Internal Model – Advanced Uses

Supporting reinsurance business decisions

Contents

Foreword

One of the key Solvency II principles is that insurers' internal capital models must be embedded at the heart of risk and capital evaluation and they must be used as a key input to a wide range of business and strategic decisions. One particular area of challenge/opportunity for the industry is consistently identifying the capabilities insurers will need to support uses of the model that go beyond solvency calculations, as well as finding ways to share best practices.

Within this context, this booklet provides a practical perspective of using internal capital models to support reinsurance business decisions. This case study is one of a series that is being published following research by our 'Flexibility and Alternative Uses of Internal Models' IMIF workstream. I would like to thank Raphael Borrel for his leadership of that workstream, our authors Yoon-Kwong Loh and Laurence Dunkling and AIG for agreeing to share their experience in this field.

The Internal Model Industry Forum (IMIF) has produced a series of documents that can be found on IRM's website, offering guidance and sharing best practice on the validation and use of insurers' internal risk models. We are a market-wide initiative aiming to ensure that these models create value for the business beyond regulatory compliance.

José Morago
IRM Chairman and Founder of the IMIF

Introduction

The IMIF work-stream on 'Flexibility and Alternative Uses of Internal Models' was set up to allow insurance firms to share insights on how they use internal risk models for business purposes beyond Solvency II compliance and how these various uses are communicated and embedded into the business.

Internal risk models can potentially provide helpful input or support to a range of business decisions and processes but it is vital that their use is appropriate and their limitations – and the impact of these limitations - properly understood by all those involved. This requirement extends beyond the risk modelling team to any part of management that might use or rely on the models, and also potentially to other interested parties like board members, regulators and investors.

A recent survey conducted by IMIF asked firms how those involved with these wider business decisions understood the limitations of the internal model. The results – shown in Chart 1 below - showed that there is significant scope for better understanding.
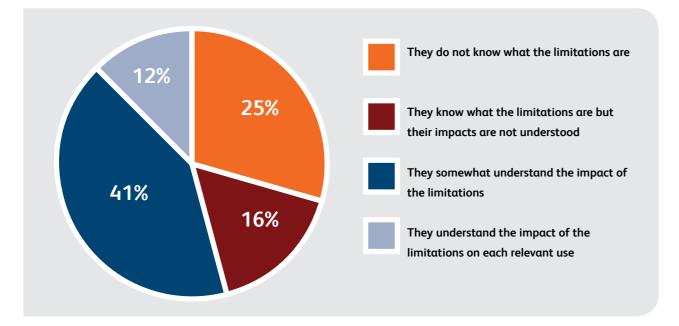

Chart 1: To what degree are the impacts of the limitations of the model on its intended use understood by all required business decision makers? (Source: IMIF 2015)

To assist in this matter this work-stream intends to publish a number of case studies that will highlight:
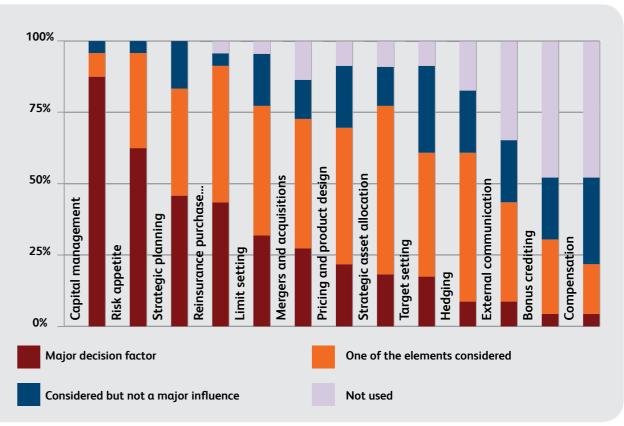
- model capabilities and functionalities that can be built to enable specific model uses;
- model limitations, and their impact on the model use, on the reliability of the consequent management information and on managing the resulting implications;
- practical examples of the uses of internal models

Ultimately, this work-stream will draw the key points from these case studies to publish a booklet to provide general guidance on using models for different purposes. It will also provide a framework to document the model use, and its limitations at use level. This will be available from the IMIF's web page[1].

1 www.theirm.org/knowledge-and-resources/thought-leadership/creating-value-through-internal-models/documents-and-resources.aspx

Insurance industry uses of internal models

A survey conducted by the IMIF found a wide variation in how firms were using internal model outputs to drive business decisions for different processes. The results are summarized in Chart 2 below.

Chart 2: Rating of the importance of uses of the model in decision making (Source: IMIF 2015)

- The survey indicated, as we would expect, that most insurance firms use their internal models to drive business decisions aiming at protecting capital. This encompasses activities such as the allocation of solvency capital and the setting of over-arching risk appetites.

- The survey also showed that market leading insurance companies increasingly use their internal models for more advanced uses which can protect and add value for the business.

We can trace a progression of key uses of internal models that indicates three increasing levels of maturity, moving from capital protection, through value protection to value creation:

Capital Protection	Value Protection	Value Creation
• Economic and Solvency capital assessment and allocation. • Understand capital implications of business and strategic decisions to make informed choices. • Setting of over arching appetites such as capital buffers and exposure limits. • Reinsurance purchase	• Setting and monitoring risks against multi point target risk appetites (including performance metrics such as earnings at risk) • Support business plan • ORSA	• Setting risk adjusted performance targets for lines of business. • Identifying more efficient uses of capital that increase value creation • Setting and monitoring asset allocation strategy • Product pricing • Reinsurance optimization

Supported by its survey and case study results, the work stream concluded that the current status quo for uses of internal models is bound by constraints that can be generalized as follows:

- The level of reliance that the management of a firm will place on a model is largely dependent on the level of maturity of this model.
- The uses of an internal model are expected to vary according to the scope, capabilities and limitations of the model.

The table below provides examples of key capabilities that can typically be expected for different model maturity levels together with the typical uses of the model.

Capital Protection	Value Protection	Value Creation
• Focus on the assessment of tail losses • Necessity to model dependencies between risks • Need to have a comprehensive coverage of risks	• Multi point risk distribution including tail • One year and multi year view of risk and capital • Ability to measure impact of risks on Profit and Loss and Balance Sheet • Model granularity • Ability to run the model with different parameters for scenario testing	• Ability to model different business mix & scenarios • Risk adjusted performance measurement • Flexibility and response time to support management decisions • Ability to measure value creation • Requires more precision and granularity of outputs

In this case study, YK Loh and Laurence Dunkling from AIG outline how they are using their internal model to support reinsurance business decisions. This demonstrates how the internal model can be used for value creation.

AIG Europe uses its Internal Model to support various enterprise-level, profit centre and business function decision making. The Reinsurance department is one of the key users of the internal model and is one of the key supporters of the capital team alongside other departments such as AIG's Asset Management Group (AMG), Data Science and Finance. We collaborate regularly with AIG reinsurance departments across the globe on a range of projects.
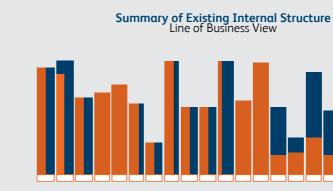
Reinsurance and capital are closely linked. Reinsurance can be considered as an alternative to capital. The capital reduction resulting from a treaty can be compared to the cost of the reinsurance.

Model use description

AIG assesses all reinsurance purchases and treaty renewals using the internal model. For those which are deemed to have a significant impact on risk appetite, a risk appetite run is also performed. Results are reported to the Reinsurance Committee and Insurance Risk Committee (IRC) regularly.

Working with the Global Reinsurance Department (GRD), the capital team have also provided models to support AIG's global reinsurance optimisation project (pricing model for Stop Loss contracts). The overall objective of the project was to simplify reinsurance structures across various subsidiaries worldwide (a target of 50 countries in 2015) from having multiple reinsurance treaties each for an individual line of business to having aggregate reinsurance cover where:

- An aggregate quota share is used to transfer risk proportionally; and
- A stop loss is used to transfer tail risk

Additional uses of the internal model to support reinsurance business decisions also include:

- Commutations of existing reinsurance agreements
- Other forms of reinsurance pricing, including Adverse Development Cover (ADC), which is another form of aggregate reinsurance used to protect a company against adverse reserve runoff.

Aggregate reinsurance refers to reinsurance which provides protection based on total claims, from all perils, arising in a class or classes over a period of time. Such covers are usually applied to company-wide claims for a legal entity and are subject to a total aggregate claim limit. A company's Internal Model would be best placed to price or analyse the effectiveness of such multi-line/company-wide covers as it would already have a dependency structure between lines of business which should have been validated through a regular Validation process. When used together, an ADC protects a company from adverse reserve risk (on earned business) and a Stop Loss protects a company from severe premium risk (on business not yet earned as per the business plan's projections).

Outputs of the internal model used in the reinsurance optimisation

A range of outputs is produced to communicate the results of the Internal Model to the business. These include:

- Trade-off between risk and return of various reinsurance options
- Breakeven return periods between reinsurance premium and reinsurance recoveries Breakdown of claims and recoveries by return period and claim type
- Penetration by claims layer and by number of reinstatements
- Impact on company's risk appetite/risk profile
- Impact on economic profit/risk-adjusted profit.

The diagram below illustrates an example of trade off between risk (99.5 % capital) and return (P&L profit) for multiple combinations of quota share and excess of loss for a line of business. As expected, we observe that the reduction of reinsurance coverage increases the risk retained by the company, measured as the 1-in-200 capital requirement, while simultaneously increasing the profit measure due to the savings in reinsurance premium.
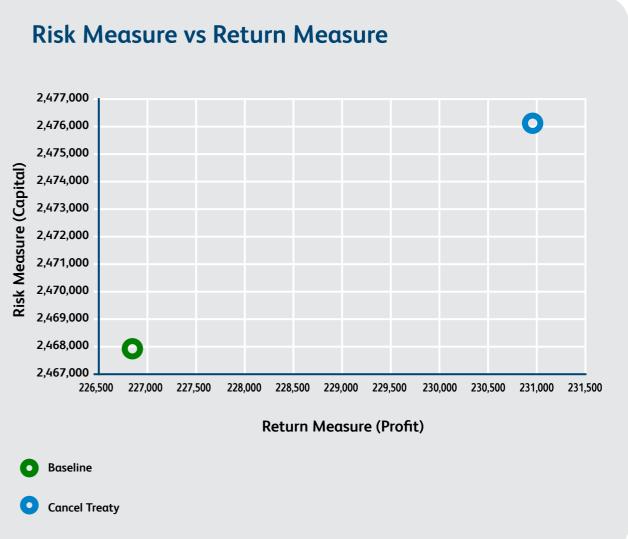
Risk Measure vs Return Measure

● 45% Quota Share & $125m xs $25m XoL
● No Quota Share; $100m xs $50m XoL
● No Quota Share; $125m xs $25m XoL
● No Quota Share; $50m xs $100m XoL

* Figures are purely for illustration purposes.

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Model use case study: treaty cancellation

In this section, we go through an example where management wanted to understand the impact that a specific treaty cancellation would have on the company's P&L and risk profile. The use of internal model outputs identified a positive economic impact over the longer term despite some breaches in risk appetite. The cancellation was approved by Management and ultimately the Risk & Capital Committee (RCC) with the analysis provided to the Board Risk Commitee (BRC) for feedback. Below are sample outputs that illustrate this analysis.

Trade-off between risk and return

The risk-return analysis which compared the change in the 99.5 % capital requirement against the change in P&L profit clearly showed that when compared to the baseline (green dot), cancelling the treaty (blue dot) would increase both P&L profit (due to the savings in reinsurance premium) and capital requirement (driven by the increase in insurance risk).
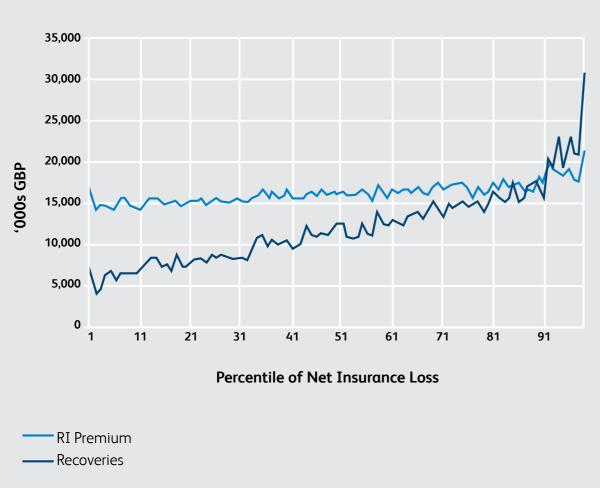
Risk Measure vs Return Measure

● Baseline
● Cancel Treaty

* Figures are purely for illustration purposes.

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Breakeven return periods between reinsurance premium and reinsurance recoveries

A comparison of reinsurance premium against reinsurance recoveries would be a very helpful tool for communication with the business. The graph below shows a comparison of reinsurance premiums and recoveries plotted in the same order as net insurance losses. As net insurance losses increases, recoveries increases and reinsurance premium increases as reinstatement premiums kicks in. For the treaty in question, our analysis indicated that the break-even return period for this treaty is around the 92nd percentile. This means that we would need to suffer losses greater than a 12.5 year event (the 92nd percentile equivalent) in order to see a positive return arising from this treaty.

Reinsurance Premium and Recoveries Distribution

[Line chart: x-axis "Percentile of Net Insurance Loss" marked 1, 11, 21, 31, 41, 51, 61, 71, 81, 91; y-axis "'000s GBP" marked 0 to 35,000. Two lines: RI Premium and Recoveries.]

— RI Premium
— Recoveries

Impact on company's risk appetite

The risk appetite analysis indicated that the treaty cancellation would result in an increase in standalone capital for natural catastrophe and man-made catastrophe due to the reduction in reinsurance protection. Specifically, cancelling the treaty results in a breach of the amber risk appetites for the 1:200 threshold for natural catastrophe risk and the 1:7 year threshold for man-made catastrophe risk although they remained well within their respective red risk appetite threshold.

		Current Risk Profile	Risk Profile After Cancellation
Total Entity	1:7		Increased
	1:200		Increased
— Insurance Risk	1:7		Increased
	1:200		Increased
— Premium Risk	1:7		Increased
	1:200		Increased
— Reserve Risk	1:7		Increased
	1:200		Increased
— Natural Catastrophe Risk	1:7		Increased
	1:200		Breached
— Man-Made Catastrophe Risk	1:7		Breached
	1:200		Increased
— Market Risk	1:7		Unchanged
	1:200		Unchanged
— Credit Risk	1:7		Increased
	1:200		Increased
— Operational Risk	1:7		Increased
	1:200		Increased
— Pension Risk	1:7		Unchanged
	1:200		Unchanged

GREEN: ON TARGET	AMBER RISK APPETITE	RED RISK APPETITE

Impact on Risk Adjusted Profits - our common currency

AIG has developed a global Risk-Adjusted Profit (RAP) framework for the purpose of ensuring an adequate return is provided to investors, commensurate with the risk taken on the business. RAP helps to identify areas of the business for growth, and those to be cut back, by making an allowance for the relative riskiness of each segment in budgeting and performance measurement processes. It incentivises effective risk management processes, with granular outputs from the process helping to guide positive changes. Perhaps more importantly, RAP provides a "common currency" to measure economic profits across all AIG business. Our analysis identified that the cancellation of this cover would have a positive economic profit impact of £2.9m despite the increase in capital requirements.

			Baseline (£'m)	Cancel Treaty (£'m)
A	Benefit in year 1	Treaty Premium net of commission (at the mean)	16.1	
B		Recoveries (at the mean)	11.9	
C=A-B		Profit (Loss) from the treaty - before cost of capital	(4.2)	
D=-C		Profit (Loss) compared to base		4.2
E		Treaty Premium net commission (1 in 200)	22.3	
F		Recoveries (1 in 200)	38.4	
G=F-E		Increase (Decrease) in Required Capital	16.1	
H=G		Increase (Decrease) in Required Capital compared to base		16.1
I		Multiplier for benefit for successive years		1.3
J=HxI		Ultimate Capital Increase (Decrease)		20.1
K		Cost/(saving) of capital for change @ 6.5%		1.3
L=D-K		Total economic benefit (cost) compared to base		2.9

At the mean, we suffered a loss of £4.2m as the treaty premium is higher than the expected recoveries of £11.9m. Therefore, cancelling this treaty would lead to a positive P/L impact of £4.2m.

The required capital is calculated on the basis that we suffer a 1-in-200 year event which results in recoveries being higher than the treaty premium by £16.1m. However this only quantifies the 1st year capital impact (the premium risk element). After accounting for the risk of reserve deterioration when running-off the underlying liabilities over successive years (the reserve risk element), the ultimate capital increase is £20.1m. Charging a 6.5% cost of capital rate results in a £1.3m cost of capital.

Hence the economic profit impact of the cancellation of this treaty is £2.9m which is the difference between the P/L impact of positive £4.2m and the cost of capital of £1.3m. We can therefore conclude that in the long run, there will be economic benefit from the cancellation of this treaty.

Once a reinsurance treaty is in place, it would continue to have a capital benefit in future years. In order to get to an ultimate capital position, we have derived multipliers for each lines of business which allows for capital relief in future years depending on whether the treaty is a quota share or an XoL.

Model capabilities necessary to enable the use

In order to ensure that the model is fit for purpose, a range of model capabilities is desirable and these are set out below.

Capabilities	Description	Comments
Gross less recoveries	Model needs to simulate gross claims and its recoveries explicitly	For the purpose of reinsurance analysis, the Internal Model has to be capable of applying reinsurance treaties explicitly to gross claims. To state the obvious, an Internal Model based on net claims would not suffice for reinsurance analysis.
Frequency – severity	For XoL contracts, model needs to simulate number of claims (frequency) and average claim size (severity)	If the Internal Model only simulates loss ratios or aggregate claims, it would not be able to apply per risk Excess of Loss (XoL) treaties. On the other hand, frequency-severity calibration has a more onerous data requirement and leads to longer model run time. A practical approach would be to have an attritional and large claim split where only the large claims portion is modelled on a frequency-severity basis as XoL are usually put in place for risks which has a higher potential to result in large claims.
Reconciliation / P&L Attribution	Financial statement distribution generated by the Internal Model has to be reconciled to Business Plan	In order to aid the communication of any reinsurance analysis, the mean of simulated results should be reconciled back to the Business Plan as we would have to show results gross and net of a particular treaty.
Full range loss curve	The availability of the full range of simulated gross and net results are ideally required to be able to perform detailed reinsurance analysis	As opposed to capital setting, which focuses on the 99.5th percentile, reinsurance analysis will focus on more than just one particular percentile therefore most analysis will require the full range of simulated results. At a minimum, there will need to be a comparison of the mean results, the 99.5th percentile and any other percentile that is commonly reported. Ideally, the full range loss curve is available which would allow, for instance, the comparison of breakeven point of reinsurance premium against recoveries.
Granularity	Flexible grouping of lines of business	The Model has to be able to group lines of business within the same major / minor lines, within the same country and in total for a particular entity for aggregate reinsurance.
Link to risk appetite	assess impact on risk appetite	The impact on risk appetite is tested when the purchase or cancellation of a treaty is expected to have the potential to cause a breach of any risk appetite metrics which the company has set.
Dependency	Dependency between lines of business and risks	The dependency structure between lines of business is necessary when the model is utilised to optimise global reinsurance strategy and the dependency between risks is required when the impact on risk appetites is measured (both tail and core of the distribution events).
Benchmarking	Reinsurance premium quotation from commercial insurers could be used as benchmarks	Reinsurance premium quoted by the commercial reinsurers acts as a form of benchmarking against the expected claims generated by the Internal Model

Model limitations

When considering model limitations, the Principle of Proportionality has to be observed as results may be more spurious and the time (and cost) of further development may outweigh the benefits. In short, it is important to know when enough is enough and this can only be achieved by actively using the model and actively gaining feedback from the business. A range of common limitations are set out below, with a link to the affected model capabilities set out in the previous table, however none of them are expected to have an overbearing importance such that the model cannot be used for reinsurance analysis.

Data limitation	Link to Model Capabilities	Comments
Not able to model small lines of business or sub-sections separately	Granularity	Claims and premium experience are often aggregated into groups of risks that have homogeneous characteristics. This means that we will not be able to distinguish between risks within the same group and as such these small lines of business or sub-sections cannot be modelled separately. A practical solution to this is to assume that the sub-portfolio of interest is a fixed proportion of the risk group it is in.
Not able to model new lines of business which have not been parameterised	Granularity	Cyber risk is a new product which many insurance companies have recently started selling. Due to the lack of historical claims experience, the volatility calibration of such products is not available. A sensible approach would be to perform a scenario test which can then be included within the ORSA or added as a Realistic Disaster Scenario (RDS) within the model.
Not all lines of business have a frequency-severity split	Frequency – severity	Lines of business which are modelled using a loss ratio approach rather than a frequency-severity approach would not be able to simulate Per Risk XoL recoveries. It is important to gain feedback from the business on which lines are expected to have Per Risk XoL before starting with any calibration work.
Unmodelled perils	Reconciliation / P&L Attribution	Unmodelled perils which materialises in significant actual claims would result in reinsurance recoveries or claims retention which were unexpected. These should be picked up through the P&L Attribution exercise. Common approaches used to account for these include a loading through expert judgement or scenario testing.

Modelling limitation	Link to Model Capabilities	Comments
Not able to model cross-country contracts which covers countries not included in the Model.	Granularity	Companies which are part of a wider group may have cross country reinsurance treaties. Naturally, recoveries in countries which are not already in the model could not be calculated therefore a broad brush approach (e.g. assuming those recoveries are x% of total recoveries) may be the only practical solution.
Certain feature of reinsurance contracts are difficult to model: • Indexation clause • Hour clause (for Catastrophe XOL) • Reinstatement premiums that are pro rata as to time • Sliding scale commissions	Gross less recoveries	In order to model certain types of special reinsurance features, which are usually unique to a particular type of reinsurance, the Internal Model would have to first enhance its capabilities. For instance, in order to be able to model the Hour Clause, the Model has to generate a time stamp of each simulated loss and aggregate multiple losses during the specified time period as a single aggregated loss. Such limitations should be made known to stakeholders which uses the results of any reinsurance analysis and their feedback should obtained on whether the absence of modelling such features are expected to cause a significant deviation from modelled results.
Fixed rates of FX specified in reinsurance contracts	Gross less recoveries	FX rates are often explicitly specified in reinsurance treaties. It would be tedious for models to accurately reflect these FX rates, which are often specified for more than one pair of FX rates. It is more common to use universally specified FX rates or to use the FX rates simulated by the ESG.

Conclusion

As set out in this paper, risk-adjusted profit or economic gain frameworks could be applied to reinsurance analysis via the use of an Internal Model and the analysis is completed by applying multipliers which allows for capital relief in future years. Whilst such economic profit frameworks already exist in most companies, in one form or another, they are usually only applied to assess its insurance business when it could be expanded to reinsurance and investment etc. Together, they form a useful "common currency" which is understood company-wide hence allowing for a meaningful comparison between initiatives in different functions.

Engaging senior management and business units at an early stage is critical to successfully build an internal model that will be fit for purpose for the various uses intended.Setting the ambitions for the desired functionalities related to the business needs is essential. These should be defined to a level of detail sufficient for Internal model design. If some of the requirements are not feasible, Modellers should clarify in a manner that can be easily understood by the model users how the limitations encountered may affect each use of the model.

As described in the IMIF booklet "The validation cycle: developing sustainable confidence and value", this process should be supported by an independent validation cycle that will provide assurance on the fitness for purpose of the model. An ongoing feedback loop between users and owners of the model should be implemented to monitor and where possible mitigate the limitations

The statistician George Box once said "All models are wrong but some are useful". It is through the proactive use of an Internal Model, by as many parts of the company as possible, that the Internal Model could be refined into a useful tool which is widely accepted throughout a company. After all, why should a regulator approve the use of your company's Internal Model to calculate your firm's capital requirement if you are not actively using it yourself?

Authors

Raphael Borrel is a member of the IMIF steering committee and leads the 'Advanced Uses of Internal Models' work-stream. He manages the Solvency II Experts Group, a large non-commercial European network of Solvency II interested parties. He is an experienced risk strategy, risk transformation and compliance consultant with over 15 years of experience within financial services. He previously worked within the Lloyd's market, Big 4 consultancies and Aon. He currently focuses on assisting companies to transform their risk management capability through the integration of an enterprise-wide approach, shifting the risk focus to a more strategic and forward looking perspective and driving a significant strengthening in Internal Model capabilities and use.

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Laurence Dunkling is the Head of Model Uses at AIG. He is a Fellow of the Institute of Actuaries (FIA) and was a member of the Institute's Solvency II Technical Provisions working party. Together with YK, they specialises in helping the business find practical uses of the Internal Model.

The Internal Model Industry Forum

This document has been produced by the Internal Model Industry Forum (IMIF). The Institute of Risk Management (IRM) set up the IMIF in 2014 to address the key questions and challenges that insurers face in the use, understanding and validation of internal risk models. It is designed to work in a collaborative way to develop and share good practice to ensure that these models add value to the organisation and support regulatory compliance. IMIF now has over 300 members and we have run a series of Forum meetings to explore key issues. A number of workstreams are also undertaking research and we aim to publish the results along with other useful resources and guidance.

The IMIF work is led by a steering committee comprising modelling experts from insurers alongside representatives from Deloitte, EY, KPMG, Milliman, PWC, the Institute and Faculty of Actuaries, ORIC and the Bank of England Prudential Regulation Authority.

As the leading organisation promoting education and professional development in all aspects of risk management, IRM is pleased to be able to support this industry initiative to share good practice
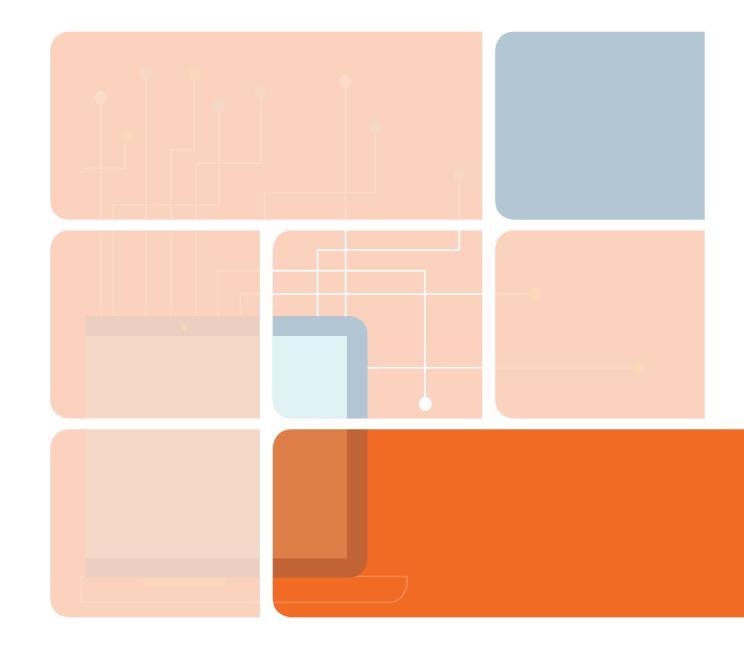
More information about the IMIF and its work can be found on the IRM website www.theirm.org

Internal Model *Industry Forum*

Who are the IRM?

This work has been supported by members of IRM, which has provided leadership and guidance to the emerging risk management profession for over 25 years. Through its training, qualifications and thought leadership work, which includes seminars, special interest and regional groups, IRM combines sound academic work with the practical experience of its members working across diverse organisations worldwide. IRM would like to thank everyone involved in the IMIF project.

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