensuring that excess capital on a local basis remains unchanged after scaling. This second option was analyzed below.

Probability of Default

This method relies on the probability of default estimated under each jurisdiction to serve as the anchor point for calculating scalars. Probabilities of default can be regressed against solvency metrics (available capital/required capital) for each local regime using an ordinary least squares regression. By relating probability of default to solvency metrics (RBC ratios for the US), it is possible to calculate two scalars, one applied to local available capital and one applied to local required capital.

ICS Ratio Regression

This method uses scalars that are calibrated to a level equivalent to the average level of ICS Version 2.0 for the monitoring period. A simple regression was performed using ICS and AM ratios for several local regulatory regimes reported by IAIS monitoring period participants. Due to the sparsity of the available ICS and AM data, the regression results were not considered to be useful. It is unlikely that additional data could be obtained as the ICS is only applicable to IAIGs and not all IAIGs participate in the AM data collection exercise.

Criteria for Evaluation

This report seeks to advance scalar development by evaluating potential scalar methods with goals of (1) demonstrating that scalars can be calibrated for key jurisdictions and (2) providing a quantitative assessment of the performance of potential scalar methodologies.

In particular, this report assesses the identified scalar alternatives on the basis of the following practical and conceptual considerations:

- **Ease of implementation:** *Can the methodology be implemented in a manner that does not place undue burden on either regulators or industry participants?* This criterion favors methodologies that rely on relatively simple computational approaches and existing supervisory data (preferably, although not critically, public information).

- **Reasonableness:** *Do the scalars result in a view of available and required capital of an IAIG that can support an evaluation of the sufficiency of its capital resources?* An important characteristic of a scalar methodology is the ability of the scaled capital ratio to provide a signal on the solvency of an insurance entity. A methodology that leads to meaningfully false negatives (e.g., scenarios where regulatory intervention would occur, but is not suggested under the scaled capital ratio) or false positives (e.g., scenarios suggesting intervention is merited but an entity continues operations in the relevant jurisdictions) would not be viewed as 'reasonable.'

- **Reliability:** *Would two entities or groups independently calibrating a scalar be expected to achieve similar results?* This implies that the determination of scalars must be transparent, unambiguous, and based on broadly available and understood data. A scalar methodology would be viewed as unreliable if it is highly sensitive to reasonable implementation choices, as this characteristic could call into question whether the scalar was derived in an impartial manner.

- **Stability:** *Are scalars stable over time absent a substantial change in regulatory regime or macroeconomic conditions*? Large year-to-year swings in scalars could result in volatility in group capital even if an insurer has stable capital levels in its own jurisdiction(s). As a result, stability is an important characteristic to enable insurance groups to manage their group capital and forecast it over a multi-year period.

Overview of Quantitative Findings

To evaluate the potential methods in a quantitative manner, each method that required data-driven calibration was pursued. These efforts allow both a practical assessment (can scalars be calibrated in a simple and reliable manner?) and provide the quantitative information to support discussion of the traits of each method.

The findings from this effort identified two supportable methods: "Scalar equal to one" and the Excess Relative Ratio method. Each of these methods meet the criteria outlined around ease of implementation, reasonableness, reliability, and stability.

- The "Scalar equal to one" method is, by definition, simple to implement, reliable, and stable. In addition, it fulfills the minimum criteria for reasonableness by providing

  - accurate signals about the solvency of a local entity by maintaining the point of regulatory intervention, although it does not recognize varying approaches to prudence.
  - The ERR method provides a more nuanced view of the relative capital adjusting for the level of prudence within reserves relative to required capital across jurisdictions. While, unlike a Scalar equal to one, it requires a calibration exercise, as demonstrated in this report. It is still straight-forward to implement in reliable manner, sufficiently stable over time, and produces reasonable results that maintain solvency signals.

The other scalar methods explored were de-prioritized:

  - Simple Relative Ratio approach may create an outcome where a local capital ratio may indicate a capital deficiency, but the scalar operates to adjust the required capital such that at the group level, the capital ratio may not signal a deficiency.
  - Probability of Default and the ICS Ratio Regression methods suffered from a lack of sufficient data to generate supportable scalars.

The Appendix includes further details on the work performed on the Simple Relative Ratio and Probability of Default methods that were set aside.

Relative Ratio Approaches

Under these approaches, scalars are applied to the required capital of the local jurisdiction, and also used to adjust available capital of the local jurisdiction under some methods, such that the scaled local capital information can then be aggregated with the capital information in the home jurisdiction. The various relative ratio scalar approaches use different methods to derive an anchor point to calculate the scalars used to aggregate the different capital measures.

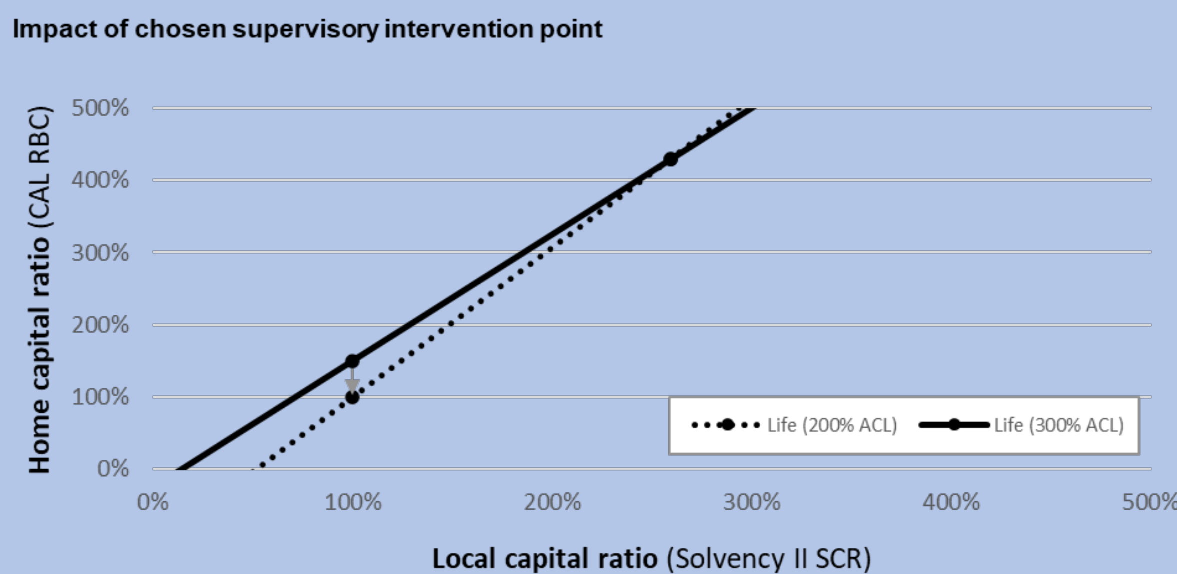
A home jurisdiction could represent the jurisdiction under which the solvency measure is being applied. For example, home jurisdiction for US-based groups would refer to US RBC. Alternatively, the home jurisdiction could be a common framework such as the ICS. US RBC is used as the example of the home jurisdiction for purposes of this report; however, the US would not necessarily be the home jurisdiction under the AM or for other adaptations of aggregation-based solvency frameworks.

Certain relative ratio approaches compare the relative level of required capital between the home and local jurisdictions under the assumption that there are similar average solvency operating levels between the jurisdictions. As a result, where the home regime includes more prudence within the underlying valuation and a lower required capital relative to the local regime, the scalar will typically be less than one. Conversely, where the home regime includes less prudence within the underlying valuation and a higher required capital relative to the local regime, the scalar will typically be greater than one. For home and local jurisdictions with similar levels of valuation prudence, the scalar would typically be closer to one.

Selection of a local and home jurisdiction must also include the identification of the supervisory intervention level. For jurisdictions with escalating levels of intervention, it would be necessary to identify a particular level that is to be used to calculate scalars. Scaling options may be calibrated to different levels based on the interpretation of the target level for capital or the level at which supervisory intervention is required. In the US, for example, the intervention point could be interpreted to be at 200% of the Authorized Control Level (ACL) risk-based capital, also referred to as the "Company Action Level" (CAL). This is the first intervention point at which a supervisor would require an insurer to submit a capital remediation plan. Another possible interpretation of intervention level could be at 300% of ACL, referred to as the "Trend Test" level where, if breached, an insurer must submit a trend test calculation to its regulator.[10] Ultimately, the AM and the scalar approaches in this report would support both a 200% or 300% ACL calibration point; determining the possible calibration point linked to scalars is a supervisory decision and outside of the scope of this report.

Observation #7: The scalar methods used by the AM support different levels of calibration based on the target level of capital at which supervisor intervention is assumed. Under the relative ratio methods, a different choice of intervention level affects the scaling factors between jurisdictions, as ratios are relative to the chosen intervention point, but do not otherwise affect the core solvency signals provided by these methods.

Chart 1:



This shift has the effect of shifting the slope (scaling factor), while maintaining both (i) equivalence of typical operating levels and (ii) relative capital levels of insurers within the jurisdiction.

[10] Model Law Act 312, Risk-Based Capital (RBC) for Insurers Model Law Act, NAIC, 2012. https://content.naic.org/sites/default/files/model-law-312.pdf

Excess Relative Ratio

The Simple Relative Ratio method and the Excess Relative Ratio method can be evaluated in parallel as the two methodologies rely on common data and similar methodologies. In both methods, 'typical' operating levels of regulatory capital form the basis for scaling.

The core difference between the methods is the assumed equivalence points. Both methods include an inherent assumption that typical operating levels are comparable across jurisdictions. The difference centers on the second anchor points: the simple ratio method assumes that the point of insolvency is equivalent, whereas the excess relative ratio method assumes equivalent points of regulatory intervention.

Chart 2:

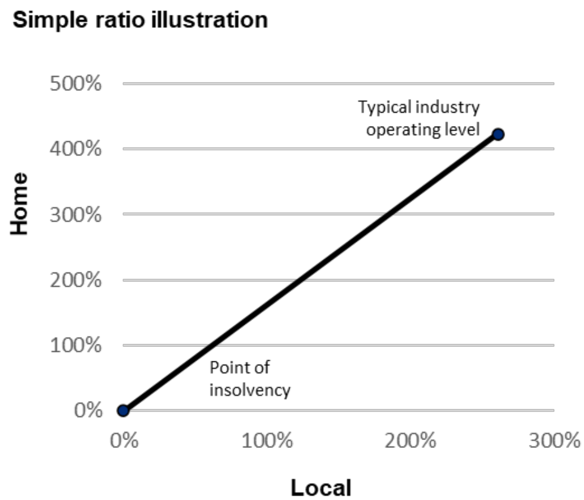
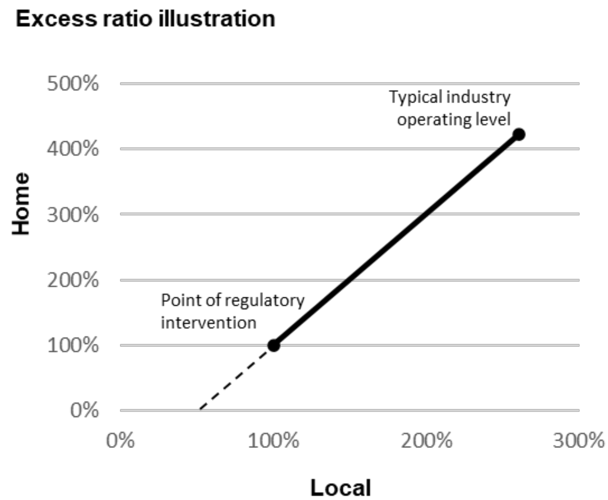


Chart 3:



The Excess Relative Ratio method is preferable as, by design, an entity will reach a 100% scaled capital ratio at the same point that it reaches the intervention level in its own jurisdiction. In contrast, the simple ratio method allows for an insurer to reach regulatory intervention levels in its local jurisdiction without doing so on a scaled basis (or vice-versa).

This report calibrates scalars between EU Solvency II[11] (as the "local" jurisdiction) and US RBC (as the "home" jurisdiction) to examine their reasonableness, the reliability of the estimates to alternative implementations, and their stability over time. Scalars were calculated separately for Life and P&C; this method reflects both differences in typical operating ratios between Life and P&C companies and different capital regimes in some jurisdictions.

[11] Excludes the U.K. for all years.

The remainder of this report focuses on the Excess Relative Ratio (ERR) method. Further discussion of the Simple Relative Ratio method can be found in the Appendix.

Ease of Implementation

Scalar calibration uses historical, entity-level information on regulatory capital. This process relied solely on publicly available information from existing regulatory filings and was sourced through third-party sources aggregating this information.[12]

Table 1: Industry-aggregate capital ratios[13] by jurisdiction for life and non-life (excluding health); 2016-2022

	US (CAL RBC)		**EU Solvency II** (SCR)	
Year	**Life**	**Non-life**	**Life**	**Non-Life**
2016	477%	338%	240%	271%
2017	465%	312%	257%	269%
2018	419%	308%	263%	268%
2019	430%	312%	264%	247%
2020	425%	306%	251%	246%
2021	439%	308%	266%	249%
2022	424%	293%	261%	253%

[12] Scalar calibrations were based on aggregated, entity-level filings pulled from S&P Capital IQ.
[13] As calculated based on entity-level reporting. Use of entity-level solvency data enables a broader set of analysis, but also creates slight differences with the reported industry-aggregates. For the US, in 2022, the aggregated capital ratio reported by the NAIC for Life entities was 427% CAL RBC; for P&C entities, the aggregated capital ratio was 309% CAL RBC. For EU Solvency II, legal entities were initially classified as either Life or P&C based on the classification in S&P Capital IQ and then manually reviewed; reinsurers, multiline, and financial guarantee entities were excluded. This approach excluded ~10% of industry capital. The aggregate SCR for in-scope companies compared with all entities (inclusive of reinsurers and multiline but excluding financial guaranty) was within 2% for all years.

As noted earlier, the ERR method anchors on the intervention level for each jurisdiction. The following invention levels have been assumed in the following analysis.

Jurisdiction	Intervention level	Description
US	200% ACL	Company submits plan to regulator
EU	100% SCR	Supervisory actions required to restore solvency level

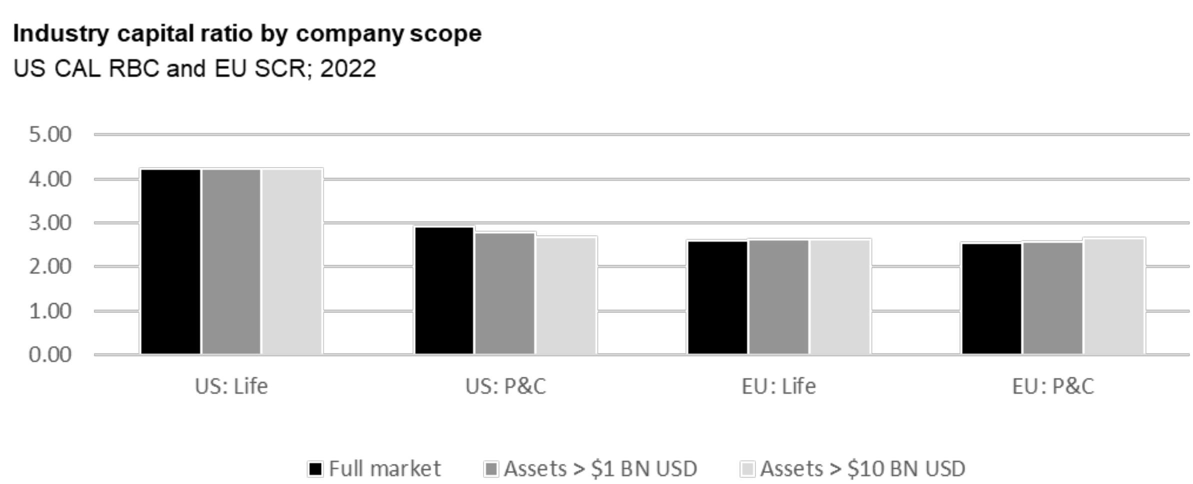
Under both methods, the base scalars are calibrated using aggregate available and required capital across all entities operating in the relevant jurisdiction using a 3-year historical window. The sensitivity to this specific implementation is evaluated in the discussion of reliability.

Reliability

The core implementation choices for the ERR relate to the definition of typical operating levels within a jurisdiction. In particular, (i) the scope of companies to include and (ii) the method to calculate a 'typical' capital ratio from company-level information. The materiality of these choices was considered to evaluate reliability of the ratio methods.

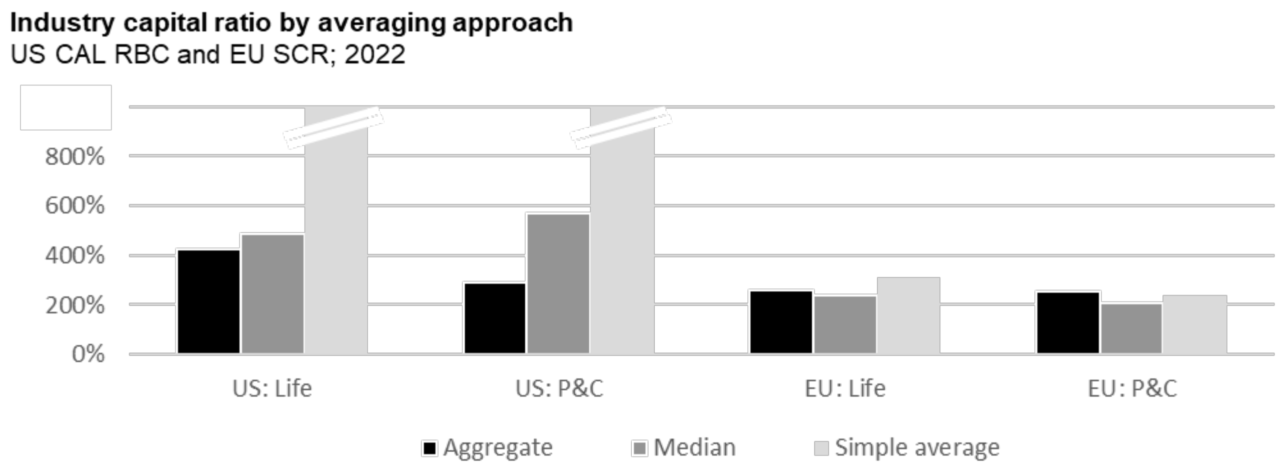
Company scope: scalars depend on the scope of companies used to measure operating levels within a jurisdiction. From an ease of implementation perspective, using the full market is preferable because it allows use of aggregated data reported by regulators. However, if scalars are intended primarily for use by large insurers, such as IAIGs, and it is believed that these companies operate at different capital levels, then limiting company scope could be appropriate. As illustrated in the chart below, there is limited sensitivity in capital ratios when using the full market compared with only large entities (above $1 BN USD or $10 BN USD in assets).

Chart 4:



Capital definition: three methods were considered to define 'typical' capital levels within the industry: industry-aggregate ratio (i.e., calculating the industry capital ratio from the total available and total required capital held), median (i.e., median of the capital ratio of in-scope companies), or simple average (i.e., average of the capital ratios for in-scope companies). Because significant outliers are observed in capital ratios, a simple average is not a reasonable method for this purpose. For example, given the number and variety of insurers in the US market, the simple average implies a capital ratio in excess of 1,000% CAL RBC, well above what could reasonably be considered 'typical' operating levels. Both industry-aggregate and median approaches produce reasonable capital ratios.

Chart 5:



This report defines the scalars based on aggregated capital for the full market. Notably, this method does not require entity-level data to support scalar calibration and therefore allows the calibration for jurisdictions where entity-level information is not readily available or disclosed by the regulator.

The calibration results, which follow the methodology described above, are shown below.

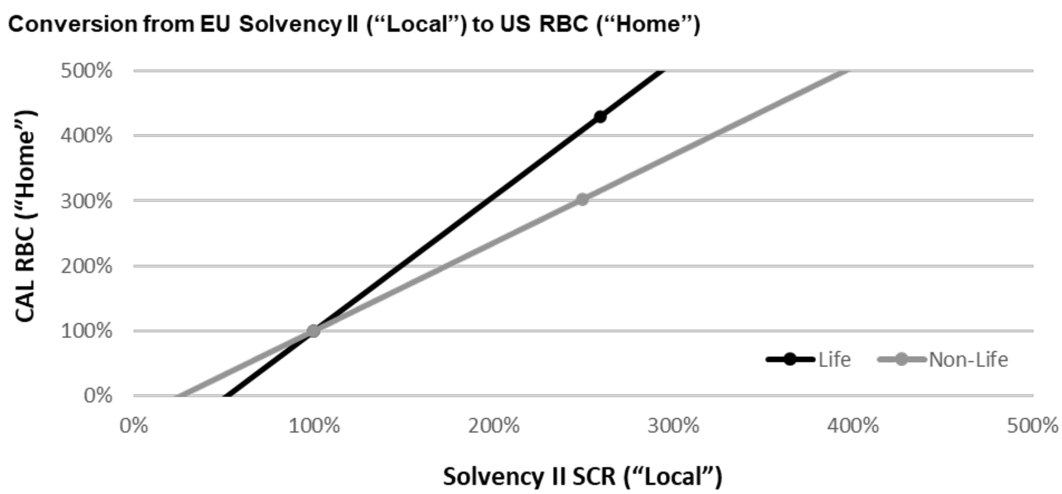
Table 2: Excess method scalars from EU Solvency II (100% SCR) to US RBC (200% ACL)

	Life	***P&C***
2018	0.43	0.77
2019	0.48	0.77
2020	0.49	0.74
2021	0.48	0.70
2022	0.48	0.74

Reasonableness

In the Excess Relative Ratio Method, by design, an entity will reach a 100% scaled capital ratio in the home jurisdiction at the same point that it reaches the intervention level in its local jurisdiction. This feature means that signals from the excess ratio will align with any regulatory action in the local market.

Chart 7:



In addition, the distribution of entity-level capital ratios is considered after application of the scaling factor (applied to both available capital and required capital). A similar distribution for both life and P&C entities is observed across both jurisdictions.

Chart 8:

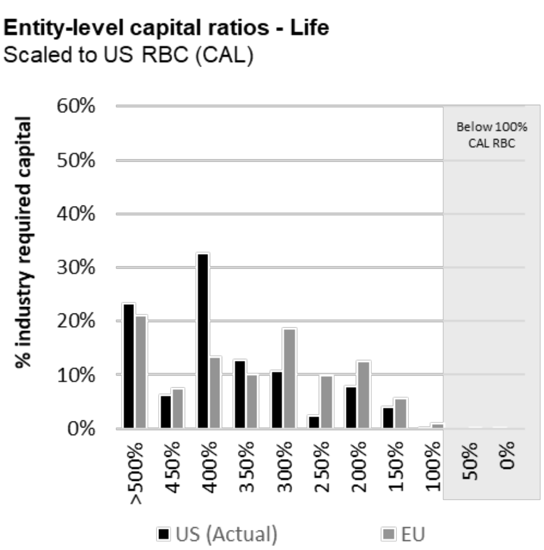
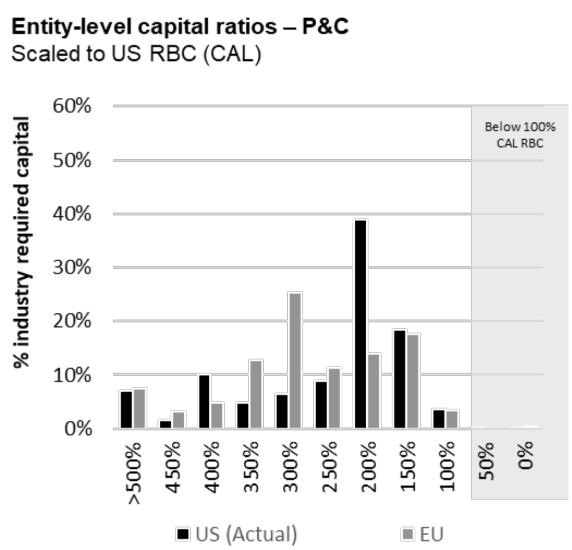


Chart 9:



Stability

To assess the stability of the scalars under the ERR, the implied scalars are calculated on a year-by-year basis since the introduction of Solvency II.

Chart 10:

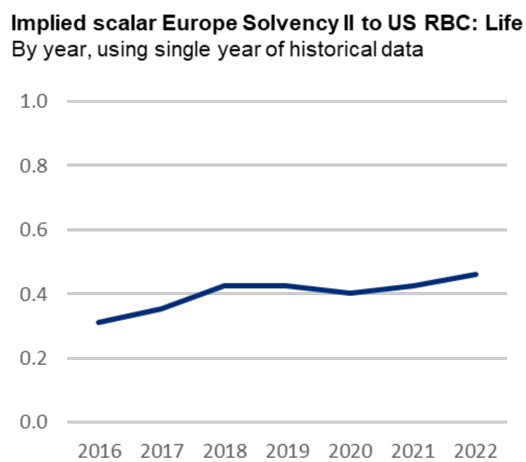
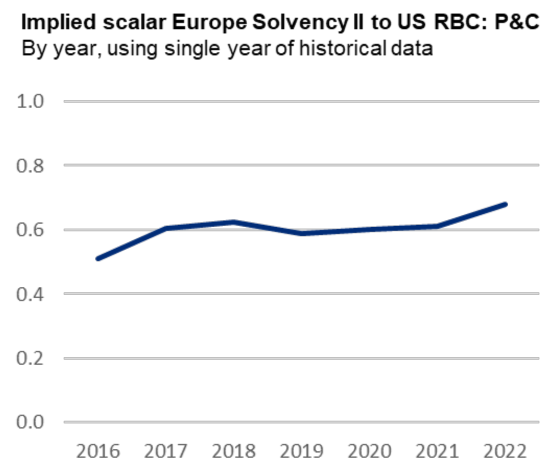


Chart 11:



These scalars are then applied to convert the capital ratio for an entity operating at a constant capital level in its local jurisdiction of 250% SCR to a US home jurisdiction. The capital ratios shown apply adjustments to both available capital and required capital. In general, the scaled capital ratios are stable through time, with the largest variation occurring for Life companies from 2017 to 2018, when a change in corporate tax rates in the US led to an industry-wide reduction in reported capital ratios of ~10% (that is, changes in the scaled capital ratio reflect the effects of a specific policy change, which impacted industry-wide operating levels).

Chart 12:

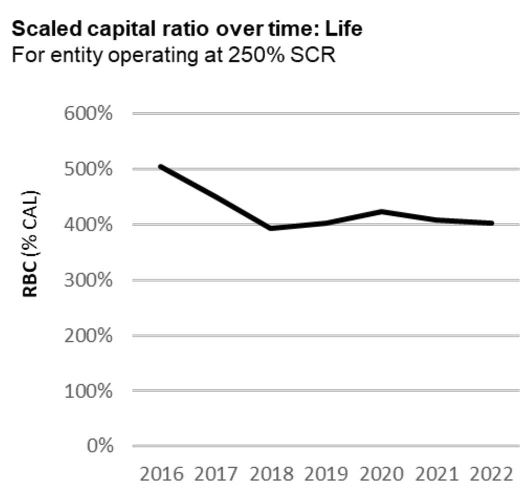
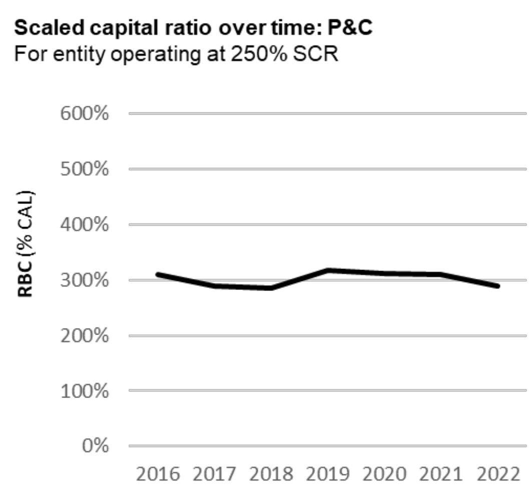
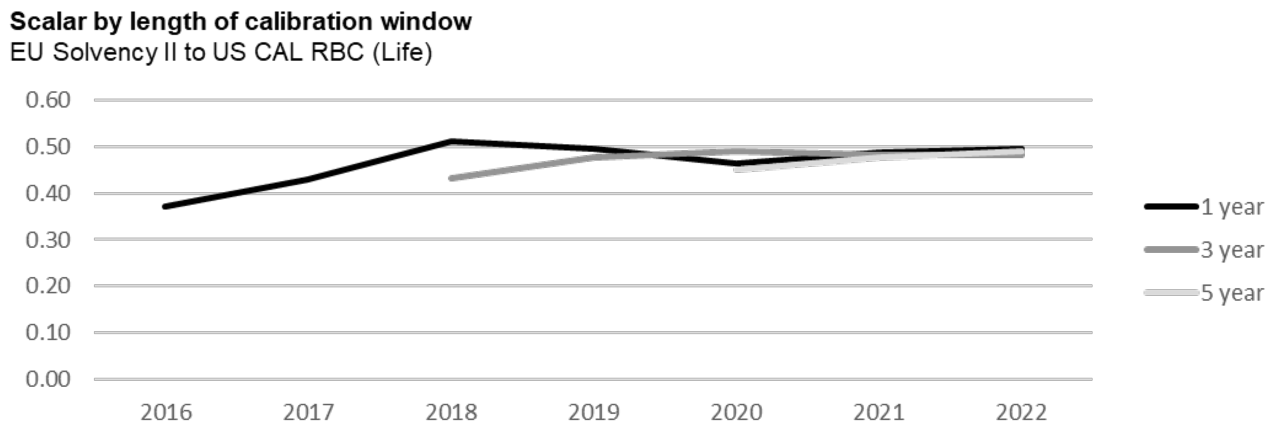


Chart 13:



In addition, scalar stability can be enhanced by calibrating based on multiple years of data. Except for the analysis above, this report uses three years of historical data to calibrate scalars. This period was elected to balance the desire for year-to-year stability while allowing reflection of refinements to the solvency regime and/or business models shifts in a timely manner.

Chart 14:



Summary

The ERR adheres to the four criteria identified for evaluating potential scalar methods, and thus provides a suitable method for aggregating capital across jurisdictions. It is straight-forward to implement, requiring only the collection of existing supervisory data and no complex calculations to support calibration. The ERR produces reasonable results that maintain solvency signals across jurisdictions, as, by design, an entity will reach intervention levels in both its local and home markets at the same point. In addition, the quantitative results demonstrate that the range of reasonable scalar design choices are not likely to result in significantly different scalar calibrations. Lastly, the calibration itself has been sufficiently stable over time, not introducing non-economic volatility.

Conclusion

The Aggregation Method, developed in recent years to be an outcome equivalent alternative to the ICS, requires scalars to synthesize various jurisdictional required capital into a coherent view of group-wide solvency.

This report thoroughly assesses the potential scaling methodologies under four practical and conceptual considerations and demonstrates that scalars can be calibrated for key jurisdictions. The Excess Relative Ratio method has been proven to satisfy these considerations and is the preferred scalar method. While viable in practice and plausible in concept, the Simple Relative Ratio and Scalar Equal to One methods are less reasonable than the Excess Relative Ratio method and are not preferred. The Probability of Default and the ICS Ratio Regression methods, on the other hand, are not viable at this stage due a lack of sufficient data to generate supportable scalars.

The development and assessment of scalars, both in choice of method and in calibration of factors, relies on expert and prudent judgment, similar in degree to the design and calibration of elements of other group capital frameworks. While this report has advanced the understanding of particular scaling approaches for the Aggregation Method, scaling itself is not a novel practice and has been integrated into other existing group capital regimes. For the group-wide view of the AM, scaling facilitates its bottoms-up construction and is applied to the capital and reserve information from the underlying jurisdictional capital and valuation frameworks.

In summary, the preferred Excess Relative Ratio method generates scalars in a viable, reasonable, reliable, and stable manner, enabling group capital solvency information derived using the Aggregation Method to further regulator understanding of the financial condition of internationally active insurance groups.

Appendix: Scalar Methods Set Aside After Evaluation

The following scalar methods were thoroughly assessed and viewed as less preferable than the Excess Relative Ratio method after consideration of the possible implications in the case of the Simple Relative Ratio method and the lack of data in the case of the Probability of Default method. The following sections provide detail on the evaluation that was performed.

Simple Relative Ratio

To evaluate the simple method, scalars were calibrated from EU Solvency II (excluding the U.K.) to US RBC. The results of this calibration, which follow the methodology described in the paper, are shown below.

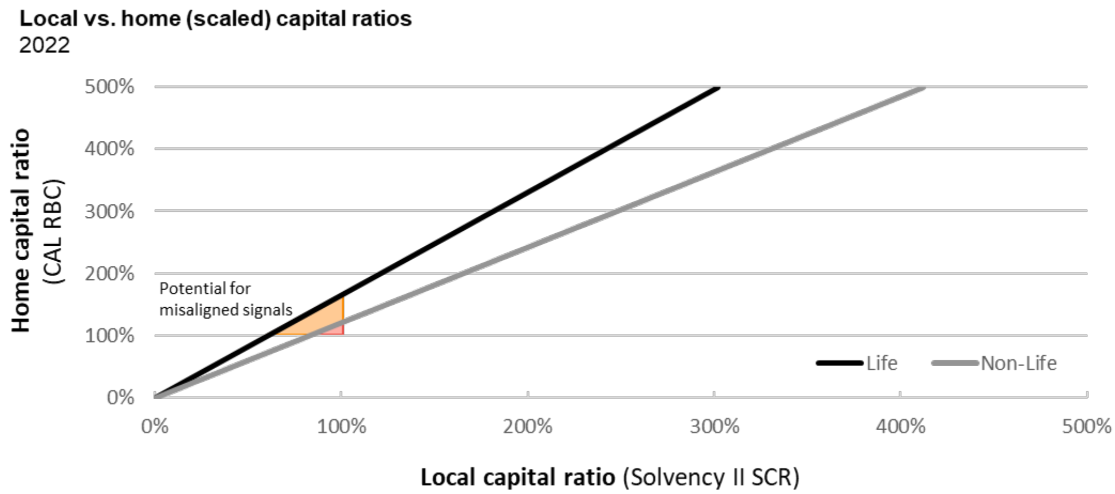
Table 3: Simple method scalars from EU Solvency II to US RBC (CAL)

	Life	***P&C***
2018	0.56	0.84
2019	0.60	0.84
2020	0.61	0.82
2021	0.60	0.80
2022	0.60	0.82

Reasonableness

A reasonable scalar provides a good signal of when regulatory intervention will occur. As demonstrated in Chart 15 below, under the simple ratio method, it is possible for a company to operate below regulatory intervention levels (100% for SCR) yet maintain a scaled capital ratio in excess of 100%.

Chart 15:



Observation #8: Under a simple ratio method, signals based on the scalar capital ratio may not align with the local jurisdiction. Because the simple ratio method does not anchor on the point of regulatory intervention, it is possible for an entity to fall below this level under its local regime, while its scaled capital ratio remains above the intervention level under home regime.

Stability

To evaluate the stability of the scalars, the implied scalars on a year-by-year basis were examined. With the simple ratio method, changes in the calibrated scalars will proportionally impact scaled capital ratios. The largest observed single year movement is ~15% in the Life scalar from 2017-2018 and reflects a policy change (corporate tax rate) in the US that affected reported capital ratios. In addition, the scalar stability can be enhanced by calibrating based on multiple years of data.

Chart 16:

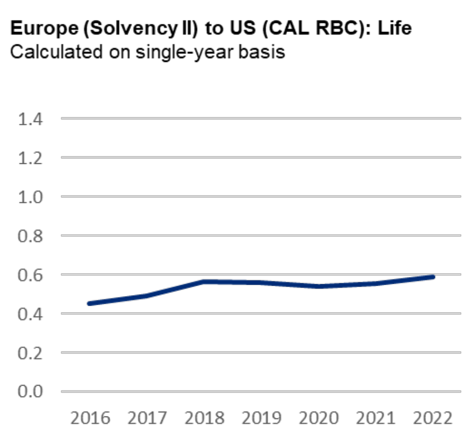
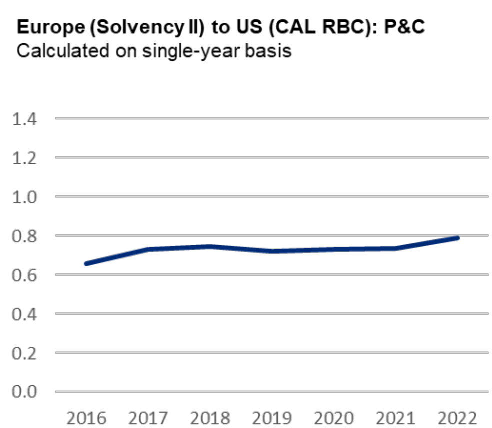


Chart 17:



Probability of Default (PoD) Method

Scalars estimated based on the probability of default depend on a reliable, widely available data source, one based on a validated methodology. By relating probability of default to solvency metrics (RBC ratios for the US), it is possible to calculate two scalars, one for available capital and one for required capital. The only prior effort to build scalars from probabilities of default, in the Federal Reserve Board's 2019 paper[14], which provided a reasonable methodology for converting parameters relating probabilities of default to solvency metrics into scalars, relied on administrative data on defaults for US banks and insurance companies, and derived reasonable scalars. However, that paper expressed skepticism about the availability of equivalent data with which to estimate scalars in other countries in the world. That skepticism is highly relevant to the primary focus of this report, the aggregation of insurance entities in different jurisdictions.

The Academy's 2021 paper identified a source potentially meeting the criteria required: estimates produced by Prof. Jin Duan and his team at the National University of Singapore (NUS)[15]. The Academy recently contracted with Prof. Duan to produce entity-level estimates for all insurance companies in the United States, Canada and France from 2008-2021. The Academy also contracted with AM Best for operational and business status data for those same companies. The results discussed below were produced with that data.

Ease of Implementation

To provide the required data to Professor Duan, the Academy licensed two sets of data from AM Best, in each case for all insurance entities in the United States, Canada and France for the time period 2008 – 2021.One data set included basic data on the assets and operations of the companies, and the other included the business status of the companies, from which defaults could be derived. Based on that data, Prof. Duan and his team estimated the probability of default for each entity for each month of each year. Their estimates ranged from one to sixty months forward. For comparability to solvency metrics, one year forward probability of default estimates were examined as of December 31st of each year.

In order to estimate scalars following the pathbreaking model developed by the FRB, the Probabilities of Default are regressed against Solvency metrics for each country. The parameters from those regressions for the US and either Canada or France are the underlying elements for the scalars. While the FRB was required to use logistic regression for their estimates (given the binary nature of their default data), the PoD data fits a linear model more nearly, with continuous independent and dependent variables. Hence, ordinary least squares regression was relied upon.[16]

To produce robust, consistent parameters for the building of scalars, the following two steps were undertaken:

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[14] https://www.federalreserve.gov/newsevents/pressreleases/files/bcreg20190906a1.pdf
[15] https://www.actuary.org/sites/default/files/2021-04/scalars.pdf
[16] The analysis was repeated using generalized linear models without any qualitative change in the results.

1. Identifying salient differences among companies and time periods, recognizing that results needed to be based on comparable observations; and
2. Identifying outliers in each of the samples studied.

Step 1: Differences in companies and time periods

Preliminary analysis revealed three important differences within the overall sample for each country. First, while the capital and valuation regime remained structurally consistent in the United States from 2008 – 2021 (RBC), both Canada and France made notable changes during the period. In Canada, Life insurers reported MCCSR until 2017; in 2018, they began using the LICAT. For non-life insurers in Canada, the Minimum Capital Test was reported until 2014; in 2015, they began reporting MCT/BAAT. In France, the introduction of Solvency II in 2016 changed reporting for both Life and non-life companies. For this current effort, only the French results after the shift to Solvency II are reported. To estimate parameters before and after each regulatory shift, all years since the shift (ending in 2021) and an equal number of years before the shift are used. For example, with Life reporting in Canada, 2018 – 2021 is estimated for the post-shift period, and 2014 – 2017 for the pre-shift period. In the United States, periods which match those in both Canada and France have been estimated.

Next, significant differences were observed in preliminary estimates between life and non-life companies. Given different periods of regulatory consistency, estimates for those companies were made separately. Finally, significant differences between smaller and larger companies were observed. For this reporting, each sample was divided based on the median total assets of companies during the entire relevant time period, distinguishing between those below and those above the median.

Step 2: Outliers

In all three countries, but especially in Canada and France with smaller samples, results were easily influenced by outliers. Stability in results was found by employing a two-stage method for eliminating outlying cases: first, instances were eliminated with solvency metrics at the tails of the distributions, specifically less than 0 or higher than the 90^{th} percentile; regressions were then performed with the samples remaining. A measure of undue influence by individual observations was estimated in a regression (Cook's D) and those observations were removed which were influencing parameters more than expected. The regressions following these two stages of outlier removal proved relatively robust and stable.

To summarize the steps required to produce scalar estimates:

1) acquisition of data from AM Best;
2) contracting for the calculation of probability of default estimates from Prof. Duan;
3) obtaining solvency data from S&P's Capital IQ Pro database for the United States and France, and from the Office of Supervision of Financial Institutions in Canada;
4) matching data derived from the different databases; and

5) identifying and excluding outliers to produce stable, robust regression estimates for the relationships between probabilities of default and solvency metrics.

Even if the resultant relationships had proven strong enough to allow the production of reasonable scalars (as reported below), this method is difficult to implement and would have to be repeated with all its difficulty every time the scalars are updated.

Reliability

Prof. Duan's methodology has been explicitly described both in academic articles and papers published on the website of the NUS Credit Research Initiative[17]. While the original methodology was designed for publicly traded companies, Prof. Duan developed an extension of the methodology to estimate the probability of default for privately held companies. His application and extensive assessment of this methodology in the case of South Korea demonstrates it as an effective method.

A notable feature of Prof. Duan's methodology is the assumption that all companies in all industries in all countries are similarly impacted by the elements of the model, with country and industry-level exceptions introduced only when the data reveals it as necessary. The methodology produces monthly estimates for the probability of default (i.e. from one month forward up to sixty months forward) for each company in a way that ensures that the estimates for different periods forward are statistically independent. The focus here is the 12-month forward estimates of probability of default.

Before turning to those estimates, the data provided by AM Best, as analyzed by Prof. Duan and his team, contained a total of 168 defaults in the three countries, but only one each in Canada and France, during the entire time period. A summary of the results follows in Table 4.

Table 4: Probability of Default Estimates from NUS

	US	Canada	France
Number of Distinct Companies	6,972	504	468
Number of Defaults	166	1	1
Defaults as % of Companies	2.38%	0.20%	0.21%
Mean PoD (12 month)	0.20%	0.13%	0.04%
Median PoD (12 month)	0.13%	0.10%	0.03%
10th Percentile PoD (12 month)	0.05%	0.04%	0.01%
90th Percentile PoD (12 month)	0.33%	0.24%	0.07%

[17] https://nuscri.org/en/

In Table 4, more than ten times as many companies are represented in the US compared to Canada or France. More importantly, the number of defaults as a percentage of those companies present is also more than ten times in the US compared to Canada or France. This explains, in part, why the distribution of probabilities of default is lower in Canada and in France compared to the US at the mean, the median, the 10th percentile, and the 90th percentile.

In the Academy paper, the challenge of endogeneity is discussed, namely, that the number of defaults – and hence the probabilities of default – are the product, in part, of the interventions common in given regulatory regimes. In other words, if some countries more aggressively intervene to facilitate outcomes other than defaults for companies at risk of default, then their probabilities of default will appear lower even though the "riskiness" of the companies in their jurisdiction might be equivalent to less aggressive jurisdictions. To get a sense of the possibility that this issue affected the three countries, each of the categories of exits identified in the data were examined (the possibilities varied slightly from country to country). For each category in each country, the median change in assets of companies exiting was examined, assessing the change from two years before exiting to one year before exiting.[18]

The categories in which the NUS team identified defaults were those companies In Liquidation, Liquidated, and Dissolved (this last category led to a case-by-case analysis of each exit). Table 5 presents the results of this analysis of exits. For the US, defaults originated with 151 companies In Liquidation, five Liquidated companies, and 10 Dissolved companies. In Canada and France, no companies were identified as In Liquidation or Liquidated; one Dissolved company in each country was identified as a default. The respective percentages of Dissolved companies identified in each country as Defaults was 3.4% for the United States, 5.5% for Canada, and 5.0% for France.

To roughly approximate the extent to which different countries intervened more aggressively, the other exits available in the data were examined to see whether the assets of companies in those categories declined significantly in the period immediately before the exit. Where a large reduction was observed, it may be beneficial to investigate further whether some of these exits would have ended as defaults had the companies existed in the US, rather than Canada or France. In France, there was no such evidence found. In Canada, possibilities were found both in Ceased Operations and Suspended. The US category of Surrendered License also appears suspect, although those companies did not default under the US standard intervention. With caution in attributing too much weight to this analysis, it suggests that France does not appear to reflect an undercount of defaults while Canada might.

[18] This analysis was repeated looking at changes in net profits and in available capital and obtained materially similar results.

Table 5: % Changes in Assets (and % of Exits) across Countries

Exit	US	Canada	France
Ceased Operation	-9% (0%)	**-38% (13%)**	
Dissolved	**-7% (16%)**	**-97% (14%)**	**-100% (13%)**
Domiciliary Change	2% (16%)		
In Liquidation	**-45% (8%)**		
Liquidated	**-2% (0%)**		
Merged	-1% (1%)	-10% (15%)	-5% (33%)
Name Change	2% (31%)	0% (41%)	4% (45%)
No Longer Filing	-100% (0%)		3% (2%)
Ownership	3% (21%)	0% (10%)	
Portfolio Transfer	35% (0%)		2% (2%)
Sold as Shell	-5% (4%)		
Surrendered License	**-20% (2%)**	-4% (6%)	
Struck from Register			0% (5%)
Suspended		**-41% (2%)**	
Total # of Exits	1,831	130	154

Black Bold Text – Exits which count as Defaults (Dissolutions are examined on a case-by-case basis).
Red Bold Text – Exits not counted as Defaults in which the median loss of Assets suggests some significant number might have counted as defaults.

Note: the percentages in each cell correspond to the change in Assets, with the percentage of exits in the country in parentheses)

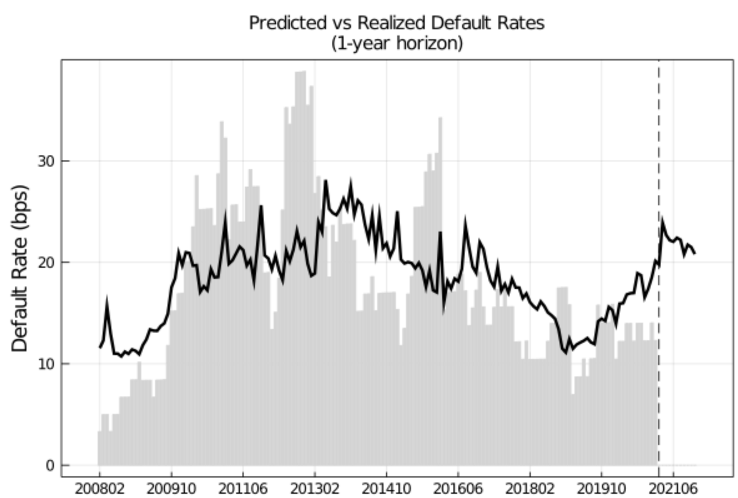
Along with the assessments of the methodology for producing probability of default estimates, Prof. Duan and his team assessed the performance of the specific estimates produced for these three countries with the data provided. In the NUS Report to the Academy, they have assessed the accuracy of the estimates by comparing the estimates to observed defaults. Given the existence of only one default in Canada and France, respectively, the assessment necessarily reflects the experience with only the US companies. In Chart 18, the accuracy[19] results are reproduced as they show the accuracy for one month forward estimates to 10 year forward estimates. One-month forecasts are more than 80% accurate and, after a sharp drop-off in months 2 and 3, the accuracy declines slowly and steadily to 60% after ten years. Accuracy for

[19] Duan explains that the accuracy ratio roughly corresponds to R2 for the ordinal analysis of PoD. See https://www.actuary.org/sites/default/files/2023-05/20230517A_Insurers_PD_Model_American_Academy_of_Actuaries.pdf

the one year forward estimates is approximately 75%. In Chart 19, the observed and predicted default rates by year are shown, using the one year forward estimates.

Chart 18:

Chart 19:



To summarize, the reliability of Prof. Duan's probability of default estimates, upon which scalars might be built, is plausible for the estimates for the US, but difficult to assess for France and Canada. With only one identified default in each of those countries, Prof. Duan's assessment methodology cannot be applied to those countries. Further, probabilities of companies in Canada and France being at risk of default but not defaulting due to differences in regulatory practices (and thus making the defaults not directly comparable to those in the United States) raises questions about the reliability of those estimates.

Reasonableness

Tables 6 and 7 below summarize the results from the regressions relating probabilities of default to solvency metrics. Table 6 summarizes results from the US and Canada estimates, while Table

7 provides results from the US and France. Reasonable results depend not only on reliable data (as discussed earlier), but also on a consistently negative relationship between probabilities of default and solvency metrics. Namely, as the ratio of available capital to required capital increases, the probability of default should decrease.

Table 6: Regression Results, US and Canada

REGRESS PoD = alpha + beta*Solvency Ratio				USA				CANADA			
LINE	**Size of Companies**	**Year Start**	**Year End**	**N**	**Beta**	**Adj RSQ**	**Adj RSQ with Size**	**N**	**Beta**	**Adj RSQ**	**Adj RSQ with Size**
LIFE	ALL	2014	2017	917	-0.00005924	0.05	0.13	103	0.00032582	0.18	0.30
LIFE	Small	2014	2017	347	-0.00004745	0.03	0.36	46	0.00014924	0.04	0.31
LIFE	Large	2014	2017	581	-0.00001243	0.01	0.15	60	0.00006722	0.02	0.42
LIFE	ALL	2018	2021	1098	-0.00004372	0.04	0.13	166	-0.00001625	-0.01	0.16
LIFE	Small	2018	2021	461	-0.00002505	0.01	0.32	91	-0.00020876	0.05	0.28
LIFE	Large	2018	2021	650	-0.00000952	0.00	0.15	74	0.00019157	0.05	0.40
P&C	ALL	2008	2014	7746	-0.0000521400	0.02	0.07	322	0.00017396	0.08	0.35
P&C	Small	2008	2014	3276	-0.0000848300	0.04	0.26	126	0.00001271	-0.01	0.21
P&C	Large	2008	2014	4328	0.0000050400	0.00	0.16	189	-0.00004952	0.00	0.32
P&C	ALL	2015	2021	7461	-0.0000162600	0.00	0.09	390	-0.00005978	0.00	0.16
P&C	Small	2015	2021	2863	-0.0000357000	0.02	0.34	147	-0.00013080	0.01	0.13
P&C	Large	2015	2021	4644	-0.0000040600	0.00	0.14	242	-0.00037935	0.05	0.16

Table 7: Regression Results, US and France

REGRESS PoD = alpha + beta*Solvency Ratio				USA				FRANCE			
LINE	**Size of Companies**	**Year Start**	**Year End**	**N**	**Beta**	**Adj RSQ**	**Adj RSQ with Size**	**N**	**Beta**	**Adj RSQ**	**Adj RSQ with Size**
LIFE	ALL	2016	2021	1556	-0.00004343	0.03	0.13	149	0.00000736	-0.01	0.17
LIFE	Small	2016	2021	633	-0.00002859	0.01	0.32	60	0.00005628	0.05	0.44
LIFE	Large	2016	2021	942	-0.00000862	0.00	0.16	86	0.00000456	-0.01	0.35
P&C	ALL	2016	2021	6396	-0.0000136200	0.00	0.09	331	0.00000327	0.00	0.32
P&C	Small	2016	2021	2437	-0.0000351300	0.02	0.32	154	0.00000899	0.00	0.08
P&C	Large	2016	2021	3999	-0.0000040700	0.00	0.12	175	0.00000765	0.00	0.40

Three Principal Observations from the Regressions

1. R^2 is very low in all three countries in all sub-samples. Other factors are clearly shaping probabilities of default beyond simply the solvency metrics.

2. R^2 is increased significantly when the size of companies is added to the regressions. This is true, again, for all countries and all samples. Even with the increased explanatory power from the addition of size, 70% of the variation in probabilities of default remain unexplained.

3. Most troubling, the effect of solvency metrics on probability of default, which ought to be consistently negative, is not. While it is negative in most instances for the US, with its large samples, it is only occasionally negative for Canada and France (50% of the time for Canada; and never for France). While scalars could be calculated in some instances with negative parameters in both countries, that does not seem reasonable when the relationship is not consistently negative.

When low R^2s are combined with small samples, the results, varying between a positive and negative relationship between probability of default and solvency metrics, are not surprising. To remedy this, either the excluded factors affecting probabilities of default must be identified, or the sample sizes must be increased, or both.

Given the lack of reasonableness of the regression results, scalars were not calculated for the PoD method nor was their stability assessed.

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