Moody's Analytics

RISK PERSPECTIVES

MANAGING INSURANCE RISK

VOL 3 | MARCH 2014

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FROM THE EDITOR

Welcome to the third edition of Risk Perspectives™, a Moody's Analytics publication created for risk professionals with the goal of delivering essential insight to the global financial markets. For this edition, we focus on the current challenges and opportunities in the insurance sector. After years of discussions, the Solvency II regulatory framework will finally become effective in the European Union on January 1st, 2016. However, the new risk-based regulation will not be restricted to Europe and will influence risk management practices in the insurance industry on a global scale.

According to a Moody's Analytics Solvency II survey, only 25% of firms are currently ready to comply with Solvency II and 65% are developing their solutions to become compliant. This indicates that while some firms are seizing the opportunity to step beyond compliance to achieve competitive advantages, other firms still have a lot more work to do. That is why we aim to offer a wide range of views on the numerous risk management issues facing the insurance industry in 2014 and beyond and provide best practices that will help insurers address and overcome these challenges.

Risk Perspectives offers actionable information to assist risk professionals with their day-to-day and strategic efforts to comply with new regulatory guidelines, master data management and infrastructure problems, and create value for their organizations through better and more effective risk management.

In the section, *Rethinking Insurance Risk*, we provide an outlook on the global insurance industry in 2014 and discuss how insurers can leverage the regulatory exercises to improve their businesses. For instance, in the article "Using Analytical Data to Support the Decision-Making Process," Brian Heale explains the value of analytical data and how an insurer can get the most out of it.

In *Regulatory Spotlight*, we look at the emerging insurance industry regulations from a global point of view in the article "Regulatory Radar for Insurance" by María C. Cañamero and Sandy Sharp, and take a closer look at the new mandatory reporting in "Taking a Holistic Approach to Pillar III Reporting" by Karim Ben Ayed.

The *Approaches to Implementation* section provides best practices on how to implement an insurance solution, such as Economic Scenario Generators (ESGs) or an effective enterprise risk management framework, and evaluate the benefits and challenges of adopting an internal model.

Finally, in the *Principles and Practices* section, we describe effective best practices for applying risk management to an insurance organization. These range from the design of arbitrage-free scenarios for Solvency II to achieving efficient asset allocation by leveraging a Least-Squares Monte Carlo simulation.

Once again, we hope our perspectives on overcoming the challenges the insurance industry is facing will help you attain a better understanding of how to approach and thrive in a world of ongoing regulatory, business, and industry demands. I encourage you to take part in this discussion and help us shape the future issues of *Risk Perspectives* by sharing your feedback and comments on the articles presented in this issue.

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RISK PERSPECTIVES

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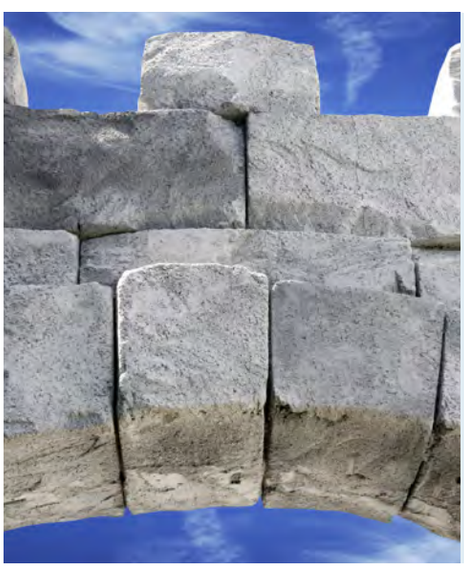


PRINCIPLES AND PRACTICES

INSURANCE BY THE NUMBERS

15%

With P&C premiums growing at about 15% per year, China will likely surpass Japan as the largest Asian market within two or three years.

Global Insurance Outlook for 2014
Page 16

$1m

Realistic ESG solutions for a multi-national insurer will likely run well beyond the $1 million per annum mark.

Build Versus Buy: The Pros and Cons of an In-House ESG
Page 50

67%

Based on the Moody's Analytics Solvency II survey, 67% of insurance companies had to increase their staff by at least 10% to address the Solvency II requirements.[1]

70

There are more than 70 standard reports required for Solvency II.

Global Insurance Industry: What to Expect in 2014
Page 24

100s

A large insurer may have hundreds of source systems and thousands of spreadsheets from which data is needed. Spreadsheets are coming under increasing regulatory focus for Solvency II.

Data Quality is the Biggest Challenge
Page 30

70%

Around 70% of North American life insurers take a "stat approach" or "stat-like" (real-world run-off) approach to managing capital.

Implementing an ERM Program in the North American Life Insurance Industry
Page 64

10,000

Completing QRTs requires approximately 10,000 cells of information to be pulled from a broad spectrum of sources.

Taking a Holistic Approach to Pillar III Reporting
Page 44

30%

30% of the firms who currently use the Standard Formula plan to upgrade to a partial or full internal model within the next three years.

The Benefits and Challenges of Adopting Internal Models
Page 58

9

As of December 2013, nine insurers have been designated as systemically important.

Regulatory Radar for Insurance
Page 38

€350m

Based on the Moody's Analytics Solvency II survey, some Tier 1 insurance companies have already spent more than €350 million on Solvency II compliance.[2]

1-in-20

While regulatory compliance may require a focus on a 1-in-200-year event, a 1-in-20-year event may be more relevant for business planning purposes.

How to Build an Effective ERM Framework
Page 54

25%

Only 25% of the companies interviewed during the Moody's Analytics Solvency II survey had their Solvency II process in place and solutions running.[3]

1 *Moody's Analytics 2013 Solvency II Practitioner Survey,* page 26.

2 *Moody's Analytics 2013 Solvency II Practitioner Survey,* page 25.

3 *Moody's Analytics 2013 Solvency II Practitioner Survey,* page 10.

RETHINKING INSURANCE RISK

Discusses the 2014 industry outlook, challenges, and opportunities, and how insurers can leverage analytical data and the ORSA process to improve their businesses.

USING ANALYTICAL DATA TO SUPPORT THE DECISION-MAKING PROCESS

By Brian Heale

Brian Heale
Senior Director, Business Development Officer, Global Insurance

Brian is an insurance and Solvency II specialist who has significant experience in technology solutions for the global insurance industry. He has an in-depth knowledge of the life and pensions business, coupled with a comprehensive understanding of enterprise technology.

This article discusses the ways in which insurers can use their analytical and operational data to measure risk and performance, and support their business decision-making processes.

The insurance marketplace is more competitive today than ever, owing to the pressure to reduce operating costs, the impetus to provide better returns to shareholders, the emergence of new distribution channels, and the climate of low investment returns.

Consequently, making the right business decisions is absolutely crucial – decisions that are directly linked to high-quality data.

Equally, insurers have to contend with an ever-increasing regulatory burden, including Solvency II (SII), International Financial Reporting Standards (IFRS), Dodd-Frank, and the Retail Distribution Review (RDR) in the UK, and equivalent distribution legislation across Europe. Compliance with this legislation is challenging, considering the operating environment. While most of the legislation is primarily concerned with governance, much of the practical management is driven by data – particularly Solvency II and IFRS.

The connection between decision-making and regulatory compliance data

Data is the common theme between decision-making and regulatory compliance. A significant amount of analytical data is required for Solvency II and IFRS, but much of this data is also relevant for making business decisions. While additional data may be required for decision-making, the key to success is developing a common approach and standards to data management and storage that can meet both regulatory and business needs. A further crossover is that informed business decisions are at the heart of Solvency II – the Own Risk and Solvency Assessment (ORSA) and Use Test processes.

Analytical versus operational data

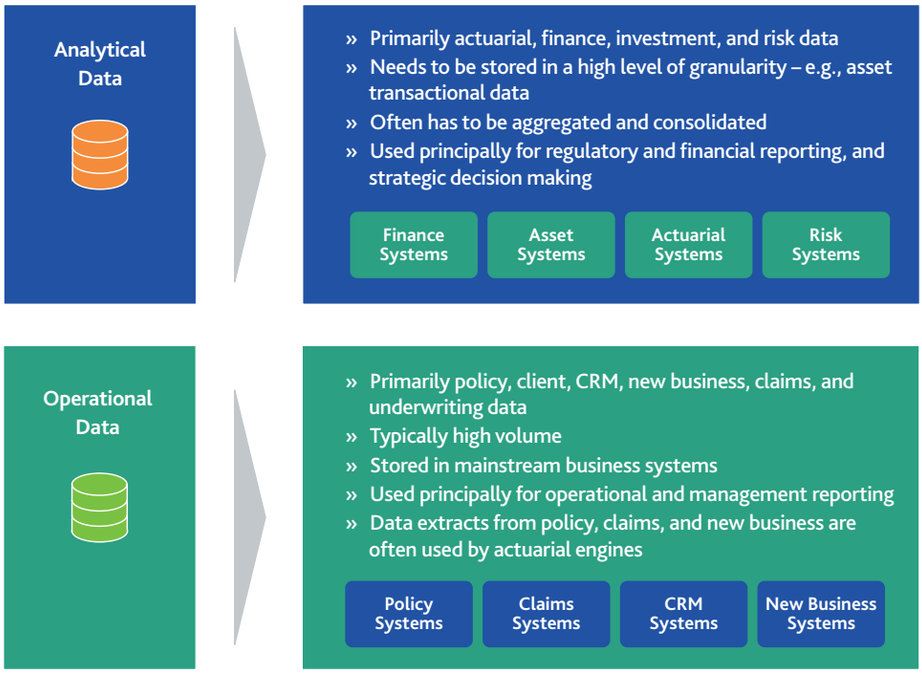
Analytical data, or risk data, refers to the actuarial, finance, investment, and risk data required for SII/IFRS and multi-faceted management and business reporting. **Operational data** is the day-to-day information insurers use, such as client, claims, customer relationship management (CRM), and distribution data. Traditionally, insurers are more apt at handling operational data than analytical data. Figure 1 illustrates these main differences.

Risk data is key

As the fundamental business of an insurer is to underwrite and pool risk, strategic business decisions are often based on risk data (or analytical data). Granular data on all these risk factors is required to support the decision-making process and regulatory reporting. Much of this data is analytical in nature, but some operational data is needed, such as policy and claims data for input into an insurer's actuarial modeling engines.

While much of the regulatory risk data is defined and can effectively be reused for decision-making purposes, new data may be required, particularly for generating risk-adjusted metrics – for instance, risk-adjusted return on capital (RAROC) or return on risk-adjusted capital (RORAC) – and for forward-looking planning (e.g., multi-year projection of balance sheets).

Figure 1 Main differences between analytical and operational data



Source: Moody's Analytics

This latter aspect is the most problematic and, as well as base data, it may require new models, methodologies, and macroeconomic scenarios to project into the future.

Presentation and structure of information

From a business perspective, a plethora of unstructured data stored in a database is of little value. Value is added when that data is structured and made available to users in a format that is readily understandable – "translated" so that business users and senior management can understand it.

A significant amount of data will already exist (particularly data required for Solvency and IFRS reporting); however, new data sets will often be required to generate the information to support the decision-making process. This requires the business to provide IT with the exact information needed. IT can then ensure that the data is first available and then structure the data into Online Analytical Processing (OLAP) cubes.[1]

In terms of strategic decision-making, a significant amount of information may be required to meet key questions, such as:

- How much risk capital will be needed to survive the next five years?
- What is the most effective and profitable use of the firm's capital?
- How can the business grow profitably?
- What should the firm's product portfolio look like?
- What are the scenarios that might put the firm out of business?
- How would an acquisition impact the firm's capital requirements?

In order for insurers to remain competitive, they must be able to react quickly to change, which involves instant access to accurate and relevant information. This information is often provided via interactive dashboards that are produced at a set time or when certain events occur.

Storing data – a repository is crucial

An insurer's data, both analytical and operational, is typically scattered across many systems in a series of non-integrated silos. There are usually no common enterprise data models and standards. Instead, there are disparate data architectures, applications, and methodologies.

To overcome this problem, some insurers have already built operational data repositories, but few have built analytical repositories. Figure 2 illustrates how an analytical repository would plug into an insurer's risk architecture with potential links to an operational repository. Some data from existing operational data repositories is part of the analytical process.

A risk and capital literate development team is essential for providing insight into how successful the repository is in supporting risk-based decision-making. Nonetheless, building the repository can be a complex task because it involves numerous detailed steps:

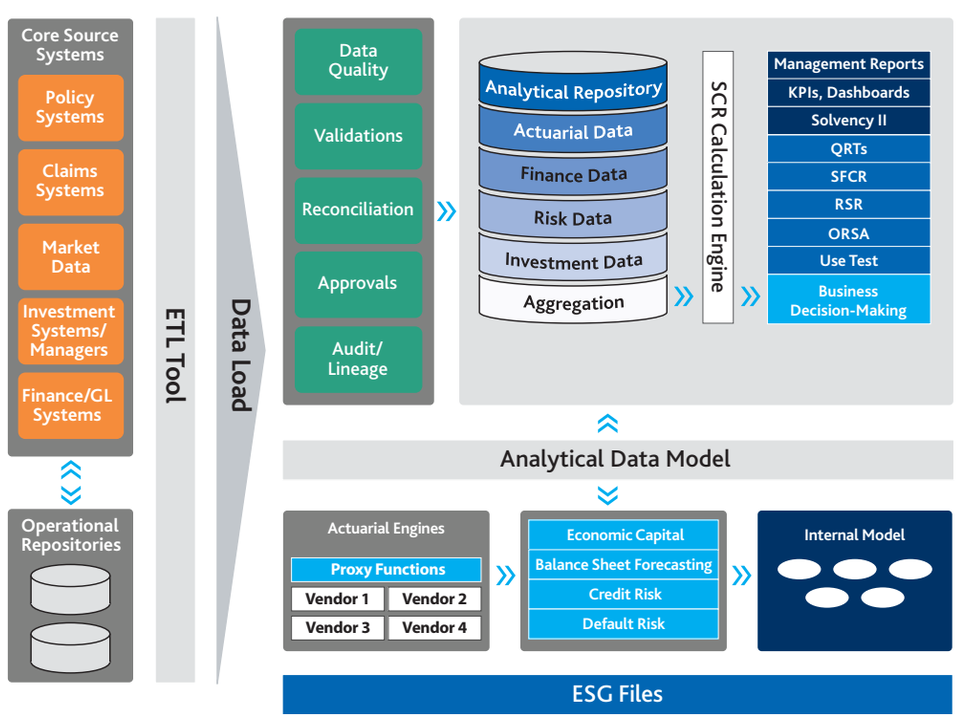
- Business owners and the users must define the reports, dashboards, and data they require and the drill-down (granularity) capability needed
- IT can then accordingly build a flexible data model and the structure of the repository
- IT will have to build the data extraction and transformation processes required prior to loading the data into the repository
- IT will have to construct the OLAP cubes necessary to support the generation of multi-dimensional reports and dashboards specified by the business

> A major benefit of a centralized repository to store data is that risk and capital data and metrics are available to the whole enterprise to access and analyze. This approach also avoids duplicated and unnecessary movement of data.

Data storage – centralized repository

At the heart of the architecture is a centralized repository that works for both operational and analytical data. This section speaks to an analytical repository, yet applies to both operational and integrated repositories. A major benefit of a centralized repository is that risk and capital data and metrics are available to the whole enterprise to access and analyze. This approach also avoids the duplicated and unnecessary movement of data.

Figure 2 An analytical repository plugging into an insurer's risk architecture



Source: Moody's Analytics

» Many insurers already have sophisticated actuarial engines, which may have to be extended or supplemented with new tools to provide the required metrics

Capital metrics – ORSA

The ORSA and Use Test put risk and capital-based decision-making at the core of the strategic planning process and need a significant amount of analytical data. Insurers can adopt a minimal compliance approach to the ORSA or adopt a proactive risk and capital culture throughout the business by embedding it within the overall strategic planning and decision-making process. The latter is the most advantageous approach.

Figure 3 highlights the ORSA, which comprises, at the center, three key process layers: risk identification and processes, risk and capital calculations, and management controls and action.

The key outputs of the ORSA process are the metrics that the process generates. Analytical data is critical as it feeds the engines that produce the metrics – data from actuarial systems, risk systems, capital projection engines, and finance systems – which ideally will be stored in a central repository. The metrics also have to be stored at a low level of granularity so that the business can not only view the figures, but also have the capability to drill-down into the underlying data to obtain a better understanding of the metric makeup.

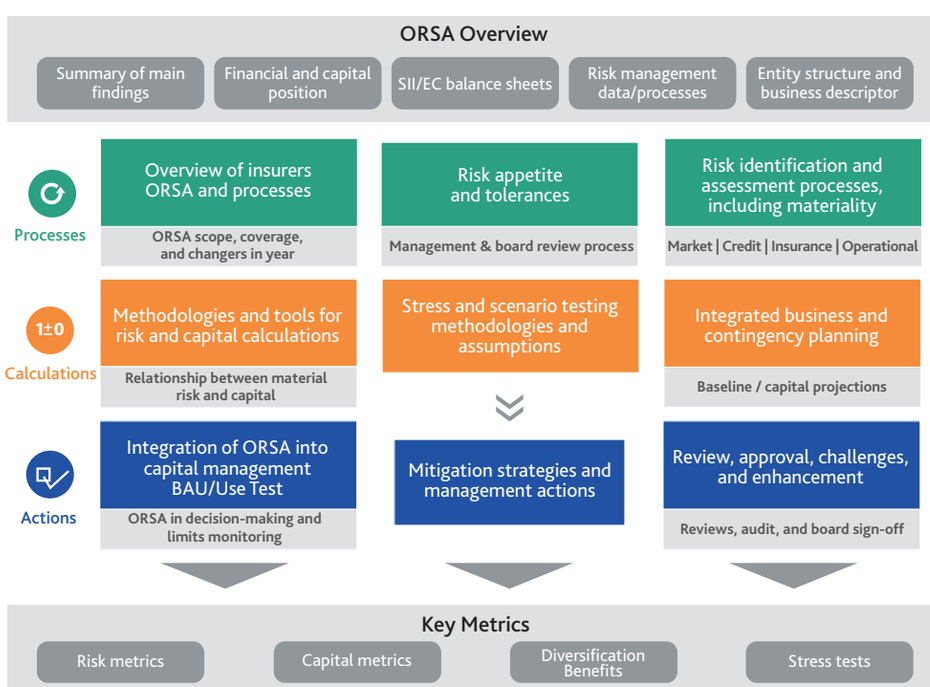
Investment information

Volatility in the financial markets and historically low yields mean that making the right investment decisions is of paramount importance, but what type of investment information (and hence data) should decision makers and senior management look for? The following provides some areas they could consider:

» **Market risk dashboard:** Shows capital adequacy across a range of measures based on current market prices and is typically produced daily or weekly

» **Optimal asset portfolio:** Provides information that compares yield and capital allocated to assets. It indicates the best yields, capital, and risk ratios

Figure 3 Moody's Analytics ORSA Framework



Source: Moody's Analytics

» **Credit/concentration risk:** As insurers seek better yields, they increasingly look to invest in alternative credit assets, such as infrastructure and corporate loans, and credit default swaps (CDS). These provide a better yield than bonds and match the insurer's long-term liabilities, but more granular credit risk information is required to fully understand the risks and returns

It can be a challenge for insurers to obtain granular asset information from investment managers and internal investment systems so they may evaluate returns and assess how differing investment portfolios impact the level of capital required. Such information, however, is essential to supporting the decision-making and the regulatory reporting processes (e.g., the D1-D6 of the EIOPA quantitative reporting templates).

Product portfolios

Low yields on bonds and the capital requirements of Solvency II have encouraged insurers to switch from insurance products with inherent guarantees, such as with-profit life contracts, toward unit-linked contracts, where all investment risk is effectively transferred to the policyholder. As a consequence, insurers are reassessing their product portfolios with the aim of reducing capital held in relation to products. To support this, however, insurers need a whole raft of actuarial modeling and capital data at their disposal.

Legal entity structure and diversification

Solvency II is also driving insurers to closely examine their legal entity structures and how it impacts capital and where capital is held. For instance, some multi-national insurers have restructured their legal entities to different groupings or converted subsidiary companies into branches. To obtain regulatory and capital advantages, others have sought to relocate the group geographically. Clearly tax and fungibility rules come into play, but there is a definite trend toward legal entity simplification. For this to happen, granular analysis of finance, actuarial, asset, and risk data at entity levels are required.

The advantages of seeking diversification benefits are widely endorsed, which has led many insurers to carefully consider what businesses and books of business to acquire or divest. The traditional approach of valuing books of business on an embedded value basis is now influenced by its impact on diversified capital.

> Value is added when that data is structured and made available to users in a format that is readily understandable – "translated" so that business users, executives, and the board can understand it. To remain competitive, insurers must also be able to react quickly to change, which means they may need instant access to accurate and relevant information.

What-if analysis

The interaction of investment portfolio, product portfolio, legal entity structure, and the potential effect of diversification benefits are heightening interest in conducting what-if analysis. The scope of any what-if analysis might include:

» Economic capital/solvency capital requirement projections under multiple scenarios
» Hedging strategy analysis
» Changes in product portfolios
» Strategic asset allocation
» Acquisitions and sales
» Changes in entity structures
» Interim balance sheet valuation

The analysis and performance measures previously discussed require a high volume of analytical data. And, while the data is critical, many insurers will also have to review their actuarial models and develop new ones (e.g., for International Financial Reporting Standard

figures). They will also need to look for new tools and techniques, such as economic capital calculators and proxy modeling, particularly for large complex liability portfolios, where full stochastic modeling is required for internal model solvency capital calculations.

The importance of management actions

Generating correct and meaningful information, reports, and dashboards is undoubtedly an important part of the decision-making process, but so too is the willingness of management to take action on the basis of the information provided. In some situations, management actions can be pre-built into certain scenarios, so that in the event of the scenario materializing, a series of pre-planned actions are triggered. In other circumstances, actions will have to be much more reactive.

The quest for better informed decision-making

Complying with regulation such as Solvency II is a major cost to insurers and requires a vast amount of data. That data, however, has tremendous value if it is enhanced and used properly. Deriving benefits from Solvency II programs is a topic on the agenda of most boards. One of those benefits is undoubtedly better decision-making. To support this, insurers need high quality data that is stored in a structured repository to generate the reports, dashboards, and KPIs the business needs. Data is one of the most valuable assets an insurer has – they should make sure they use it to the fullest.

1 Transforming data primarily involves the construction of online analytical processing (OLAP) cubes by IT specialists, which enables databases to be accessed to provide specific views (or sub-sets) of multiple data elements that meet a user's requirements. This process effectively translates data into information, which can be presented in the format of reports, dashboards, or other forms of graphical output.

GLOBAL INSURANCE OUTLOOK FOR 2014

By Simon Harris

Simon Harris
Managing Director, Head of Insurance in EMEA, MIS

Simon is responsible for the analytic teams that maintain Moody's ratings on European insurers and, since the summer of 2009, Nordic banks. He joined the Moody's European Insurance team in 1998.

Moody's Investors Service (MIS) is a regulated credit rating agency that is separate from, and an affiliate of, Moody's Analytics.

This article describes Moody's expectations for the main global insurance sectors through 2014, highlighting our overall stable expectation in each of the main sectors, albeit with many different positive and negative drivers.

GLOBAL LIFE INSURANCE

The global life insurance sector has a stable outlook, amid a backdrop of gradually increasing interest rates and relative stability in the world economy.

Gradually increasing interest rates create a more benign context for life insurers. Declines in their investment yields will continue, but their pace shows signs of diminishing. The risk of yields falling below the levels of policyholders' guarantees appears more subdued. Increasing rates will also ease the intensity of the "hunt for yield" and corresponding portfolio allocation toward relatively riskier asset classes, although structural factors could sustain this trend in Europe despite the increase in interest rates.

Growing evidence of a nascent economic recovery taking hold in leading economies will also reduce pressure on life insurance sales. Improvements in both growth and unemployment in most advanced economies will reduce constraints on households' savings and purchasing power and free up expenditure on discretionary items such as life insurance.

Evolving regulatory frameworks across the world create uncertainties, but their impact will be limited in 2014. Far-reaching regulatory changes are emerging and their eventual impact will be credit positive by enhancing capital levels and creating incentives to reduce risks. However, work-in-progress regulations create uncertainties and the short-term effect could be disruptive by limiting flexibility and restricting the fungibility of capital for the holding companies of international groups, although the impact should be somewhat subdued during the outlook horizon.

Insurers' responses to underlying sector trends include de-risking products, expanding asset management activities, increasing focus on insurance risks, divestments aimed at sharpening strategic focus, and sustained expansion in emerging markets that are currently underpenetrated and stand to exhibit high growth in the future.

Stagnant or spiking interest rates could put pressure on the stable outlook. An interruption of the current trend in interest rates, whereby they would remain at depressed levels, could weigh on the outlook. Conversely, a spike in interest rates, triggered by a disorderly departure from monetary stimulus policies or other factors, would have the same effect. A flare-up of the sovereign-debt crisis is a further downside risk to our outlook.

GLOBAL PROPERTY AND CASUALTY (P&C)

Our stable P&C outlook begins with the economic recovery fueling broad premium growth, which is generally at or above loss cost trends. We expect P&C premiums to grow at low-to-mid-single digits in North America and Europe, and at high single digits or double

digits in the emerging markets of Asia and Latin America. P&C insurance penetration rates are stable in North America (~4.5% of GDP) and Europe (~3%), and rising gradually in Asia and Latin America (currently 1.5%-2%).

- **A key strength** of the P&C sector is the mandatory nature of major lines, such as auto, home, and commercial property, leading to relatively stable performance through economic cycles.
- **The key challenges** are natural and manmade catastrophes, and setting pricing and reserves for long-tail lines such as US casualty.

North America

P&C price increases are moderating, but the cumulative benefit of past increases is still rolling through earnings, notably in US commercial liability lines. We expect these lines to generate an accident year combined ratio in the mid-90s by 2014, reflecting steady improvement since 2010. Low market interest rates hurt investment income but promote underwriting discipline. We estimate that the overall US P&C reserves will remain slightly redundant, albeit with a declining cushion.

Europe

The P&C pricing outlook is mixed, with moderate increases in Germany and France, and moderate decreases in Italy and Spain. Combined ratios in most markets are benefiting from the gradual economic recovery plus reserve releases, mitigating the impact of lower investment returns. We believe reserves are still modestly redundant, but with a diminishing cushion to support future earnings. Euro zone investment risk is easing but remains a concern.

Asia

We expect Japanese pricing to increase by low single digits, led by the auto sector, whereas pricing in other Asian markets will likely decline, reflecting competition from local and international carriers. China, with P&C premiums growing at about 15% per year, will likely surpass Japan as the largest Asian market within two or three years. These two countries currently account for about 60% of Asian P&C premiums.

Latin America

We expect the P&C sector to continue its strong growth (double or high single digits), buoyed by favorable trends in sovereign credit quality and the insurance operating environment. Latin American sovereign ratings have trended up at a time when many other sovereigns have seen their credit metrics weaken.

GLOBAL REINSURANCE

Our global reinsurance stable outlook reflects continued underwriting discipline, improvements in risk management, and firmer pricing in some primary insurance markets. Challenges facing the industry include competition from alternative markets that has pressured property catastrophe reinsurance pricing, continued low interest rates, and tepid demand given sluggish economic conditions in North America and Europe. We believe these pressures are manageable as reinsurers adapt to the evolving marketplace for insurance risk transfer. Reinsurers with large capital bases, high diversification, and an ability to leverage both traditional and third-party capital are best positioned going forward.

Influx of alternative capital roils market. An estimated $10 billion of new alternative capital has entered the industry over the past year, raising the total amount to approximately $44 billion, or roughly 15% of the global property catastrophe reinsurance limits placed. This has put pressure on property catastrophe pricing, with June/July renewals in the US down 10%-20%. We expect this pricing softness to continue into the key reinsurance renewal period.

Resilience and discipline are key strengths. Reinsurers over the past two years have remained profitable and grown equity capital despite large losses from the worst and third-worst natural catastrophe loss years on record. Underwriting discipline continues to be maintained and after four long years of trading at a significant discount to book value, reinsurance sector equity price to book value ratios have returned to 100%, which improves financial flexibility and is a positive development for creditors.

Pricing picture is mixed; profitability outlook dependent on business mix and geography. A number of crosscurrents are creating a mixed pricing outlook for the sector. Property catastrophe reinsurance rates are under significant pressure from alternative capital. This weakness could spill over to other reinsurance lines in the coming year. On the other hand, ongoing pricing improvements in specialty primary insurance lines, a significant portion of premiums for many reinsurers, are leading to increased underwriting margins, particularly in the US.

Reinsurers are adapting to the evolution of the market. While alternative capital has the potential to alter reinsurers' business models, many firms in the sector have been preparing for this eventuality for years via participation in sidecars and the insurance-linked securities market.

Moody's Insurance Ratings Universe and Ratings Approach

Moody's maintains ratings on more than 500 insurance companies globally, including some of the major life, property and casualty (P&C), and reinsurance groups. Our ratings address both the security of policyholder claims – via Insurance Financial Strength Ratings (IFSRs) – and, in common with other Moody's debt ratings, the credit quality of certain individual debt securities issued by re/insurance groups.

Our approach to rating insurers' policyholder and debt obligations begins with assessing the financial strength of the main operating units of a re/insurer, using rating methodologies developed specifically for each of the main industry sectors. Although the methodologies show some variation, they all focus on a range of qualitative and quantitative factors and share some common elements, such as market position and brand, asset quality, capital adequacy, profitability, and financial flexibility. In addition, we consider the operating environment (e.g., macroeconomy, regulatory environment, accounting rules) relevant to the re/insurers' business scope. Moody's analysts apply both qualitative and quantitative analysis to assess re/insurers under each of these main rating factors, creating a rating scorecard, which is used as an input to rating committee decisions.

Ratings of specific long-term debt securities issued by re/insurance operating or holding companies are assigned using the IFSRs of relevant operating companies as a base. The relationship between the IFSR and a given debt rating is dependent upon the legal and regulatory framework in a particular jurisdiction, and the relative standing of policy holders and debt holders in the event of insolvency, bankruptcy, reorganization, or liquidation of the entity.

For further information on Moody's insurance ratings methodologies, please refer to https://www.moodys.com/researchdocumentcontentpage.aspx?docid=PBC_161516.

ORSA – A FORWARD-LOOKING VIEW OF CAPITAL AND SOLVENCY

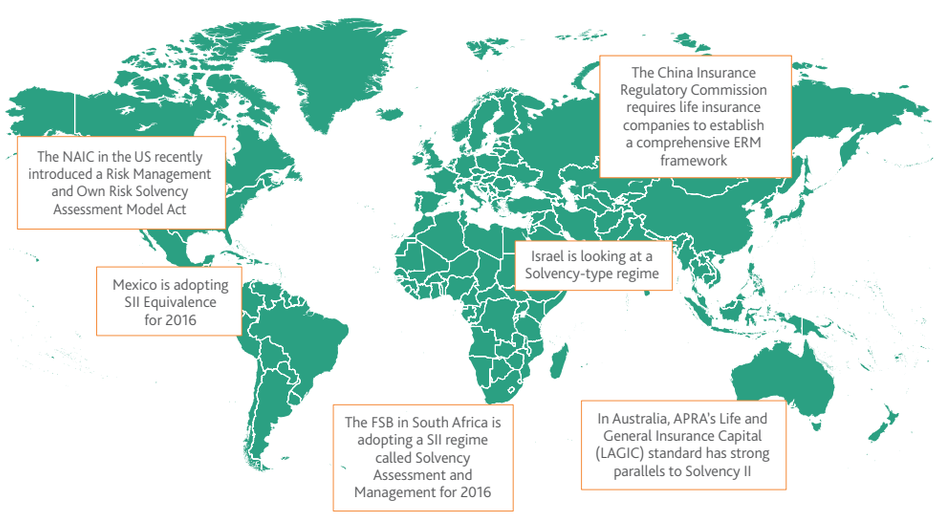
By Gavin Conn, Brian Heale, and Craig Turnbull

At the heart of the Own Risk and Solvency Assessment (ORSA) is the forward-looking solvency assessment. This article discusses how insurers should look beyond the next year, and build a capability to project solvency capital requirements under a range of scenarios – helping link capital with strategic business decisions.

Over the past year it has been apparent how global the ORSA has become, as it has been embraced across Europe, Asia, and the US. Indeed, the ORSA concept will be implemented in many countries before Solvency II actually goes live. For example, in North America the National Association of Insurance Commissioners (NAIC) has mandated that insurers must have an ORSA in place by January 1, 2015. Another example is the South African Financial Services Board's (FSB) Solvency Assessment and Management (SAM) framework, which includes ORSA requirements based not only on European Insurance and Occupational Pensions Authority (EIOPA), but also experiences from the Canadian regulator (OSFI), the Australian Prudential Regulatory Authority (APRA), the Bermuda Monetary Authority (BMA), and International Association of Insurance Supervisors (IAIS) principles.

The ORSA is viewed as an absolutely critical part of an insurer's risk management and is featured strongly in their model developments. The ORSA is a generic requirement – it is not intended to be a prescriptive regulatory calculation, but instead asks firms to describe how they manage risk and capital across their enterprise. The reference to "own" in

Figure 1 Global map of ORSA regulations



Source: Moody's Analytics

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Craig Turnbull
Managing Director, Enterprise Risk Solutions

Craig leads the research, thought leadership, and advisory activities in global insurance and pensions, particularly in valuation, capital modeling, and hedging. He has been actively involved in the development of global principal-based regulatory capital assessment implementations.

the title highlights the fact that the ORSA is meant to reflect the unique risk management characteristics and profile of an insurer.

From looking at the guidance published by EIOPA, NAIC, and OSFI, it is clear that the ORSA should include:

- Identification and assessment of all material risks
- Sufficiency of capital to cover those risks on a forward-looking basis
- A risk management framework to monitor and control risk
- A risk management culture embedded within the business to support decision-making

The building blocks for the ORSA are typically the insurer's existing risk and capital processes. The insurer should have a sound approach for risk identification and, alongside that, have a set of risk appetite statements consistent with this and approved by the board. The ORSA should encompass all material risks, including those not listed in the Solvency Capital Requirement (SCR). Insurers should consider additional risks types, such as model risk, strategic risk, reputational risk, and regulatory risk. Also, the risk identification should evaluate the major risks facing the company; not just now but over the business-planning period, which is typically a three to five year horizon.

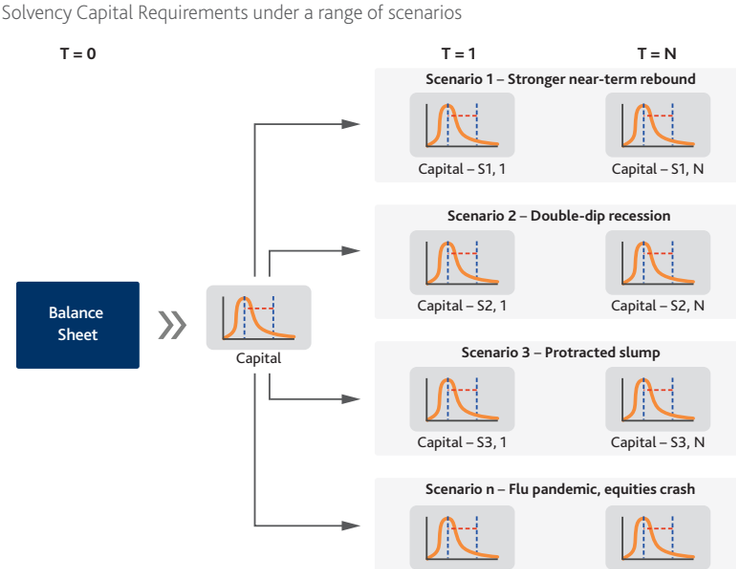
Quantitative modeling capabilities needed

Many insurance firms have identified a range of quantitative modeling capabilities they will need to support the objectives of the ORSA. These might include:

- Real-time monitoring of current regulatory capital requirements.
- The firm's own assessment of the economic capital requirements of the business. This could be calculated under a definition of capital that is specific to the business and different from regulatory capital requirements, such as Solvency II Pillar I's one-year 99.5% VaR capital or the CTE 90 run-off capital used in the US principle-based approach to reserving and capital.
- A capability to make a multi-year projection of the insurer's business plan under a range of different financial and business scenarios, with an assessment of the solvency requirements generated in those scenarios.

The last point refers to a key principle of the ORSA, namely that it should look beyond developments in the next year – meaning the ORSA must be forward looking. This requires a capability to project solvency capital requirements under a range of scenarios. This helps link capital with the big strategic decisions on the running of a company. It also presents an interesting technical challenge – how to take

Figure 2 Solvency Capital Requirements under a range of scenarios



Source: Moody's Analytics

the current "time zero" solvency calculations and develop them to understand how capital behaves not only today, but how it may evolve over time – across a range of different scenarios including, of course, potential adverse economic scenarios.

Depending on the nature of the assets and liabilities, the projection can be very complex. Typically, capital requirements are assessed using stochastic simulation. Whether the capital requirement is one-year VaR or CTE run-off, a similar technical challenge arises – a large number of stochastic simulations are in theory needed to measure the capital requirements not just in current conditions, but also at several future time steps in a number of scenarios.

This highlights an important rule in a well-functioning principle-based risk assessment – the risk management strategy must drive the risk measurement methodology, rather than vice versa.

This general projection process involves two distinct stages:

1. **Determine the multi-year scenarios in which the business is to be projected.** These could be stochastic scenarios, but are more likely to be a handful of deterministic scenarios. In both cases, the scenario model is typically done at a "macro" level. Even when the macroeconomic scenarios have been selected, mapping them to an insurer's individual risk exposure is not always straightforward.
2. **Calculate the capital requirements along the scenario paths (i.e., the capital metric).** There may be more than one metric, such as the business may be interested in the regulatory, economic, and ratings capital.

Projection scenarios

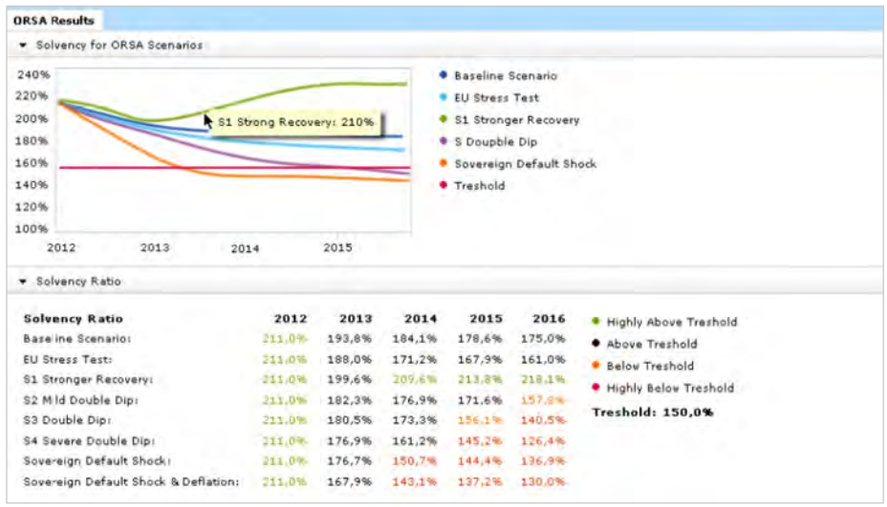
For multi-year scenarios, insurers can decide whether to use thousands of stochastic scenarios or a handful of deterministic scenarios. The stochastic approach will allow firms to examine the robustness of their business across a wide range of future possible economic outcomes. However, it is a significant computational challenge to assess future capital levels in thousands of different scenario paths, particularly where the business includes complex liabilities that are valued stochastically. Firms are therefore using deterministic scenarios in the projection of their business for the ORSA. The difficulty is then how to select the scenarios. Firms will need to decide on the appropriate stress scenarios given the nature and risk exposure of the business. There is no standard set of stress conditions that all insurers should run. The scenarios could be:

» **Top-down macroeconomic scenarios** capture the insurer's systematic exposures to adverse economic and financial market outcomes; for example, stresses expressed as a fall in equity markets, movements in interest rates, and changes in credit spreads. These top-down macroeconomic scenarios are perhaps easiest to envisage. Identification of the scenarios may rely on the input of economists to help pinpoint the key risks to the global economy. These are likely to be thematic scenarios, such as a global depression, war in the Middle East, disorganized euro sovereign debt default, and so on. Typically, the modeling of such scenarios would first involve some expert economic judgment on what their impact would have on macroeconomic factors (e.g., inflation, GDP growth, or corporate profit margins). Then econometric models would be used to estimate how unexpected shocks to those macroeconomic variables could impact high-level financial market behavior, such as equity returns and yield curves.

» **Bottom-up scenarios** are specific to the insurer based on their risk exposures, arising from their unique strategic and operational profile (e.g., unexpected legal liabilities or operational failures).

» **Systematic insurance risk scenarios** could include unexpected increases in longevity or pandemics.

Figure 3 Typical ORSA output



Solvency Ratio	2012	2013	2014	2015	2016
Baseline Scenario:	211,0%	193,8%	184,1%	178,6%	175,0%
EU Stress Test:	211,0%	188,0%	171,2%	167,9%	161,0%
S1 Stronger Recovery:	211,0%	199,6%	209,6%	213,8%	218,1%
S2 Mild Double Dip:	211,0%	182,3%	176,9%	171,6%	157,8%
S3 Double Dip:	211,0%	180,5%	173,3%	156,1%	140,5%
S4 Severe Double Dip:	211,0%	176,9%	161,2%	145,2%	126,4%
Sovereign Default Shock:	211,0%	176,7%	150,7%	144,4%	136,9%
Sovereign Default Shock & Deflation:	211,0%	167,9%	143,1%	137,2%	130,0%

Source: Moody's Analytics

The specific risk exposures and risk management strategies of a firm may place particular demands on the type of scenarios that are required in the prospective solvency assessment process. This will naturally impact the relevant financial and economic variables that need to be projected, but it may also impact the level of detail of the modeling. For example, if a firm has a risk management strategy that involves the weekly rebalancing of a significant delta hedging strategy, its risk robustness will not be well-assessed using annual projection time steps in its multi-year projection. Rather, it will be important to capture the specific risks left behind by its risk management strategy – in this case, it will have exposure to high volatility in weekly equity returns, rather than overall weakness in annual equity performance. This highlights an important rule in a well-functioning principle-based risk assessment: the risk management strategy must drive the risk measurement methodology, rather than vice versa.

Calculating future capital requirements

The ORSA requires the insurer to project its future position, including its projected economic and regulatory capital, to assess its ability to meet the regulatory capital requirement. This is often computationally challenging, particularly where the liabilities have embedded options and guarantees. Therefore, every valuation requires a full set of risk-neutral economic simulations. If a firm were to consider, say, five stress tests each with five annual steps, capital requirements would need to be reassessed in 25 different scenarios. The Standard Formula is also calculation-intensive as each capital requirement calculation will require multiple stressed market-consistent liability valuations. For Solvency II firms intending to calculate the capital requirement produced by their internal model SCR methodology, the complexity is compounded by the need to create an algorithmic description of how their internal model methodology and its implementation is applied in a wide range of different scenarios.

Proxy modeling is a possible solution to making the demanding problem of projecting capital requirements more manageable. The industry has been through a learning process in the area of proxy modeling as applied to the one-year VaR calculation. The advanced techniques that have been developed to solve the one-year VaR calculations, such as Least-Squares Monte Carlo (LSMC), are naturally extendable to calculating capital requirements over a longer horizon. Although technically challenging, we expect firms to start developing multi-period capital proxy functions that are capable of describing how capital requirements behave over multiple time horizons as a function of multiple risk factors.

ORSA output

If an insurer has established a methodology and process to implement the prospective requirements of the ORSA, then alongside a stress testing framework, the output from the ORSA can feature firmly in decision-making within the business. Figure 3 is a typical ORSA output.

Although it is time-consuming to derive and quantify the impact of the scenarios, it can be insightful for an insurer to go through the process of discussing possible scenarios, their financial impacts, and possible management actions. The output from stress testing may suggest that it is necessary to reduce specific risk exposures – possibly by hedging risk or potentially exiting product lines. Reverse stress testing should also be performed to identify and quantify those scenarios that could result in business failure, breach of economic solvency, breach of SCR and Minimum Capital Requirement (MCR), and other circumstances considered appropriate by senior management and the board.

It is correct to refer to the ORSA as a process, but it should be viewed as more than that. The output from the ORSA and the insights it provides should trigger management actions and decisions. For instance, the ORSA should play an important part in the running of the business. At the heart of the ORSA is the forward-looking solvency assessment. For this reason, we recommend firms invest in the development of a robust methodology to project the balance sheet, supported by a forward-looking stress testing framework.

GLOBAL INSURANCE INDUSTRY: WHAT TO EXPECT IN 2014

A conversation with Andy Frepp

Andy Frepp
Managing Director, Insurance Solutions

Andy has more than 25 years of experience in the insurance, asset management, and pensions industries, and helps global insurers address their regulatory compliance and risk management needs. Prior to his current role, Andy was the CEO of Barrie & Hibbert, which was acquired by Moody's Analytics in 2011.

Learn how global regulations such as Solvency II, demographic trends, and technology will impact insurers in 2014 and how they can best prepare for the changes.

What is the outlook for insurers in 2014 and beyond?

The current state of the industry reminds me of the opening line from Charles Dickens' *A Tale of Two Cities*, "It was the best of times, it was the worst of times."

The past few years have seen insurers, along with other financial institutions, focus on strengthening their balance sheets. They have had to manage their businesses during turbulent markets with weak consumer confidence, against the back drop of historically low interest rates. This turmoil has put insurers' solvency in the spotlight and increased the call for more demanding regulatory standards.

Moving into 2014, there are positive signs that insurers can begin establishing a more growth-focused strategy. With economic activity picking up around the globe, unemployment declining, and the recent positive movement in the stock markets and real estate, consumer confidence is returning.

The core of any growth strategy during 2014 and beyond will focus on the emerging opportunities driven by changing demographics and the runaway trains of social media, mobile, and big data.

What are the demographic trends and how can mobile and social media help an insurer's business?

The primary global trend that has driven much of the growth in the insurance and financial services markets over the last 20 years has been the increasing wealth and insurance needs of baby boomers. This has now turned into another opportunity. Baby boomers globally are aging and transitioning into a retirement phase. They need to sustain their lifestyle when they are not working.

Although this demographic has been good for insurers, there is significant competition among a wide range of market participants in that segment.

Perhaps more interesting is the situation of Generation X, the demographic group that came after the baby boomers. Research shows they are the largest underserved market from an insurance perspective, and they now have as much accessible money as the baby boomers.

Targeting Generation X will also spark a greater focus on mobile and social media, both in terms of how people interact with insurers and how they will transact. The most significant aspect of this demographic shift is what it will mean for the type and volume of data an insurer will have available.

Insurers generally assess risk based on models that rely on historic data. The increasing availability of data through mobile and social media and the acceptance by customers to supply that data are likely to be disruptive and present an opportunity for many segments of the insurance market.

One example is telematics, or pay as you drive. An insurer can capture second-by-second

information on driving behavior, either through a mobile phone or a specific in-car device. They can then price the auto insurance on the basis of this information. This type of insurance product is already available in a number of countries and, as it becomes more widely adopted, could be a great opportunity for insurers to grow their business by essentially personalizing the price.

This is the most well developed example of use-based insurance. There will also likely be growth in how the data from "fit bands" and other fitness or health-related data capture devices can be leveraged to assess health and life risks – maybe all those gym work outs will pay off eventually.

For many insurers, capitalizing on these emerging trends will help move them back into a growth phase during 2014.

How will regulations impact insurers in 2014?

Insurance regulation is generally local, reflecting the requirements of individual markets. In 2014, local regulatory regimes will have the most impact on insurers. As with most industries, however, insurance is global as many insurance companies are active in different markets. The globalization of insurance has led to more consideration of whether there should be global regulatory requirements, particularly in relation to prudential regulations and solvency.

This push for global standards has been the work of the International Association of Insurance Supervisors (IAIS), who have set core principles for insurers, such as solvency and a risk management framework. These core principles have been agreed on by almost every country around the world and certain aspects are starting to be adopted.

During 2014 and 2015, Canada and the US are adopting the IAIS ORSA core principles, which require insurers to have a documented risk management framework, with associated risk assessment, stress testing, and capital planning.

In 2014, there will also be a focus on insurers seen as globally systemically significant. The IAIS will introduce higher capital standards and the Federal Reserve Board will apply more stringent requirements to these type of insurers.

In Europe, Solvency II is nearing completion and 2014 is a key year for implementation. Many countries around the world are also basing their local regulations on Solvency II, with significant activity in Mexico, South Africa, Australia, and a number of countries in Asia.

What can insurers do in 2014 to prepare for Solvency II?

Solvency II has been in the works for many years and has experienced peaks and troughs in relation to insurers' focus and investment. Although there have been many questions about its value, Solvency II should be ultimately positive for the insurance industry around the world. It will create a single regulatory framework across Europe, with common solvency standards and reporting.

Given that the Solvency II start dates have been pushed back a few times, it now seems certain that the first full reporting will begin on January 1st, 2016.

Insurer readiness varies widely by country, but they will still need to do a lot of work in 2014 to complete what they have started. Most of that activity will likely focus on the reporting preparation. There is a significant amount of reporting required for Solvency II – there are more than 70 standard reports – and most insurers are not ready for these reporting standards. Implementing that number of regulatory reports presents challenges, most notably in accessing, storing, and validating the required data.

There are also a significant number of data items (in excess of 10,000) required for these reports. Although some insurers may take tactical shortcuts, the majority would greatly benefit from identifying the data requirements and establishing a process to put the data infrastructure in place. There will be a reporting dummy run for a subset of insurers in 2015, so they really only have a year to implement the infrastructure.

Many of the larger insurers have developed an internal model as part of their Solvency II

preparations. These are complex models, and insurers will have to go through the regulatory model review process. It is inevitable that, as a result of this review, insurers will need to enhance their model validation and analytics automation processes.

Although 2016 is the Solvency II start date, this will not be the end of its impact. Many insurers will have done the minimum to get through the first regulatory round and the regulators themselves will only start to truly understand the issues once they have experienced the first full reporting cycle. Solvency II will continue to impact insurers and regulators for at least the next five years.

How will insurance technology be influenced?

The volume, variety, and velocity of data that insurers have to manage will continue to increase. That data is more and more unstructured and insurers will need the enabling technology, infrastructure, and analytics to leverage this data. Breaking down silos and viewing data, risks, and business opportunities at an enterprise level – rather than just at a product or business unit level – will be critical to future success.

The regulators will continue to put greater emphasis on insurers to not only understand and manage their risk, but also integrate their risk management technology and capabilities across their organization. Regulators will expect insurers to support higher frequency, more granular reporting, which will only lead to a risk and regulatory technology infrastructure being a priority spend for insurers. Perhaps the days of the spreadsheet are numbered.

ORSA

A forward-looking view of capital and solvency

Moody's Analytics helps insurers meet the challenges of ORSA, so they can better link capital with strategic business decisions.

Learn more about our ORSA solutions at:
MoodysAnalytics.com/ORSA2014

REGULATORY SPOTLIGHT

Addresses how regulatory updates will impact organizations, as well as how to effectively approach data quality and Pillar III reporting.

DATA QUALITY IS THE BIGGEST CHALLENGE

By Brian Heale

Brian Heale
Senior Director, Business Development Officer, Global Insurance

Brian is an insurance and Solvency II specialist who has significant experience in technology solutions for the global insurance industry. He has an in-depth knowledge of the life and pensions business, coupled with a comprehensive understanding of enterprise technology.

This article looks at the inherent analytical data quality problems in the insurance industry and how to improve them. Insurers have a vast store of both operational and analytical data, but this article focuses primarily on the analytical data required for Solvency II and risk and capital decision-making.

With Solvency II firmly back on the radar following the recent pronouncement from the European Insurance and Occupational Pensions Authority (EIOPA), insurers are once again re-energizing their Solvency II programs. However, there are clearly many challenges ahead that they must overcome before they can establish a risk-based culture and derive business benefits from a Solvency II program. But perhaps the biggest challenge relates to data, as it is at the core of Solvency II.

Many insurers are good at calculating numbers, but those numbers are only accurate if the data fed into the actuarial engines is correct. Indeed, EIOPA stipulates that the data used for Solvency II purposes must be accurate, complete, and appropriate. It also mandates a data governance framework. Thus, data is critical for regulatory purposes. Insurers also need good data to support their decision-making processes and meet internal compliance requirements.

Scope of the problem

Historically, insurers have suffered from poor data quality, primarily caused by having vast amounts of unstructured data stored in a plethora of systems. Many of these systems are somewhat antiquated (so called legacy systems) and others are desktop based (actuarial software). The problem is compounded by new applications that have been added to these legacy systems, creating multi-layered and potentially redundant IT architectures. Additionally, there is a lack of common data models, data structures, and data definitions.

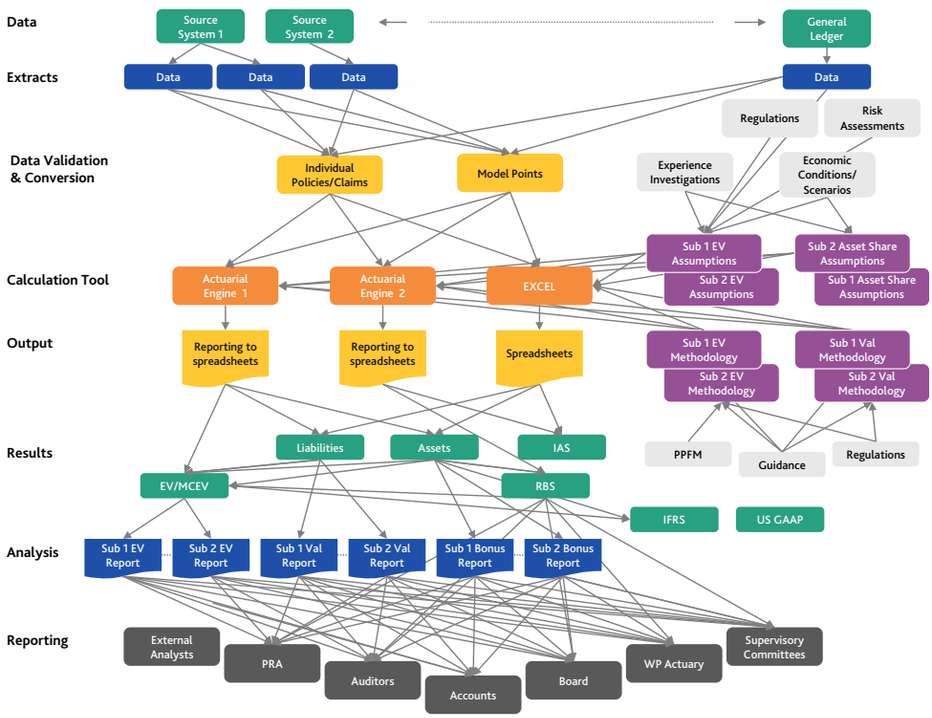
Spreadsheets are another problem as they store a significant amount of actuarial and finance data. For example, a large insurer may have hundreds of source systems organized in a number of discrete silos and thousands of spreadsheets from which data is needed. Often the same data is duplicated in different systems but stored in different formats. Standardizing data from external sources such as asset managers and reinsurers is also a challenge.

Insurers have tried to rationalize legacy systems and impose common data models and structures across these diverse systems. This has generally met with little success. The interaction between these legacy and desktop systems also creates its own problems. The complexity can be overwhelming as shown in Figure 1, which illustrates the overly complex interaction surrounding actuarial modeling.

What types of data do insurers need for Solvency II?

Solvency II basically requires granular actuarial, finance, asset, and risk data, which is categorized as analytical data. Figure 2 illustrates, with some examples, the types of analytical data and from where that data may come. Analytical data primarily comes from systems that, in turn, require data from core administration,

Figure 1 Overly complex interaction surrounding actuarial modeling



Source: Moody's Analytics

claims, CRM systems, etc. Thus, there is a link between analytical and operational data. This sophisticated data chain can be complex, but data quality throughout the chain is essential.

Perhaps the key issue is that analytical data is different in its structure from the operational data that insurers traditionally store in their warehouses. This is particularly evident in the actuarial arena, which is a new ground for IT. Traditionally, actuarial modeling has been the domain of desktop modeling systems and supplemented heavily with spreadsheets.

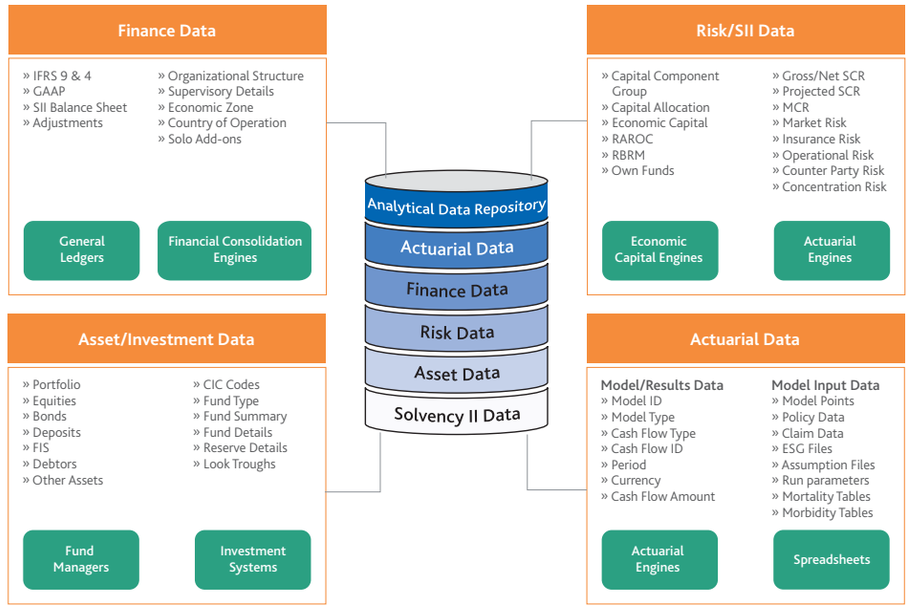
There are potentially many inputs into an actuarial model – mortality tables, economic scenario generator (ESG) files, assumptions sets, run parameters, policy data (potentially hundreds of inputs). So there is significant value in storing inputs in a repository, especially regarding enterprise access and management and audit controls. There is equal value in storing the output of actuarial models (essentially cash flows) in a sufficiently high level of granularity – something that is typically not covered in modeling technology – particularly for sensitivity analysis and populating the Technical Provision Quantitative Reporting Templates (QRT).

Regulatory requirements

Good data governance and practice should already be in place as part of an insurer's compliance program; however, recent regulation such as Solvency II, International Financial Reporting Standards (IFRS), and Dodd-Frank focuses significantly on data management and quality. Solvency II is an example of this increased focus on data.

> Having homogeneous data is meaningless unless it can be aggregated in a manner that promotes its use. Solvency II (and actuaries) requires aggregated views of multiple sets and the raw data may require sophisticated analytical methods. To ensure that data is properly aggregated, standards must be applied to both the data collection and analysis.

Figure 2 Types of analytical data and related source systems



Source: Moody's Analytics

Solvency II

Pillars II and III of Solvency II introduce extensive data management and quality requirements. This not only involves the creation of new data sets and reports, but also data management standards and controls that must be transparent and fully auditable. Indeed, EIOPA requires a Data Quality Management Framework and Policy to be in place as part of the Internal Model Approval Process (IMAP), which is also relevant to the ORSA.

The purpose of this requirement is to ensure that all data used for Solvency II purposes is accurate, complete, and appropriate. It also establishes standards for data quality. A practical problem is that insurers are not always able to define accurate, complete, or appropriate. The Prudential Regulation Authority (PRA) in the UK noted that this was a particular issue with catastrophe exposure data, where underwriting teams did not always have an adequate understanding of the quality criteria or the point at which a data error could be considered material. Table 1 provides EIOPA's interpretation.

EIOPA will finalize the data management requirements in the Omnibus 2 Directive, but insurers can commence their data management projects now as sufficient principles have already been established.

Table 1 EIOPA data quality requirements

Accurate	» Free from material mistakes, errors, and omissions » Accurate, timely, and consistent recording » High levels of confidence » Credibility demonstrated though usage in decision-making process
Complete	» Allows recognition of the main homogeneous risk groups » Sufficient granularity to identify trends and the full understanding of the underlying risks » Sufficient level of historical detail is available
Appropriate	» Fit for purpose » No bias » Relevant to the portfolio of risks of the insurer

Source: *CEIOPS' Advice for Level 2 Implementing Measures on Solvency II: Technical Provisions – Article 86 f Standards for Data Quality (Formerly CP 43) and Own funds - Article 97 and 99 - Classification and eligibility (Formerly CP 46).*

Data quality improvement processes

The fact that raw analytical data can come from numerous sources (both internal and external) leads to questions regarding its quality, consistency, and reliability – particularly as the volume of data increases.

An example of this can be found in the multiple policy administration systems maintained by insurers – each of which may store a policyholder's age and birth date in different formats. Reconciling data is also important. For example, premium data may come from both a policy administration system and the general ledger, but rarely are they the same number.

Figure 3 illustrates the data chain (or lineage) between source systems and ultimate reporting, and highlights the seven-step data quality process.

Data quality process

Improving the quality of data is a multi-faceted process. In essence, it takes raw data and subjects it to a range of tools that use algorithms and business rules, coupled with expert judgment, to analyze, validate, and correct the data as appropriate. Effective data quality tools have in-built data "logic" in terms of patterns, trends, and rules built up over a number of years against which data is tested. Simple errors can thus be automatically corrected. It also raises flags for data that requires expert judgment. The end result may not always produce perfect data (no process can do that), but the data should at least be fit for purpose. Table 2 looks at a typical seven-step process for improving the quality of data.

Making use of data profiling tools

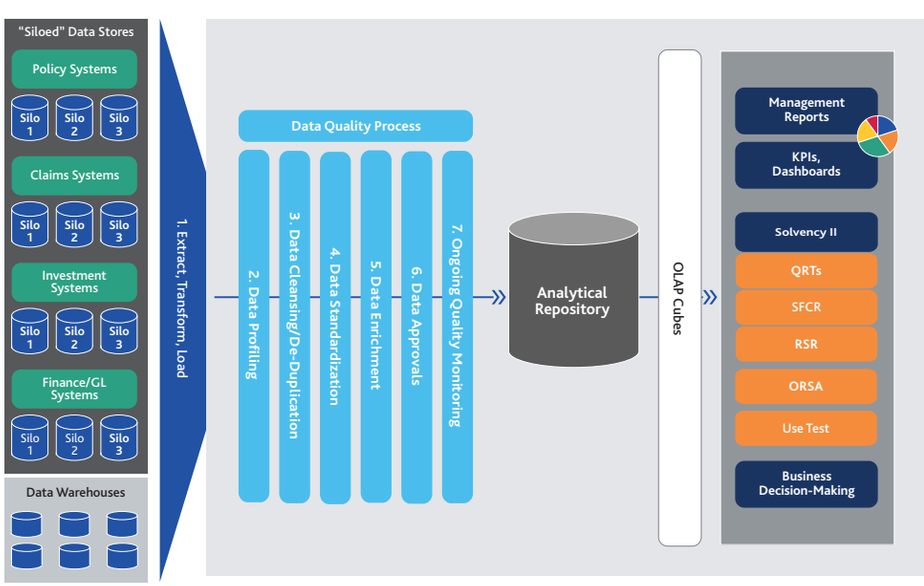
Using data profiling, insurers can examine the data available within an existing data repository and assess its quality, consistency, uniqueness, and logic. This is one of the most effective techniques for improving data accuracy in an analytical repository. A number of proprietary data profiling tools are available from vendors in the market.

Data profiling uses different kinds of descriptive techniques and statistics – such as minimum, maximum, mean, mode, percentile, standard deviation, frequency, and variation, as well as other aggregates, such as count and sum – to analyze data according to known patterns. Using these, an expert can find values that are unexpected and therefore potentially incorrect. Profiling can help insurers identify missing values, which can then be replaced by more logical values generated by data augmentation algorithms.

Introducing data quality rules

A key part of the process is data standardization, which fundamentally relates to the execution

Figure 3 Source system and reporting data chain



Source: Moody's Analytics

Table 2 Seven-step quality process

Step	Process	Description
1	**Data extraction**	The extraction process comprises three stages: 1. Data extraction from the various source systems – policy and claims systems, general ledgers, actuarial systems, investment systems, etc. 2. Data transformation into a common format recognized by the repository. 3. Transformed data loaded either directly into the repository or into data profiling/quality tools that are allied with the repository. The approach will depend on how good the data is. Specialist ETL tools are normally used for this step.
2	**Data profiling**	The next step uses data profiling tools and techniques to make an initial assessment of the data to understand its overall quality challenges and anomalies. This step primarily uses patterns, trends, and algorithms (both general and specific to the insurance industry) to produce a picture of the overall data quality. This typically would be represented as a percentage of the data that appears accurate. Profiling tools may be part of the ETL tool referred to in step 1 or a specialist tool.
3	**Generalized "cleansing and de-duping"**	Step three is a dual process: **Data cleansing:** 1. Identify and modify corrupt or inaccurate data from the repository. 2. Remove or modify incomplete, incorrect, inaccurate, and irrelevant data. These processes may involve removing typographical errors or validating and correcting values against a known list of entities. The validation may be strict (such as rejecting any address that does not have a valid postal code) or fuzzy (such as correcting records that partially match existing and known records). After cleansing, a data set should be consistent with other similar data sets in the repository. **Remove duplicated data:** 1. Eliminate redundant data to provide consistency and reduce storage space. 2. Retain only one unique instance of the data within the repository. Redundant data is typically replaced with a pointer to the unique data instance.
4	**Data standardization**	Execution of a series of data quality checks and rules against the data. There are a number of data tools that include many thousands of pre-built data quality rules (both general and industry-specific). These are then supplemented with a number of user-defined rules to reflect the unique circumstances of the insurer. Best practice is to execute the data quality rules with the repository. Alternatively, this can be undertaken in the extraction (ETL process).
5	**Enrichment**	The value of internally-held data is enhanced by appending related attributes from external sources (e.g., consumer demographic attributes or geographic data). This may be valuable for the underwriting and pricing of household policies – e.g., flood risk or marketing certain types of products to certain customers who have certain socioeconomic attributes, such as high disposable income.
6	**Approvals**	The processed data needs to be approved by the relevant authority and then it can be locked down in the repository. Controls should exist as to who can change locked down data. Audit, lineage, and approvals are important elements of the data controls required for SII.
7	**Quality monitoring**	Data quality should be seen as an ongoing process; therefore, it is important to track data quality over time to avoid data decay, which fundamentally occurs over time due to changes not being captured or system upgrades. Typically, the ongoing process would use specialist software to auto-correct the variations based on pre-defined business rules. The process should only be repeated on values that have changed. That means that firms would need to keep a cleansing lineage that requires efficient data collection and management techniques. These processes can be in real time or batch oriented.

of a number of data quality rules against the data. Various vendors offer data quality tools that include thousands of rules. These comprise a number of generic rules, together with some specific to the insurance industry. Additionally, such tools also enable insurers to define supplementary rules specific to their own lines of business or function. Table 3 provides examples of the types of data quality rules.

> Most data-related projects do not fail because of the technology – they fail because practitioners cannot precisely define what data they need.

While it is the role of the IT department to actually use data quality rules, it is up to the practitioners in the business to provide the "logic," in conjunction with rules that are specific to a particular set of data. When discussing this logic with IT, carefully consider what is the ultimate usage of the data. For example, in terms of policy data, the input required for actuarial modeling is primarily around the type of contract, benefits/coverage, premiums, term, etc. These inputs have to be correct as they impact the accuracy of the cash flows. Other policy-related data, such as postal code, phone number, etc., are not relevant for these purposes and, if incorrect, have no impact on accuracy.

The role of spreadsheets: are they a problem?

No review of analytical data quality would be complete without considering the role of spreadsheets. Spreadsheets are now commonly considered a part of the wider group of technology assets called end user computing

Table 3 Data quality rules

Type of rule	Description	Insurance example
Basic business rules	Basic business logic rules.	The date of a claim cannot be earlier than the date of policy inception.
Data-type constraints	Values in a particular column must be of a particular data type; for example, Boolean, numeric (integer or real), date, and code.	CIC/ISO Code in asset data for QRT templates.
Regulatory constraints	Data validations or rules laid down by regulators such as EIOPA, the Federal Financial Supervisory Authority (BaFin) in Germany, or the PRA.	The validation rules contained in the QRT templates specified by EIOPA.
Range constraints	Typically, numbers or dates should fall within a certain range. That is, they have minimum and/or maximum allowable values.	» Eligible ages for contracts – eligible age must be between, for example, 18-65. » Minimum premium amounts. » Reassurance limits.
Mandatory constraints	Certain columns cannot be empty (e.g., not null).	
Unique constraints	A field, or a combination of fields, must be unique across a dataset.	No two policyholders can have the same national insurance number.
Set-membership constraints	The values for a column come from a set of discrete values or codes.	For example, a person's gender may be Female, Male, or Unknown (not recorded).
Foreign-key constraints	This is the more general case of set membership. The set of values in a column is defined in a column of another table that contains unique values.	For example, in a "town" column, it must be aligned to a county from a "County Table."
Regular expression patterns	Occasionally, text fields will have to be validated this way.	For example, phone numbers may be required to have the (0044) 1234-5678 format.

(EUC) – that is, any technology asset which may be created, updated, or deleted outside the purview of the IT department or standard software development lifecycle management processes. Other assets in this class include MS Access databases, CSV files, MatLab scripts, etc. However, spreadsheets tend to be the most prolific and problematic of all EUCs because of their flexibility and familiarity to most users – particularly actuaries.

The ability of a spreadsheet to act as a data source (e.g., data connections/links and expert judgment), a data manipulator (e.g., data joining, restructuring, and translation) and as an application (e.g., formulas and macros) create a variety of data quality issues. When combined with the additional uncertainty of ownership and access rights over specific spreadsheets, it is not surprising that spreadsheet control issues have received specific mention in data thematic reviews conducted by the FSA (now PRA).

Spreadsheets pervade almost all financial and actuarial processes, but regulatory focus under Solvency II has been drawn particularly to those that hold and manipulate data prior to consumption by the internal model. It is common to find extensive "webs" of thousands of spreadsheets connected by "links" that may have an impact on data quality. In practice, many of these are dormant, but their presence and the possibility of erroneous updates create uncertainty and risk in the modeling process.

Is there a spreadsheet solution?

Spreadsheets are not going away – they will remain for the foreseeable future. So one viable solution is to embed spreadsheets into specialist software that effectively provides a control framework. This software operates according to three steps: discovery, triage, and control.

Discovery is the process by which businesses can evaluate their current dependence on spreadsheets. Such a "health check" will consider the scope and complexity of spreadsheet usage. It can be done manually, but may be accelerated using technology.

Once the spreadsheet landscape is mapped and analyzed, the future of identified spreadsheets and spreadsheet-supported processes can be **triaged** for different forms of improvement. This may simply be a matter of training users to further exploit existing solutions, or require the adoption of new software capabilities through integration or third-party vendor solutions.

It is likely that the spreadsheet triage process will produce a road map for process improvement that will take some years to complete, so that business-critical spreadsheets will continue to exist in the business for a lengthy period. In addition, constant business innovation will undoubtedly continue to create more spreadsheets. Both these factors mean that spreadsheet elimination should be seen as a continuous process, rather than a planned destination. Businesses are therefore increasingly turning to technology to provide on-going spreadsheet **control** in the form of enterprise spreadsheet management software. This provides the opportunity to detect and report user activity that is outside pre-determined tolerance levels across the key risk areas of data, functionality, and security.

Ten key thoughts about analytical data quality and governance

1. Analytical data (actuarial, finance, risk, and asset) is very different in character compared to the transactional data insurers traditionally use and store.
2. When considering the analytical data, the business needs look to the ultimate usage of the data – usually reports and dashboards – and level of granularity and drill-through required.
3. IT may utilize Online Analytical Processing (OLAP) techniques to provide sophisticated multi-dimensional views of data, however, a clear definition about the outcome is required.
4. Not all data may be relevant for a particular purpose; therefore, it is important to express why accuracy is needed. Otherwise, valuable effort can be wasted on improving data quality that has little materiality. Basically, identify the data with the highest impact.

5. Understand that data lineage needs to be a living process and must be updated as systems and processes change. Equally, the ability to track and audit data lineage should be available on demand and be built into the data quality solution.
6. Tools can help improve the quality of data, and are a combination of techniques and expert judgment – these tools should be used wherever possible.
7. Business rules are an important part of the data quality process. While there are many pre-built generic rules, it will be critical to supplement these with user-defined rules that reflect unique business considerations – this requires practitioner input.
8. Improving data quality is an ongoing process – not just when the data is initially loaded. Data is constantly changing. It should be embedded in the data management and governance framework.
9. Spreadsheets remain an important element of analytical data and should be carefully managed and controlled.
10. Most data-related projects do not fail because of the technology – they fail because practitioners cannot precisely define what data they need.

REGULATORY RADAR FOR INSURANCE:
EMERGING REGULATIONS ARE RESHAPING THE GLOBAL INSURANCE INDUSTRY

By Sandy Sharp
Contributor: María C. Cañamero

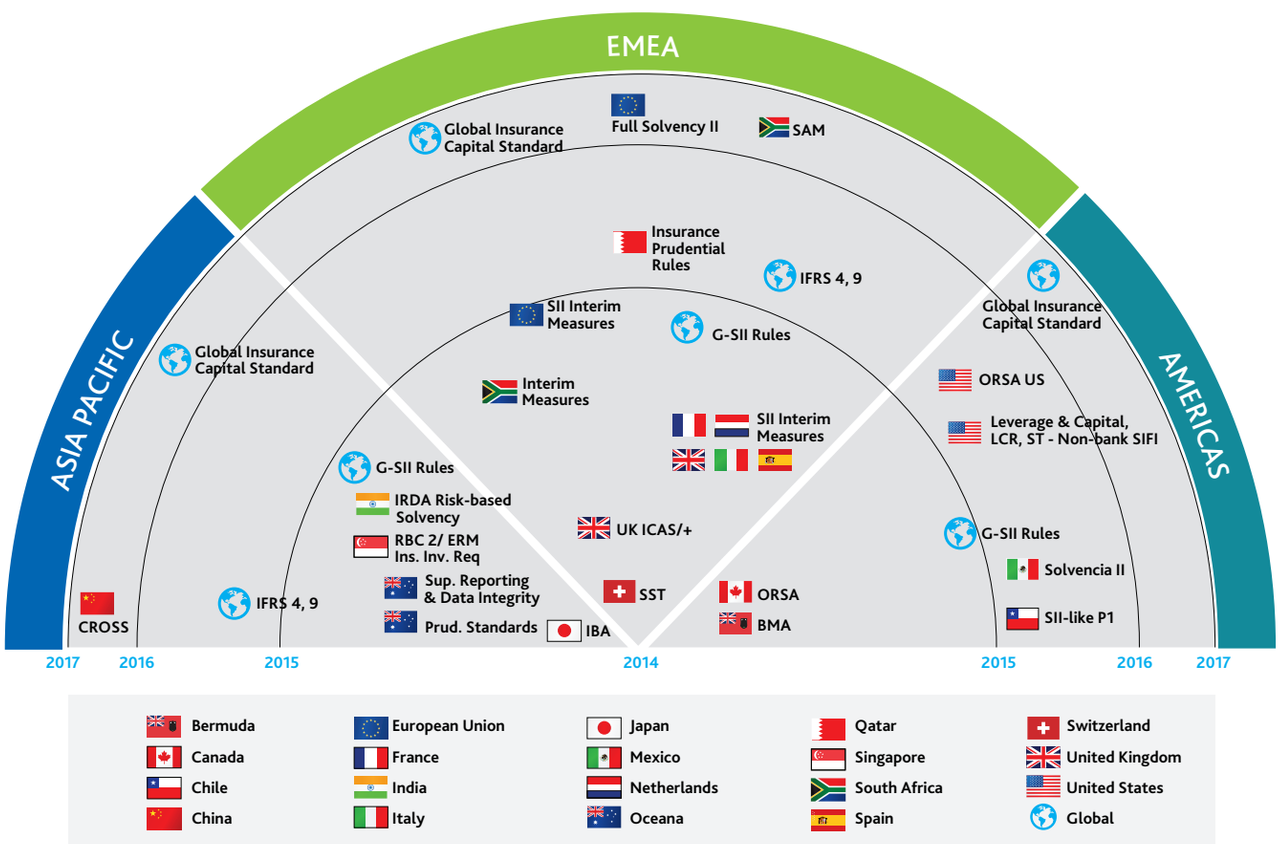
Sandy Sharp
Director, Advisory Services
Sandy maintains a close interest in regulatory developments worldwide and has presented to various EIOPA working parties on the minutiae of Solvency II. He is a Fellow of the Institute of Actuaries and has co-authored papers presented to the Institute of Actuaries.

Big themes driving regulatory changes

The increased focus and attention on the insurance industry are illustrated by the acceleration of regulatory efforts across the globe. Keeping up with the pace of regulatory change in the current environment is one of the greatest challenges facing any insurance company.

While the goal of global regulatory cooperation has been pursued for some time, the recent financial crisis has sped up the drive toward financial stability reform initiatives globally. In November 2008, the G-20 stressed the need to "review the differentiated nature of regulation in the banking, securities, and insurance sectors" and to "identify areas where systemic risks may not be fully captured."[1] Under the differentiated nature of regulation in the various sectors, regulatory arbitrage opportunities arise where the banking, securities, and insurance sectors overlap – such as "shadow banking" – an area in which Paul Tucker of the Bank of England recently identified that regulators need to up their game.[2]

Figure 1 Moody's Analytics Insurance Regulatory Radar



Source: Moody's Analytics

Even within insurance regulation, there are fundamental concerns. The current regulatory regime varies widely from country to country, which is exacerbated by the differing nature of the products offered, as these variances have frequently arisen for historical reasons (e.g., local investment markets and taxation basis). In Figure 1, the Insurance Regulatory Radar outlines upcoming regulations by region. Many countries retain valuation systems that allow the capitalization of risk premiums and employ capital measures that are not risk based. A common international standard of regulatory regimes could potentially reduce costs for multinational insurers and remove the opportunity to headquarter in a less regulated regime.

In response, the International Association of Insurance Supervisors (IAIS) developed proposals to harmonize and strengthen insurance regulations globally – notably the IAIS-revised Insurance Core Principles (ICPs), released in October 2011. The ICPs provide a globally-accepted framework for the supervision of the insurance sector and aim to increase regulatory convergence of local supervisory regimes. Among other things, the ICPs request that local supervisors introduce guidelines in terms of enterprise risk management, risk-based assessment of capital, and group-wide supervision and reporting. Moreover, the IAIS proposed the Common Framework for Supervision (ComFrame), a set of supervisory requirements based on the ICPs, for effective group-wide supervision of internationally-active insurance groups (IAIG). ComFrame is designed to promote confidence in insurance markets and to ensure that policyholders are properly protected.

Among other things, ComFrame and the ICPs focus on the three main areas: solvency assessment, enterprise risk management and ORSA, and supervisory review and reporting.

Solvency assessment

Solvency assessments should be conducted in the context of IAIS risk-based solvency requirements. This requirement implies that insurers should use a total balance sheet approach that values assets and liabilities market-consistently and addresses all reasonably foreseeable and relevant risks.

Early adopters of risk-based capital methods in Europe (including Solvency II) have proposed a measure that requires them to hold sufficient capital to remain solvent (on a market-consistent basis) with 99.5% confidence at a one-year horizon. This market-consistent valuation can provide meaningful insights into the asset and liability positions of an insurer and help regulators understand the financial situation of an insurer relative to their peers. It also provides insights into which actions may be taken by insurers and their supervisors in respect of those positions.

Enterprise risk management and Own Risk and Solvency Assessments

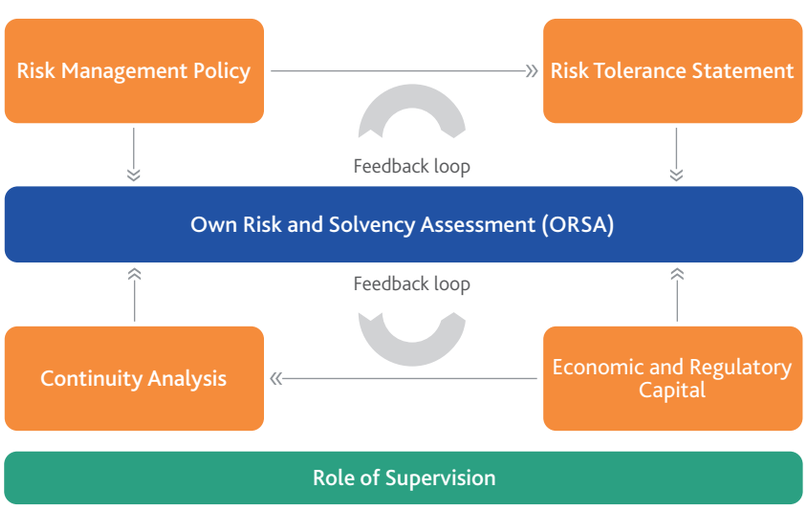
The Insurance Core Principles recognize the importance of an enterprise risk management (ERM) framework from a supervisory perspective in underpinning robust insurance solvency assessments. As a result, an insurer must demonstrate its ability to control, mitigate, and manage its risk exposures as part of an ERM framework.

An insurer's ERM framework (illustrated in Figure 2) should comprise the processes, controls, and procedures set up for managing risk, taking into account its business strategy and operations. The framework should involve a self-assessment of all relevant material risks that they may face and outline the quantitative and qualitative measures used to identify and manage these risks. The cornerstone of this self-assessment is the Own Risk and Solvency Assessment (ORSA). The ICPs request insurers to perform their ORSA regularly to assess the adequacy of their risk management and current and future solvency positions. Moreover, an insurer's board and senior management are responsible for the ORSA.

Supervisory review and reporting

The IAIS principles promote the harmonization of reporting requirements at a group level in order to ensure consistency and reduce redundant disclosure requirements. They also promote market discipline through

Figure 2 The IAIS standard enterprise risk management framework



Source: IAIS

improved risk disclosure to the public and confidential disclosure to supervisory authorities.

Supervisory authorities have also released specific proposals to address systemic risks. In particular, the Financial Stability Board has worked with the IAIS to define a list of global systemically important insurers (G-SII) and to draft policy measures that will apply to them. The IAIS has recognized that insurance does not naturally create systemic risk. Classification as a G-SII is not solely based on size, but includes measures such as scale of non-insurance and non-traditional insurance activities, the extent of global activities, and degree of interconnectedness.

As of December 2013, nine insurers have been designated as systemically important.[3] Additionally, the US Financial Stability Oversight Council has designated three firms (AIG, GE Capital, and Prudential Financial) as the first non-bank SIFIs under the US Dodd-Frank Act. These firms will also be subject to Fed supervision and capital requirements.

With these initiatives, supervisors seek to align regulatory approaches and reduce regulatory arbitrage opportunities. These measures should also provide regulators with a more consistent approach to overseeing insurances companies across jurisdictions.

Beyond these global insurance standardized frameworks, many jurisdictions have defined risk-based solvency regimes. The Swiss Solvency Test (SST) is a risk-based capital standard for insurance companies in Switzerland, in use since 2008. The EU-based regulatory framework, Solvency II, (scheduled to start as of January 1, 2016) consists of three pillars (quantitative requirements, supervisory review, and market disclosure) and represents a fundamental upheaval of insurance risk management practices. Moreover, Solvency II exercises a dominant influence on international insurance regulations and several countries have announced that they will be seeking equivalence with this regime.

Both the US and Canada are first adopting the key component of Pillar 2, the Own Risk and Solvency Assessment (ORSA). Mexico, on the other hand, plans to introduce a Solvency II-type regime called "Solvencia II" by 2015, one year earlier than the effective date of Solvency II in the European Union.

Regulators in many Asia-Pacific countries are also moving toward risk-based insurance supervisory regimes similar to those of Western countries. Japan, Australia, and Singapore are among the more advanced risk-based capital regimes. India and China are currently defining their roadmaps to introduce risk-based capital regulations.

While the efforts of the IAIS creates a powerful reason for insurers to examine the effect of the coming new regulatory regime on their products and balance sheet, there are other reasons why an early investigation of the coming changes may be desirable. The International Accounting Standards Board and the Financial Accounting Standards Board are working toward a new Insurance Contracts standard. This work appears likely to adopt a balance sheet similar to the market-consistent model contained in the IAIS's Core Principles. When finalized, the Insurance Contracts standard will apply to financial reporting worldwide – even to countries that don't immediately adopt the IAIS's Core Principals. Of course, the accounting standards are primarily concerned with the balance sheet rather than the risk measures, but an insurer whose financial reporting is based on a market-consistent balance sheet would be well advised to understand the volatility of that measure.

IMPLICATIONS OF THE NEW REGULATORY STANDARD

The emerging regulatory standard typically has the following elements:

- **A market-consistent balance sheet:** Determines the amount of capital an insurer has available.
- **A capital requirement based around a one-year VaR:** Determines the amount of capital the regulator requires the insurer to have available to remain open for new business.

The implications of the new regulatory standard can be considered from two perspectives:

- Operations in the insurance market: The demand for, and structure of, the insurance products offered in the market, which directly affects the consumer (i.e., the prospective policyholder).
- New systems and processes: Insurers will have to introduce these to comply with the new standard, although firms should be solely concerned with the new internal technical requirements.

Of course, in practice there is no clear split between the two perspectives. The continued viability of current products depends on the new processes and the capital resources available to the insurer. An early examination of the existing product range under the metric of the new regulatory standard will identify any areas that require further investigation.

While the capital available (i.e., the balance sheet) is largely fixed (depending on the size and nature of the liabilities), the capital required can frequently be managed (e.g., by de-risking exercise).

Implications of the new regulatory standard on the insurance market

In many markets, the adoption of a market-consistent balance sheet and a risk-based capital requirement has led to changes in the available insurance products. Some forms of traditional "with-profits" contracts offer inter-generational smoothing of policy payments – a feature that relies on opaqueness in an insurer's financial position. In the new regime, such contracts might not be viable. Other products will be developed that are aligned to the new regulatory standard. For example, Solvency II contains a "matching adjustment" mechanism that favors products where consumers exchange liquidity (i.e., the ability to surrender their contract) for a high (long-term) guaranteed return. Gabriel Bernardino, the Chairman of the European Insurance and Occupational Pensions Authority (EIOPA) – the European body charged with designing the detailed Solvency II requirements – recently gave a speech about the changes he expects to see in products offered by European insurers.[4]

Elsewhere, insurers are likely to review the level of guarantees present in their products. A switch to unit-linked structures, where the market risk is born by the policyholder, is one example. Another example would be the introduction of a periodic re-pricing as a function of evolving longevity experience into a pension's annuity as a means to limit the long-term mortality guarantee (and associated capital).

The specific examples identified above may not emerge in any individual market, but it is surely inevitable that insurers will review their offered guarantees and ensure they charge appropriately for them. Of course, consumers will not welcome all these changes, particularly in markets where insurers have traditionally undercharged for guarantees. The counter-argument is that the new regime will be more robust and the likelihood of a policy payout will be higher.

Technical implications of the new regulatory standards

The new regulatory standard requires many new systems and processes. Typically an insurer will require governance, data management, and the adoption of new calculations.

Governance

In order to perform a market-consistent valuation, and calculate a VaR-based capital requirement, it is necessary for everyone to have a common understanding of what is being valued. For a guaranteed contract this may be straightforward, but for a with-profits, or participating, contract it can be difficult to gain a common understanding. Frequently, a with-profits contract will have discretion on terms, such as bonus rates and asset allocation, and codifying the boundaries of permitted actions can prove challenging.

Data management

With the new regulatory regime, many companies have found it beneficial to create a new system to manage the data, perform the calculations, and produce the reports required. The alternative is to make ad-hoc enhancements to often already over-loaded existing systems. The new regulatory regime often requires data that was not needed under

the existing regulatory regime. For example, the total balance sheet approach requires granular information on the assets and the liabilities, whereas the existing regulatory regime might only need highly summarized data on the assets.

New calculation requirements

The calculation of a market-consistent value for liabilities will be a new challenge for many insurers. For a guaranteed contract, this may be relatively straightforward. For a with-profits contract, a simulation approach is likely to be required as the bonus rate and asset allocation algorithms introduce path-dependency (frequently at the aggregated fund, rather than contract level) to the embedded option.

The assets and liabilities should both be valued on numerous scenarios to assess the variability of an insurer's balance sheet (and hence the capital requirement). The volume of calculations is likely to require a highly automated system. In special circumstances a "proxy" model is required, as it is not practical to perform multiple valuations of a liability that itself requires a simulation approach to value. Proxy valuation techniques, such as Least-Squares Monte Carlo, make application of the new regulatory standards possible.

The "risk margin" is a component of the liability value that is present in most new regulatory standards (and is also present in the IASB's Insurance Contracts Exposure Draft). The risk margin is the recognition that an insurer will demand a lower premium for a fixed liability of CU100 in 10 years than for a liability that will average CU100 in 10 years. Where the risk can be hedged, as with many market risks, the market provides the risk margin – hence, only non-hedgeable risks need to be considered when calculating the risk margin.

Uncertainty in the basis

While the basics of performing a market-consistent valuation are generally agreed on, there are certain elements that usually generate a discussion – for example, the appropriate yield curve to adopt, and in particular, whether to include an illiquidity premium (and how much). Frequently, insurance liabilities involve cash flows at longer durations than risk-free tradable assets. This introduces a dependency on the extrapolation basis used to extend the yield curve derived from tradable instruments. Other complications arise when considering the volatility surfaces required.

The road ahead

It is clear that Solvency II and similar regulations will transform the risk management practices and infrastructure systems of insurance firms. While keeping up with evolving regulatory change across multiple countries is challenging, the insurance industry is moving toward global regulatory cooperation.

The IAIS has developed proposals to harmonize and strengthen insurance regulations globally, focusing on solvency assessment, enterprise risk management and ORSA, and supervisory review and reporting. This new regulatory standard may impact the insurance products offered in the market and require many new systems and processes.

An early investigation of the potential effects of the new regulatory regime is desirable. A proof-of-concept exercise would let an insurer assess if the new regime is likely to disrupt its existing operating model. With the timescale for the introduction of much of the regulatory change measured in years, action can still be taken to make the initial new regulatory regime balance sheet look substantially better.

1 *G-20 Summit on Financial Markets and the World Economy*, November 15, 2008.

2 BOE, Paul Tucker, *Shadow banking: thoughts for a possible policy agenda*, April 27, 2012. http://www.bankofengland.co.uk/publications/Documents/speeches/2012/speech566.pdf.

3 The list includes AIG, MetLife, Prudential Financial in the US, Allianz in Germany, Axa in France, Prudential and Aviva in the UK, one Generali in Italy and Ping An Insurance Group in China.

4 *Bernardino speech to the EIOPA Annual Conference*, November 20, 2013.

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TAKING A HOLISTIC APPROACH TO PILLAR III REPORTING

By Karim Ben Ayed

Karim Ben Ayed
Actuary, Insurance Solutions Specialist

Karim provides in-depth expertise to European insurance companies about Solvency II compliance and implementation of the different pillars, including ORSA.

In this article, we address why insurers should view the data collated for Pillar III reporting as an essential information source for all strategic risk and capital decision-making within their organizations.

Although their attention is currently focused on establishing processes for Pillar III reporting compliance, many insurers are already determining how they can extract long-term benefits well beyond the Solvency II deadline of January 1st, 2016. In particular, they seek to use the foundation laid for Pillar III reporting to break the barriers that have traditionally existed between risk and finance – facilitating the adoption of a more holistic and strategic approach to risk and capital management.

Leveraging Quantitative Reporting Template data

The data required for Quantitative Reporting Templates (QRTs) is complex and many parts of an organization need to be involved to aggregate and consolidate the data for capital calculations, asset valuation, technical provisions, etc. However, with an extension to the QRT's target data perimeter, insurers can reuse the required data to support wider risk and capital management decision-making. For example, it makes sense to extend the use of QRT data to other areas of their business, such as the Own Risk and Solvency Assessment (ORSA), capital budgeting, business intelligence analysis, and stress testing. The data requirements for QRTs, the national specific templates, and European Central Bank (ECB) reports are particularly good starting points for considering the ways in which assets, liabilities, and Pillar II data can be better exploited across all areas of Solvency II.

Tackling QRT data requirements

Completing QRTs requires approximately 10,000 cells of information to be pulled from a broad spectrum of sources. This data is essential for informed decision-making and comprises capital calculations, technical provisions, and asset information. The bulk of the data is primarily an extension of the QRT data perimeter, but further information will be required to carry out capital calculations, such as economic capital, performance measurement, and risk-adjusted return measures.

Much of the data needed for both QRTs and decision-making will come from the same sources – finance, risk, asset, and actuarial systems. It is therefore essential that insurers adopt a common process for automating and improving the data collection, quality, and validation. Furthermore, the large volumes of analytical data for QRT reporting call for a high level of granularity. Examples of complexity created by a large volume of data include:

- The asset data for the D1-D6 QRT templates requires not only a large volume of data, but also the granularity to enable "look through" capabilities.
- The Solvency Capital Requirement (SCR) and Technical Provisions QRT contain a distillation of results, which come from a number of actuarial models.
- The Balance Sheet and Own Funds reports include detailed consolidated financial information from both the general ledgers and financial consolidation engines.

Pillar I and Pillar III data overlaps with asset and liability data

The substantial QRT data demands, relating to both solo and group reporting, capture details such as the insurer's capital position, high-level financials, assets, liabilities, revenue/expenses, business analysis, claims experience, and reinsurance. This same data can also be reused in other areas of the standard Solvency II setup. However, the benefits insurers derive from their Solvency II programs will depend largely on how effective their processes are for generating granular risk and capital metrics.

The key to producing the necessary reports and eventually complying with Solvency II is to aggregate and consolidate data from a myriad of internal systems and some external sources. Adopting an integrated approach, which concentrates on one central source of truth for data, can provide the input for multiple steps of the Solvency II calculation and reporting requirements.

There is commonality in the data needed for both assets and liabilities:

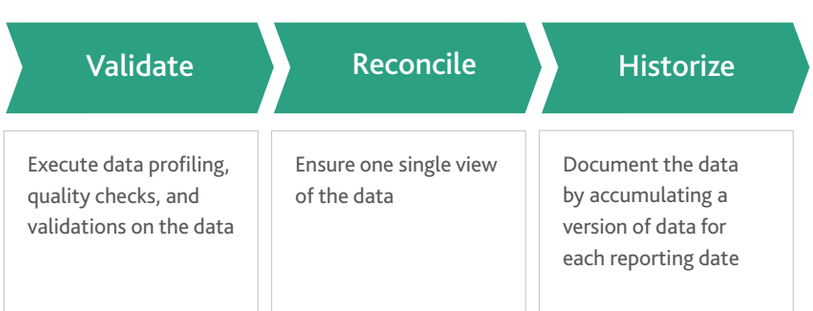
- **Assets:** Much of the data contained in the Asset QRTs can be viewed as a main ingredient of an insurer's entire Solvency II setup, as the granularity of assets is a key component of the SCR's market risk calculation.[1]
- **Liabilities:** Data such as claims triangles used by actuarial engines to compute best estimates are also included in the QRT TP E3 template.

Insurers can gain significant benefits from using a central data repository. For instance, non-life data may be loaded in high levels of granularity (non-life policies with all the claims) and claims triangles generated by line of business may be used concurrently by the actuarial and reporting engines.

As input data is required for both risk calculation and reporting, it is also recommended that insurers capitalize on those processes to manage data quality under Solvency II in a centralized way. Data quality processing can be performed in a three-step process outlined in Figure 1.

1. **Validate:** Execute data profiling, quality checks, and validations on all the data used for calculation and reporting. The tools typically associated with a central data repository could undertake this step. In addition to improving data quality, it is also important to monitor quality and demonstrate to the regulators that the data is fit for purpose. A key way of doing this is by generating dashboards that allow insurers to easily view and understand the consistency of the data. Data quality improvements are often a combination of automated checks enhanced by manual reviews based on expert judgment.
2. **Reconcile:** Ensure one single view of the data. Often the same data element may come from several sources. For example, premium data might come from both the policy administration systems and the general ledger. The reconciliation of these figures can be best achieved in the repository.

Figure 1 Data quality processing three-step process



Source: Moody's Analytics

3. Historize: Document the data by accumulating a version of the data for each reporting date. This exercise will enable access to any past data should the supervisor require a report or audit.

There are synergies between Pillar III requirements and analytical data management projects – examples include data preparation for calculations and reports, and data quality. These synergies may be exploited by adopting an integrated approach when addressing the Pillar III project and the data management framework for the overall Solvency II program. This approach, in turn, will bring the following advantages:

- A centralized repository containing a "golden copy" of the data for risk and capital management (i.e., SCR, ORSA)
- Consistency of data for calculations, dashboards, and reports
- Accuracy and completeness of data to meet the European Insurance and Occupational Pensions Authority (EIOPA) requirements
- Access to claims triangles and model points generation
- Improved management effectiveness of solo and consolidated data
- The ability to apply value in Pillar III data to Pillar I calculations

Synergies between Pillar III data and Pillar I calculations

The data required for Pillar III reporting is synergistic with asset and liability data requirements. As such, several opportunities to leverage Pillar III data to perform Pillar I calculations at both the solo and group level, according to the Standard Formula.

The first area involves "calculations with a closed formula structure." The risk taxonomy described in the Standard Formula contains numerous closed formulas with data requirements that overlap with some QRTs. For example, it is possible to reuse the same data to generate the Asset D1 QRT to perform the spread, concentration, and default risk calculations according to the Standard Formula. Assets for each of these activities should come from the same source (a centralized repository) in order to avoid inconsistencies and comply with data quality requirements. With similar data, leveraging the calculations in Pillar III and Pillar I is possible.

Further synergies can be found when calculating other market risk modules (such as interest rate, equity, property, spread, currency, concentration, and illiquidity) in the SCR calculation according to the Standard Formula. Another area in which reusing data is possible is "life risk calculations." Here, the calculations can be performed with the data required for the B3A (market risk) and B3C (life underwriting risk) QRTs. These reports contain fair values and best estimates according to the regulatory stress test.[2]

Finally, the data associated with the diversification effect and the detection of intra-group transactions (IGT) also shares commonalities. This is important in two areas: group SCR and in reinsurance programs. Group SCR calculations require IGT detection and elimination while group QRT requires IGT reporting. For instance, group internal reinsurance programs are eliminated from the group SCR and reported at a group level in IGT3 and at a solo level in Re-J1. To undertake the necessary consolidations, granular data provided by solo entities needs to be collated and then consolidated. This is typically done in a financial consolidation engine or a centralized repository.

Reusing Solvency II data across your firm

Solvency II's Pillar III has driven insurers to invest in systems and processes to collate and store all the required data. By adopting a prudent and strategic approach to Pillar III reporting programs, much of the Solvency II data can be reused across the wider organization. Indeed, with a relatively small extension to the target data perimeter, insurers can support wider risk and capital management decision-making.

This article discusses ways in which Solvency II data can be reused to support Pillar I calculations, provided it is stored in a common repository. Solvency II data can also be reused as the core data feeding the asset and liability valuation process.

As data is at the heart of any successful Solvency II project, it is crucial that insurers implement an analytical data repository that not only holds all the risk and capital data required, but also provides the lineage, auditability, and tools necessary for extracting and improving the inherent quality of the data. Ultimately, it is the insurance companies that act strategically by stepping beyond the minimum regulatory requirements – and start investing in data today – that will be most successful.

1 Regardless of whether the regulatory capital requirement is calculated with the Standard Formula or with an internal model.

2 The data required to generate the reports B3A and B3C could also be reused to perform automatically delta NAV calculations and aggregations.

APPROACHES TO IMPLEMENTATION

Examines how to implement an insurance solution, including an in-house ESG, an effective ERM framework, and internal models.

BUILD VERSUS BUY: THE PROS AND CONS OF AN IN-HOUSE ESG

By Stephen Carlin
Contributor: John Hibbert

Stephen Carlin
Director, Insurance Product Management Team

Stephen has many years of experience working with scenario generators and stochastic modeling, including calibration, development, and support. Since 2010, Stephen has led the development of the B&H Economic Scenario Generator (ESG) product suite.

This article delves into some of the arguments for and against the decision to build Economic Scenario Generators (ESGs) in-house by reviewing the steps required for implementation and highlighting key challenges and considerations for insurers.

About ESGs

An ESG provides all the financial economic and macroeconomic variables necessary for risk management and to comply with the complex demands of regulations, such as Solvency II. An ESG is the cornerstone of a market-consistent valuation of the balance sheet. In particular, ESG represents an appropriate tool to properly monitor and manage both market and credit risk from an integrated perspective.

Beyond its relevance as a key prospective element in the context of Solvency II, ESG is not only an effective tool for an efficient ALM strategy, but also facilitates a better understanding of the market risk drivers embedded into some complex life insurance products (e.g., variable annuities).

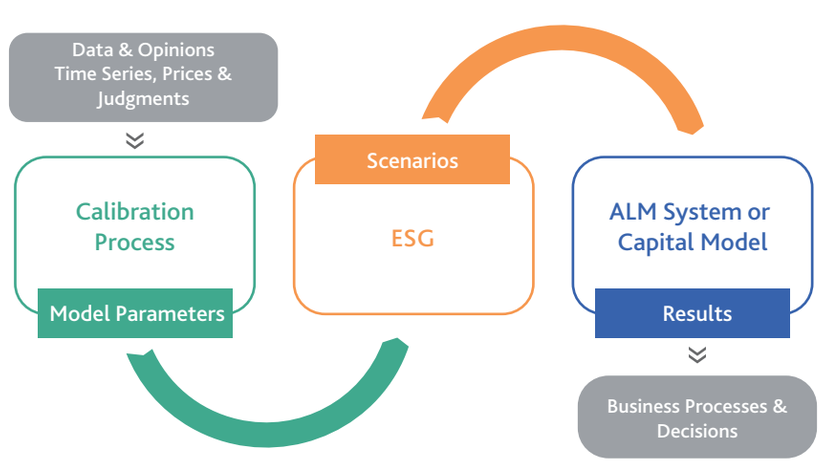
The challenges of building an ESG

For some problems, simple solutions often suffice. And while it is possible to build a simple ESG relatively quickly, the problems faced by financial intermediaries are rarely simple and the behavior of the capital markets is complex.

Similar to other financial institutions, insurance groups face a wide range of valuation, risk, capital management, and communication challenges that require deep expertise and a set of analytical tools that fit a broad array of purposes. Developing a coherent, multi-asset stochastic model that can be regularly calibrated across a range of economies and building the robust, fast, auditable, and fully documented technology to run it is a significant challenge. In practice, such a project may require different models and calibration choices for different purposes, such as market-consistent valuation and real-world projections or analysis over different planning and valuation horizons.

In the ESG design process, some of the tasks required fall unambiguously within the responsibility of the in-house user, whereas

Figure 1 ESG process



Source: Moody's Analytics

others may be outsourced. Figure 1 illustrates an overview of the ESG process.

SCOPE AND TASKS OF AN ESG IMPLEMENTATION

Software design and build

Systems design and development is key for an effective ESG. Firms must build all the procedures or tools required to initiate runs of the models, calibrations, and validation and reporting analysis on the output. Furthermore, firms must specify the functionality needed from their tools and be comfortable that the tools will meet these requirements. The remainder of the tasks – research and development of models and methods, specification, design, build, testing and documentation – may be readily outsourced.

Alternatively, some institutions opt for developing the entire software system in-house, which requires several skill sets. First, this option requires firms to attract (and retain) the deep quantitative skills needed to understand the modeling and calibration method challenges. Second, it involves acquiring the software engineering disciplines to ensure code is well designed, controlled, built to required standards, is capable of extension, and runs efficiently.

Eight tasks to consider in software design and build:

1. Functional and non-functional specification for the ESG
2. Research and development of mathematical models for the required risk factors
3. Preparation of technical specifications and test plans
4. Design, build, and testing of software
5. Management of software release cycles and version control
6. User acceptance testing (e.g., Solvency II statistical quality)
7. User documentation creation
8. Technical documentation of models and software (this should be suitable for external parties, such as regulators or auditors, as well as internal users)

Constructing a house view

Projecting future "real-world" possibilities requires a view of the future target distributions. Firms must identify the scope of coverage across territories, asset types, required update frequency, and be able to demonstrate their understanding of the assumptions underlying the models and how they have changed. Generating real-world targets involves a number of tasks that can all potentially be outsourced, including identifying market data sources, defining acceptance criteria, and designing, building, and executing data collection and target updating processes.

The assumptions underlying any risk factor model can have a big impact on the results. In order to be effective, assumptions should be reviewed and updated regularly and documented in a way so that decision-makers can understand the impact of their choices. This requires economic expertise and an ability to analyze and understand information from markets and other data sources.

Six tasks to consider when constructing a house view:

1. Identification of scope of coverage across territories, asset types, and required update frequency
2. Market data source identification and definition of acceptance criteria and tests
3. Design, build, and execution of market data collection process
4. Documentation and implementation of process for updating targets
5. Definition of processes and the pass through each process
6. Analysis of all assumptions and how they have changed

Market price discovery

Market-consistent valuation requires market data. Markets for instruments relevant to valuation work are frequently neither deep nor liquid. Some market prices may simply not exist at all. Methods are required in order to assess the available data, identify missing prices, and fill any gaps. Other tasks include designing, building, and executing these methods and the data collection process. Firms must be

comfortable with the methodology, but they do not necessarily need to create or even run them. In fact, firms choosing to do this fundamentally important step in-house will need to convince themselves and auditors that their choices are independent of the valuation process itself.

The methods should be clear, auditable, and ultimately independent of the valuation process. It is not often clear how to best build these methods and, in our experience, this requires an understanding of how the data is sourced, together with quantitative, statistical, and economic skills and a good measure of commonsense.

Five tasks to consider in market price discovery:

1. Research and development of price discovery methods
2. Outlining of price discovery methods
3. Creation of an auditable process showing independence of methods from valuation
4. Documentation and implementation of the market data collection process
5. Design, build, and execution of methods

Calibration

Any mathematical model is only as good as its parameterization. Getting the process right for calibrating these parameters is critical to the overall quality of an ESG.

Calibration involves setting up models to match selected targets or prices for specified purposes. This is not a one-off task, but something that needs to be done regularly – even as frequently as daily for some applications. Firms need to clearly identify the purpose and key performance criteria they will use for assessing model performance. They also need to select the models and targets or prices relevant to the task in hand. While there is a need to show a clear understanding of the trade-offs, the data used, and calibration decisions made, analysts do not always need to perform calibration calculations themselves.

The task of calibration requires judgment about the trade-offs that are made to fit a model (i.e., the information included in the calibration exercise and how it is weighted). These processes and material decisions should be open, with an appropriate level of governance and documentation. Given their recurring nature, firms will be required to apply significant skilled resources to these tasks. Further, given the demands of users of financial statements for objectivity, some firms believe that calibration should be performed independently and choose an outsourcing option.

Models are only useful if the results and their sensitivity are well understood. Firms must demonstrate that they have the ability to train and retain staff that can communicate these model risks and make informed choices.

Five tasks to consider in calibration:

1. Identification of the purpose of each risk factor model and key performance criteria
2. Selection of models and calibration targets / prices
3. Execution of regular calibrations
4. Determination of calibration choices and acceptance of performance
5. Documentation of processes and each pass through the process

Production and operational

Once models are calibrated, producing scenarios requires firms to set up and run models, perform and document validations, and deliver output to the end users. This process requires hardware, which for large problems can be a real constraint on the speed of the entire exercise. Firms need a documented and auditable process, but could choose to outsource scenario production.

Models are only useful if the results and their sensitivity are well understood. Firms must demonstrate that they have the ability to train and retain staff that can communicate these model risks and make informed choices. However, many of the other tasks described above involve hiring, motivating, and retaining staff with deep technical skills and then managing the key-man dependence that arises.

Five tasks to consider in production and operational:

1. Execution of ESG runs, output formats set up, validation execution and documentation, and output delivery
2. Design, configuration, and hardware platform testing
3. Documentation of an auditable process
4. Internal business process development across different teams
5. Hire, train, and retain staff with deep technical skills (and management of key-man risks)

Adding it all up

Once all these factors are taken into consideration, the complexity of implementing an ESG becomes clear. In addition to the implementation, it is important to consider that these tasks need to be performed in conjunction with a parallel set of tasks required to implement a full internal model of liabilities, normally using other third-party actuarial modeling software.

It is fair to say that the aggregate required resources, irrespective of how many of the tasks listed above are executed in-house, will be large, technical, and expensive. These technically complex functions are notoriously difficult to manage. Further, any solution must adapt to the evolving business needs and external demands on the risk management function. In the current environment, firms have to reconsider the option of completing a simple one-off build. The complexity of market risks and the demands of management and regulators mean that model users are likely to face a sustained period of development and refinement of models, software, assumptions, and related practices.

Why build an ESG?

Even the very largest corporations would not seriously consider building and maintaining all their software in-house. So, why do some large insurance groups choose to take on the task of designing, building, and maintaining Economic Scenario Generators in addition to the considerable challenges of actually using them?

Building and operating an ESG requires the execution of a large number of complex tasks. In reality, some of these business-critical tasks must be retained in-house, not least because regulators and rating agencies now (quite rightly) insist that firms acquire expertise and document their compliance. However, there are a large number of tasks that can be outsourced. Access to a library of models, calibrations, validation tools, technical research, and skilled advisers brings huge efficiency gains and mitigates the significant operational risk that arises when these skills and activities are concentrated in very small teams or inside the head of an individual.

ARGUMENTS IN FAVOR OF AND AGAINST THE IN-HOUSE ESG

Some of the common objections in the debate of whether to manage an ESG in-house are listed in Table 1 below.

Table 1 The arguments in favor of and against the in-house ESG

"Risk management is absolutely fundamental to the business. We would be crazy to outsource it."	Risk management is a core activity for large insurance groups who must hire in-house experts. However, developing all aspects of ESG in-house is increasingly complex. Instead, firms should focus on determining which functions are essential to perform inside their organization and those which may be outsourced. Any decision to bring functions in-house should be tested against the cost and risk implications of using an external supplier. Many firms, after having tried the internal approach, realize that it is harder and more expensive than expected. It involves huge key-man risk and does not scale as well as a third-party solution.
"The regulator approves of in-house development and the level of expertise it demands of firms."	Regulators expect firms to understand and document models and calibration choices. There is no question that firms choosing to build ESGs themselves gain from this expertise. However, building in-house requires a significant investment to understand an ESG. The vast majority of ESG users that chose this path have since learned that solution partners with the necessary scale, skill, and focus best perform many of these functions. Rarely is this achieved internally.
"External ESGs are expensive. We can do it cheaper in-house."	Any significant ESG project requires an ongoing commitment from software engineers, quantitative analysts, economists, actuaries, and managers. Absolute baseline in-house solutions (which come with some significant operational risk) cost several hundreds of thousands of dollars per annum. Realistic solutions for a multi-national insurer will likely run well beyond the $1 million per annum mark. These costs are a multiple of the costs of external licenses and calibration services.

HOW TO BUILD AN EFFECTIVE ERM FRAMEWORK

By Andrew Waters

Andrew Waters
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Andrew works across multiple teams to deliver tailored enterprise risk management solutions for insurers. He provides Solvency II internal models, and is experienced in liability approximations, ALM, hedging, economic capital optimization, and stress testing.

This article identifies some of the key areas of enterprise risk management and discusses how ERM can be achieved effectively.

There is no shortage of commentary hypothesizing what constitutes effective enterprise risk management (ERM). Many articles appear to draw upon the early efforts of the Committee of Sponsoring Organizations (COSO), which published *Enterprise Risk Management — Integrated Framework* in 2004.[1] Its description of ERM offers useful guidance for financial institutions to this day:

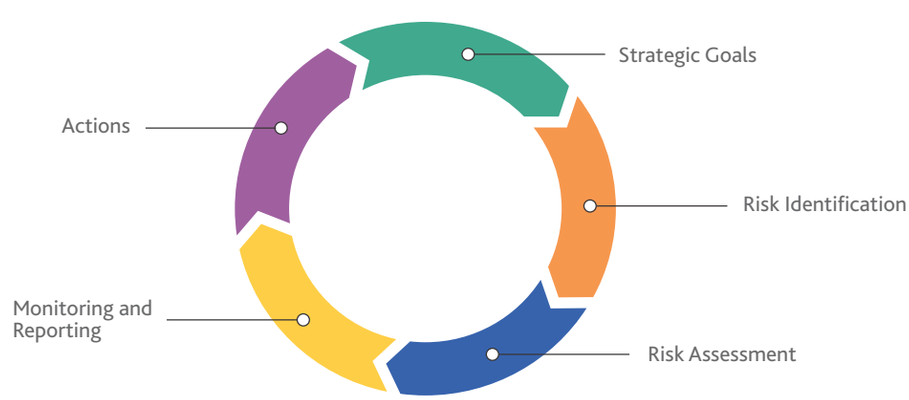
"Enterprise risk management is a process, effected by an entity's board of directors, management, and other personnel, applied in a strategy setting and across the enterprise, designed to identify potential events that may affect the entity, and manage risk to be within its risk appetite, to provide reasonable assurance regarding the achievement of entity objectives."

In essence, ERM involves managing the acceptance of risk to achieve the objectives of the business. The ERM process diagrams (Figure 1) are typically cyclical in nature, conveying the idea of continuous refinement of an insurer's risk management approach in a dynamic business environment.

A firm needs to define its strategic business objectives, explicitly identify its material risks, quantify the willingness to take on more risks, define the actions to be taken for a variety of foreseeable circumstances, and measure performance against expectation.

Evaluating performance against business objectives requires the identification and measurement of risks to be delivered to

Figure 1 ERM process



Source: Moody's Analytics

stakeholders. The information generated can automatically trigger actions (e.g., breached limits and accompanying responses specified in policies), provide the basis for decision making, foster internal debate, or stimulate further analysis (e.g., stress testing).

While most risk management practitioners recognize the guidance provided by COSO as standard best practice, achieving effective ERM is by no means simple. This article discusses the key areas of ERM to propose ways in which it can be effectively achieved.

Join together

ERM confronts the challenge of combining disparate sources of risk to provide senior management and the board with a comprehensive and holistic view of the risks facing the business, so they can create value for stakeholders. This requires intangible qualitative statements to be linked to quantitative measures, providing the basis for action and policy development.

Aggregating different risks (i.e., market, credit, insurance, and operational) together not only introduces a challenge regarding approach (e.g., copula vs. correlation matrix), but also raises the more fundamental issue of obtaining the justification to define the co-dependence of the different risk types. Of course, the Solvency II Standard Formula provides a correlation matrix, but firms should question whether it captures the uniqueness of the business and if the organization agrees with the calibrations of the regulator.

An overreliance on the Gaussian copula by banks has been blamed for exacerbating the credit crisis and hiding the true nature of correlations (i.e., they are not static). More alarming than the shortcomings of a mathematical formula is the willing or actual ignorance about the weaknesses of the model.

The highlighted concern is not about the identification of the best statistical approach to aggregation, but rather the necessity for firms to understand the limitations of the method. The question that should be asked is: What is the sensitivity of the risk results to the assumptions that underpin the method? This example also underlines the importance of accessible models whose implications can be understood outside of the actuarial modeling department.

In addition to linking qualitative and quantitative elements, or combining risk types for a holistic view, another aspect involves the interaction of different job functions. ERM permeates an organization and requires the involvement of IT, actuarial, ALM, and finance. Operational silos hinder the development of a common understanding of risk among stakeholders, which reinforces the importance of risk culture and strong leadership.

> The challenge facing most insurance companies is that they are not creating an ERM framework from a blank page. There often exists a wide assortment of software packages, spreadsheets, databases, and manual processes. The inertia caused by the seemingly impossible task of updating these various systems and processes can prevent an organization from making real progress on ERM.

Risk culture is commonly mentioned as an important factor in ERM, but few commentators acknowledge the practical difficulty in altering the existing culture of an insurance company (or any financial institution for that matter). Strong support from the board and senior management is critical to embedding risk in an organization. Senior level commitment involves more than simply stating the importance of risk – it entails the communication of how risk is defined, managed, and mitigated.

Of course actions speak louder than words, so the board and senior management must adopt and encourage risk-aware behavior. Integrating risk into a variety of business practices (e.g.,

product pricing/design, hedging, reinsurance, investing, and management compensation) can reinforce the message.

Firms must measure risk to manage risk

Shortly after management has outlined the strategic objectives, key indicators need to be defined that will allow the evaluation of performance metrics against these goals. These indicators can include profitability, capital adequacy, credit rating, dividend stability, and financial ratios. It should be apparent that the calculation of the performance metrics relates directly to the effective management of the business. While regulatory compliance may require a focus on a 1-in-200-year event (the tail of the distribution), a 1-in-20-year event may be more relevant for business planning purposes.

Regardless of the metrics selected, the ability to produce appropriate performance measures is essential. The challenge facing most insurance companies is that they are not creating an ERM framework from a blank page. There often exists a wide assortment of software packages (often multiple tools performing the same task), spreadsheets, databases, and manual processes – all of which can contribute to ineffective risk management. The inertia caused by the seemingly impossible task of updating these various systems and processes can prevent an organization from making real progress on ERM.

For most insurers, it is not practical to remove the existing technical infrastructure and start over, so pragmatic choices will be necessary. A robust technical infrastructure allows for the integration of various data sources, calculation engines, and reporting and analysis tools. The removal of unnecessary human interaction should be a guiding principal, along with security controls, audit trails, automated workflow, archival, and sign-off capabilities.

The technical infrastructure to support the generation of risk and capital metrics in a timely fashion should be robust, with the ability to accommodate the varied demands of the consumers of risk information. Firms should consider the potential for multiple representations of an insurance business, such as International Financial Reporting Standards (IFRS), Generally Accepted Accounting Principles (GAAP), Market Consistent Embedded Value (MCEV), economic capital, and Solvency II regulatory capital.

Quality of ingredients matter

Everyone readily agrees on the importance of data quality, but it is not clear that the industry has responded to the challenge. The commonly recited adage of "garbage in, garbage out" captures the issue effectively. Given the eventual usage of data to make strategic business decisions and onward planning, it follows that the source data must be of the highest quality possible. It is hard to overstate the importance of using data quality – it is of little consequence that models are highly accurate if the data used is not reliable.

In general, data management involves the automated collection of data from internal and external sources, institutes quality checks, and applies modifications to arrive at a single "golden copy" of data that can be used in all downstream calculations. This single source of data then ensures that consistent information is used by the various calculation engines and establishes with certainty that apples are being compared to apples.

Making it real

There has been a tendency to focus a lot of time and effort on the pursuit of the "perfect" model that produces the most accurate representation of the business. While this may be a worthy endeavor, it introduces potential shortcomings. If the model is too complex, it may not be well understood by management (see Gaussian copula above), or it may not be practical enough to generate a timely result.

This has led to the adoption of stress testing and what-if analysis to supplement the valuation and projection of the balance sheet. Evaluating how the risk or capital will change due to a shift in circumstances is the essence of good risk management. This could involve assessing the impact of different asset allocation strategies, altering the hedge program, comparing different management actions, new business

expectations, and changes in correlations. It is important that stress testing fosters a dialogue about how resilient the business will be on feasible and extreme outcomes.

To make things even more intuitive for senior management and the board, insurers have recently adopted narrative stresses, which aim to map macro-themed events onto the underlying risk factors to show the change in the risk and capital position. For instance, these could replay historical events (e.g., Black Monday), or use economic research to estimate the implication of events that may not occur (e.g., Italy exits the euro).

Not just about technology: embedding ERM

While a robust technical infrastructure and suitable risk management tools are prerequisites to effective ERM, just as important is the institution of good governance, processes, policies, and – above all – senior management sponsorship.

The process of embedding ERM into the daily operations of an organization requires senior management and board support, with a good dose of patience. Culture is not something that will change overnight.

Establishing an effective enterprise risk management framework can be complex and difficult. However, providing a comprehensive and holistic view of the risks facing a business, so that senior management and the board can make more informed and risk-aware decisions, is worth the effort and can be achieved by focusing on the right areas.

1 *COSO, Enterprise Risk Management — Integrated Framework*, September 2004.

THE BENEFITS AND CHALLENGES OF ADOPTING INTERNAL MODELS

By Gavin Conn

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Gavin assists clients in implementing economic capital models, has been heavily involved with Solvency II programs, and is an experienced practitioner in the field of stochastic modeling and its application to both shareholder and regulatory reporting in the UK.

This article provides an overview of how internal models are used to calculate the Solvency Capital Requirement and the advantages and disadvantages of adopting this approach. It also highlights the use test, proxy techniques, and the development of full or partial internal models.

Under Solvency II companies can either use the Standard Formula or, if approved by their supervisor, their firm's own internal model to calculate the Solvency Capital Requirement (SCR). A recent Solvency II readiness survey carried out by Moody's Analytics confirmed that most large insurers in Europe have opted for a partial or full internal model.[1] Even among smaller firms, the survey showed that 30% of the firms who currently use the Standard Formula are planning to upgrade to a partial or full internal model within the next three years.

The benefits of internal models

The survey results suggest that firms are mindful of the benefits of adopting an internal model, as they can use their own risk management structure and their own calibrations for the risk factors. The improvement in risk and capital management, which should be realized from implementing an internal model, is deemed to outweigh the significant effort in building and maintaining one. The internal model route is particularly advantageous for firms that already have an established enterprise risk management (ERM) system in place. For some insurers, adopting the Standard Formula is not a viable option. Using the Standard Formula would not be justifiable or defendable and, in doing so, they would risk a capital add-on (see articles 37 and 119 of the directive). By construction, an internal model should more accurately capture the risk profile of the entity. It also provides an opportunity for firms to take credit for any risk mitigation strategies that they have implemented (on the proviso that these are approved and documented).[2]

The burdens of internal models

A significant burden attached to internal models is the requirement to receive approval from the supervisor. The Solvency II Directive sets out the requirements that must be met, which include standards relating to statistical quality, calibration, validation, and documentation. Furthermore, there is the much talked about use test, which requires firms to demonstrate that their internal model is widely used in the business and plays an important role in the decision-making process. Interestingly, in the Moody's Analytics Solvency II survey, some firms opting for the Standard Formula cited the use test requirement as a barrier to choosing the internal model route.

Developing advanced internal models

The delays to Solvency II have provided additional time for firms to develop more advanced internal models. The core of an internal model is the ability to use an insurer's internal risk management structure and systems, and their own risk models and calibrations to determine the stresses and evaluate the SCR. However, internal models often now go further than that. The previously daunting challenge of producing a full probability distribution for

economic capital is now achievable. Article 121 of the directive covering the statistical quality standards makes specific reference to the probability distribution forecast.[3] Although no calculation method is specified, proxy techniques have been widely adopted. Proxy models (sometimes referred to as lite models) are an approximation to the actuarial cash flow model and techniques used in the industry, and include curve fitting and Least-Squares Monte Carlo (LSMC). Proxy functions provide a means of quickly valuing the assets and liabilities across the entire distribution. Larger firms are implementing a full Monte Carlo simulation-based internal model, making use of proxy models.

Proxy models: evaluating the SCR and beyond

The benefits of the simulation-based internal model extend beyond the primary objective of reading off the 99.5th percentile result to give the SCR – having a full distribution enables more transparent decision-making. Furthermore, proxy models can be used in the day-to-day management of the business, which helps with the fulfillment of the use test. The deferment of Solvency II has given insurers time to assess the quality of both their risk scenario generator, which defines the risk distributions and the quality of fit of the proxy models, and to implement improvements. Insurers still have to contend with the computational demands of running internal models and are looking to identify the optimal approach for a given computational budget. With this in mind, the technique of Least-Squares Monte Carlo (LSMC) is increasing in popularity as it provides a more efficient alternative to curve fitting when determining the proxy functions.

A simulation-based internal model, as described previously, contains numerous elements, including key technical components such as the marginal risk factor models, the proxy functions, and the dependency structure between risk factors. This approach overcomes the limitations of the simplistic "stress and correlate" aggregation approach found in the Standard Formula. In an internal model, the insurer has the scope to choose the form of the dependency structure and to apply company-specific aggregation rules. Under the Monte Carlo approach, this enables the capture of any non-linearity in the business and to more accurately model tail dependency.

Partial internal models

Under a full internal model approach, all risks are evaluated using the firm's economic capital framework. However, not all large European insurers are going for a full internal model – indeed the Moody's Analytics survey suggested an equal split between those going for a full internal model and those applying for a partial model. There are a wide variety of possible approaches to a partial internal model. The model may be "partial" in the sense that the internal model is only adopted for specific risk modules. For example, a Monte Carlo simulation-based approach may only be applied for the market risks with underwriting risks quantified using the Standard Formula stresses.

Alternatively, the "partial" may refer to when the internal model only applies to specified lines of business. The aggregation approach needs to be carefully considered when determining how to integrate the capital requirement for the internal model components with those calculated using the Standard Formula.

> Interestingly, in the Moody's Analytics Solvency II survey, some firms opting for the Standard Formula cited the use test requirement as a barrier to choosing the internal model route.

Internal model approval

Solvency II is scheduled to come into force on January 1, 2016. Companies intending to use an internal model will now be well established in the internal model approval process (IMAP) with their supervisor. The final compromise text of the Omnibus II details a phasing-in approach where supervisors will have the power to approve internal models from April 1, 2015. In the UK, an enhancement to the existing Individual Capital

Assessment, known as ICA+, allows firms to use their Solvency II models as part of the ICA submission, which forms part of the current regulatory regime. Although ICA+ is optional, it provides a practical solution whereby the UK regulator, the Prudential Regulation Authority (PRA), combines their review of the ICA with the IMAP. For those firms opting to go down this route, ICA+ appears to be an essential part of IMAP. The PRA has emphasized the importance of firms keeping to their IMAP submission schedule and have made it clear that they will adopt a robust approach to internal model approval. In his speech on December 12, 2013, Julian Adams, Deputy Head of the PRA, stated that "models must meet the required tests and standards, capture all quantifiable risks, and deliver prudentially sound outcomes in a range of scenarios and over time".[4] The PRA expects firms to have contingency plans in place in case their model is not approved.

The delayed implementation of Solvency II (and to justify the significant costs spent on implementation) does offer the advantage that, when it does go live, insurers should have more advanced internal models that aim to more accurately quantify the risks they face. Another equally important consequence of the delay is that it has given time for a more thorough model validation to be carried out and, crucially, for senior management and the board to become more familiar with their internal models and the benefits which they can bring. With the complexity of creating and implementing internal models, this additional time may prove beneficial to insurance firms working toward meeting these regulations.

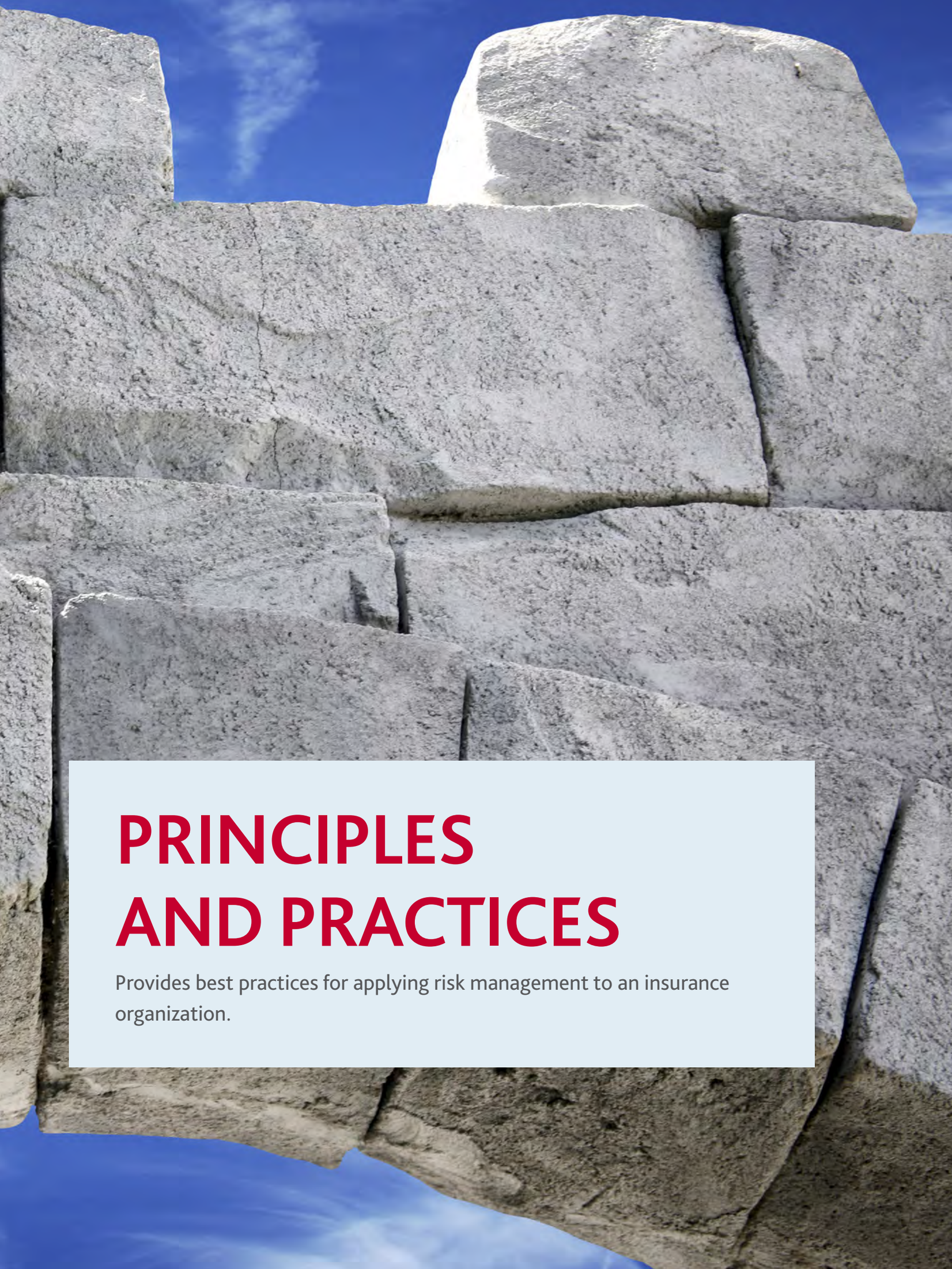
This article has highlighted the benefits and limitations of adopting Solvency II internal models. Although the first priority for many firms is to attain compliance, those firms that fully embrace the proper development of an internal model are more likely to obtain commercial and operational benefits from their investment. The improvement in risk and capital management realized from implementing an internal model seems to outweigh the significant effort in building and maintaining one.

1 Solvency II – A Field of Missed Opportunities, a survey by Moody's Analytics. Of those firms surveyed, 86% of Tier 1 firms have opted for an internal model.

2 Directive of the European Parliament and of the Council on the taking-up and pursuit of the business of Insurance and Reinsurance (SOLVENCY II), February 2008.

3 Directive of the European Parliament and of the Council on the taking-up and pursuit of the business of Insurance and Reinsurance (SOLVENCY II), February 2008.

4 Julian Adams, Deputy Head of the Prudential Regulation Authority and Executive Director of Insurance, PRA Solvency II industry briefing, London, Solvency II – a turning point, December 12, 2013.



PRINCIPLES AND PRACTICES

Provides best practices for applying risk management to an insurance organization.

IMPLEMENTING AN ERM PROGRAM IN THE NORTH AMERICAN LIFE INSURANCE INDUSTRY

By Tony Dardis and Vall Herard

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Life insurers, irrespective of company size or asset and liability profile, continue to invest in successful ERM programs. Within these programs, common themes and best practices are emerging. This article discusses some of these best practices and offers ideas on how life insurers may further fine-tune their programs to add greater value to their organization.

Background and scope

Enterprise Risk Management (ERM), a common practice in the North American life insurance industry over the past 20 years, has evolved significantly. In 2000, an industry panel conducted the first major survey of risk reporting and methodology for the North American insurance industry. Among the panel's findings was an emphasis placed on reporting, including a *Total Company Risk Exposure Report*.

"In addition to improving operational risk reporting, the industry should look forward to seeing future improvements in the preparation of reports which bring together all of the various risk exposures. Only 10 of the 44 survey participants indicate that they prepare a *Total Company Risk Exposure Report*. Although relatively few appear to do this type of analysis, clearly this type of overall picture could be of much interest to top management, and this looks like an area where we would anticipate there being major developments in the years to come." [1]

Since that time, all of the Tier 1 North American institutions – the largest life and property and casualty (P&C) companies – have implemented an enterprise-wide risk management program. Nearly all have a dedicated Chief Risk Officer (or a combined Chief Actuary/Chief Risk Officer role), a role that would have been considered a novelty in the industry 15 years ago. Moreover, the Society of Actuaries, acknowledging the growing importance of risk management among its members, has developed the Certified Enterprise Risk Analyst (CERA) designation. This designation, an internationally recognized credential, may be the first step toward developing a Society of Actuaries Fellowship.

Despite the growing emphasis placed on risk management, methodologies of implementation vary from institution to institution. However, there are common best practices emerging in North America. This article discusses some of these best practices and offers ideas on how life insurers may further fine-tune their programs to add greater value to their organization.

This article also focuses on the life insurance industry and references comparative practices in the P&C industry. Many ERM considerations are global in nature, so we discuss ERM practices outside of North America – particularly in Europe, where the emerging Solvency II regulatory regime has fast-tracked the development of risk reports and analytics by insurance companies.

The ERM Continuous Improvement Cycle

ERM may be thought of as a Continuous Improvement Cycle, comprising seven broad

areas of activity as illustrated in Figure 1:

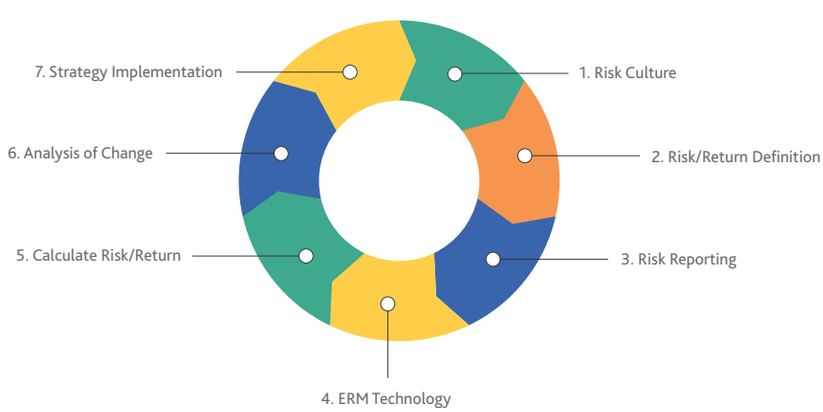
1. Risk culture: Define or redefine risk culture
2. Risk/return definition: Define risk (capital), and return (value), and establish risk appetite
3. Risk reporting: Develop risk reporting requirements
4. ERM technology: Design, build, and implement ERM technology (to meet risk reporting requirements)
5. Calculate risk/return: Perform calculations of risk and return
6. Analysis of change: Analyze risks contributing to capital and the change in capital over time
7. Strategy implementation: Apply results to management decisions (capital allocation, risk management, product strategy, and asset and liability management)

At the end of activity 7, firms re-evaluate their risk culture and the cycle begins again.

The Continuous Improvement Cycle is useful as a framework and contains two activities that can either make or break an ERM program:

» In activity 2: Defining risk/capital and return/value may not accurately reflect how senior management seeks to run its business, which will quickly render the ERM program ineffective

Figure 1 ERM Continuous Improvement Cycle



Source: Moody's Analytics

» In activity 3: The establishment of ERM technology is fraught with pain points. However, there are three main actions that may make a significant difference:

1. Enabling ERM information to be processed and disseminated quickly, so it does not lose its relevance
2. Efficiently handling risk data
3. Eliminating duplication of process

Adopting best practices in these two activities will be critical to a successful ERM program. For that reason, the remainder of this article focuses on these areas.

Definition of risk and return

For an ERM program to obtain corporate-wide buy-in and genuinely add value, it must be built around analysis and metrics that are truly reflective of the company's risk culture. In other words, it must be in line with how senior management wants to run the company. While this practice may seem obvious, it is often not applied.

It should flow naturally from a company's risk culture, stated risk appetite, and definition of risk and return. These steps should form the building blocks on which the ERM program can be built.

Return may be based on statutory or Generally Accepted Accounting Principles (GAAP) earnings, or it may be a more "economic" measure, such as an internally calculated economic value. Similarly, risk may be defined in terms of certain external risk-based metrics, such as statutory or rating agency capital, or again an economic capital measure (i.e.,

an internally assessed risk-based view of the amount of required capital). Having determined these metrics, the insurer can then focus on maximizing value while managing risk to a level reflective of the organization's risk appetite. Ultimately, the determination of these risk-and-return measures comes down to a company-specific, philosophical senior management decision.

For an ERM program to get corporate-wide buy-in and genuinely add value, it must be built around analysis and metrics that are truly reflective of the company's risk culture and philosophy. In other words, it must be in line with how senior management wants to run the company.

In the North American life insurance industry, a lively debate continues about how risk should be defined. In particular, opinions differ on whether or not a life office should take an economic capital approach and how an internal risk-based capital measure should be calculated. In Europe, Solvency II has required companies wishing to use an internal model to become conversant with calculating capital on the basis of shocks to the one-year forward value of the balance sheet. As a result, there has been a natural tendency to use the same "one-year Value at Risk (VaR)" approach when calculating internal risk-based capital. This is in stark contrast to North America, where regulators have focused on evaluating insurers on the basis of what is needed to meet the emerging policyholder liabilities as they become due, which is usually described as a "run-off" approach. Hence, in North America there has been much less of a natural tendency toward the one-year VaR approach for an internal risk-based capital measure.

The picture is also further complicated by the difference between how life and P&C insurers handle the one-year VaR approach. Life companies invariably need to look at the market-consistent values of their balance sheets because of the optionality inherent in their assets and liabilities. Thus, they look at the market to see what the "price" is for such optionality. P&C liabilities generally do not have such optionality, so a one-year VaR calculation for a P&C insurer will typically involve doing stressed one-year roll-forward projections of statutory reserves and comparing them to the market values of assets at that one-year point. Table 1 compares the life versus P&C approaches to economic capital.

This difference in the North American versus European regulatory perspective is reflected in how North American life offices assess capital for internal purposes. A significant number of institutions use a run-off approach for the internal assessment and a large number of medium-sized insurers simply manage statutory capital – which today remains still largely formulaic – without adjustment.

Based on our discussions around the market, Table 2 summarizes the split of economic capital methodologies across the industry.

Table 1 Comparison of life versus P&C approaches to economic capital in the North American insurance industry

Methodology	Life	P&C
One-year VaR	Shocked market-consistent value of assets and liabilities of one-year forward	Shocked market-consistent value of assets compared to statutory reserves for liabilities
Real-world run-off	Present value in the tail of accumulated deficits	Present value in the tail of accumulated deficits

Thus, around 70% of these life insurers take a "stat approach" or "stat-like" (real-world run-off) approach to managing capital. Of the approximately 30% of life insurers that use a one-year VaR approach, the vast majority

are North American subsidiaries of European parents, where the Solvency II approach reigns and is used for reporting group-wide capital. In some instances, the North American subsidiary may be reporting the one-year VaR Solvency II-type number up to the group for consolidation, but locally this number is completely discarded. US statutory capital is used to manage and run the local business. In such cases, companies develop much more robust processes around measuring US statutory capital at the expense of the Solvency II-type number.

Table 2 How the top 50 North American life insurance industry companies (by number of companies) define economic capital

	Stat cap	Real-world run-off	One-year VaR	Total
With European affiliation	2	0	12	14
Without European affiliation	22	12	3	37
Total	24	12	15	51
Percentage of total	47%	24%	29%	100%

Source: Moody's Analytics

While the regulatory precedent certainly contributes to the differences in approach to how capital is defined for internal management purposes, there are other fundamental differences that have a significant impact:

- Historically, life insurers in North America are familiar with a "real-world run-off" approach, having used it for many years for traditional asset and liability management.
- The market-consistent approach to valuation used prior to the 2008 crash has been criticized, particularly regarding how it could lead to highly volatile reserve/capital valuations. The fact that US insurance companies were not regulated on a "mark-to-market" basis when the crisis hit and the industry as a whole performed well on a solvency basis was highlighted by US regulators as a victory for the US framework. These issues were indeed acknowledged by the European regulators and led to the refining of the Solvency II calculations.
- Many life insurers in North America genuinely manage their assets and liabilities on a buy-and-hold basis and both sides of the balance sheet are expected to be on the books for an extremely long period of time. What sense does it make to hold capital that is reflective of an immediate (or at least one-year forward) liquidation of the assets and liabilities?
- There are measurement difficulties with both approaches, but the market-consistent approach raises a very fundamental problem – putting a market value on liabilities where there is no deep and liquid market. Simply put, the overwhelming majority of insurance liabilities are not "marked-to-market" and companies are managed accordingly.
- Many life and annuity writers in the US write what are exclusively "spread products," such as vanilla fixed deferred annuities and universal life products. On a market consistent basis, these products will have no added value and are therefore impossible to justify writing new business on using a market-consistent valuation approach.

The importance of establishing risk and return measures that are genuinely reflective of how a life office runs its business cannot be highlighted enough. The exercise is not necessarily a straightforward one, however, and the discussion about how to define capital for internal management purposes is a case in point.

Establishment of ERM technology

Technology and data is ever changing, which is made especially complex in the context of an established life insurance company. A life insurer may have old policies on its books with inception dates decades in the past and legacy systems issues where the cost to extract, transform, and load (ETL process)

to a new system is deemed to outweigh the benefits. Moreover, whenever the technology improves, there is another set of actuarial and risk reports that become de rigueur and usually involve processing requirements that are multiples more demanding than the predecessor analytics. And while all life insurers have processing issues to contend with, certain types of companies deal with particularly onerous requirements. For example, reinsurers can receive data from ceding companies in an incomplete state. A guaranteed living benefits writer is another example, where it is challenging to avoid policy-by-policy processing for virtually any actuarial projection.

Ultimately, the technology issue may be distilled to three main challenges that need to be addressed in a logical and streamlined way:

1. Speed: How quickly can ERM information be made available
2. Data: How to obtain clean, efficiently stored, and accurate data that may be readily analyzed historically
3. Process duplication: How to be efficient with technology processes and how to avoid duplication of processes

Speed

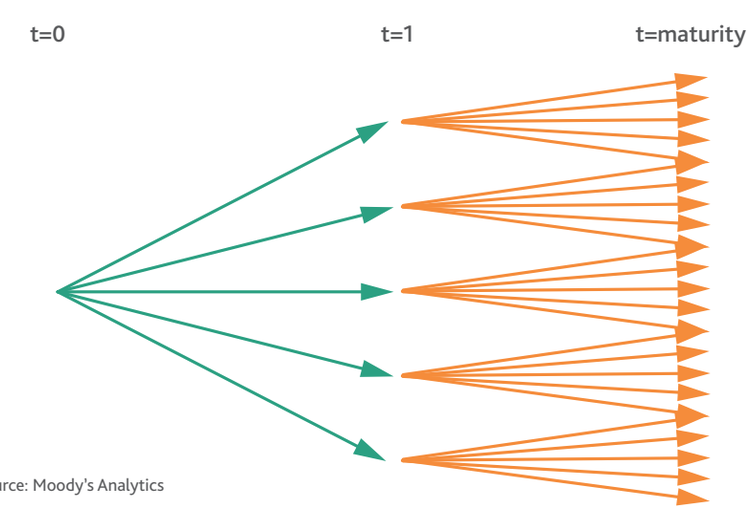
Many of the required computations for ERM can be extremely onerous calculations in terms of processing requirements. In many instances, these computations may simply be impossible using current hardware and software technology.

Solvency II's one-year VaR economic capital calculation for companies adopting an internal model is a case in point. The full version of this calculation involves a complete set of one-year forward real-world scenarios (say 1,000 scenarios). In addition, at each one-year forward point, insurers need to generate a full set of market-consistent scenarios to compute the market-consistent values of assets and liabilities (say another 1,000 scenarios at each one-year point). This "nested stochastic" calculation is illustrated in Figure 2. Firms are potentially looking at processing one million scenarios (1,000 outer x 1,000 inner scenarios). And if insurers want to do this across a large corporation with many complex lines of business potentially on a global basis, they are looking at an extremely burdensome calculation in terms of processing demands.

Moreover, the above complex calculation covers one-year VaR capital at just a single point in time. By projecting capital at multiple time steps (annually over a three to five year period and possibly across six to seven stress scenarios), insurers will eventually reach a point where processing is simply impossible.

This naturally leads to the usage of approximation techniques. Again, similar to the economic capital debate, the experience

Figure 2 Complex nested stochastic one-year VaR computation



Source: Moody's Analytics

has been different in North America versus the rest of the world – especially when compared to Europe, where the Solvency II requirements have sent life insurers down a particular path.

"Proxy modeling" has been commonly used in Europe, particularly in the context of internal models for Solvency II, where the nature of a nested stochastic market-consistent one-year projected real-world calculation necessitates some type of approximation technique, even for a point-in-time calculation. The projection of such a metric required for the Own Risks Solvency Assessment (ORSA) under Solvency II only compounds the issue. There are a number of ways in which a "proxy model" can be constructed. The aim of proxy modeling is to fit a function to a block of liabilities, and then use that function to put a value on the liabilities, rather than performing a full-blown computation on the actuarial projection platform. The technique is flexible enough to also fit assets. As such, the full actuarial ALM calculation can be consistently proxied to a high degree of accuracy.

Of the largest European insurers who have developed an internal model to meet Solvency II – adopting what is referred to as an "Advanced Approach" – all are using some form of proxy function methodology to speed up the revaluation. In order to facilitate aggregation and analysis of the calculated risk and capital metrics, companies will typically produce proxy functions along product lines, business lines, different geographical entities, or any other dimensions along which they want to view risk and capital. For example, we are aware of one large European corporation using up to 1000 functions (300 liabilities and 700 assets) along different product lines and geographical entities within the insurance group.

In North America, the need for approximation techniques is less pressing. First, the reserve and capital calculations required to meet both the US and Canadian statutory regulations are not as complex as the Solvency II internal model calculation. In the US, for example, the two lines of business where stochastic modeling is currently required – variable annuities and universal life with guarantees – need only a single set of real-world stochastic paths, not a nested calculation. Moreover, under the current regulation, a formulaic approach or deterministic calculation is used for all other business. Thus, the point-in-time calculation for capital under the North American regulations necessitates a "brute force" calculation, and any type of proxy approach is neither appropriate nor necessary. Second, as discussed earlier, the majority of life offices in North America use a statutory approach or a stat-like approach to internal risk-based capital, unless they have European affiliates. Finally, for purposes of projecting capital for the US and Canadian ORSAs, the statutory guidelines are, at least presently, laissez-faire, which is quite unusual in particular for the US regulators. There is strong empirical evidence suggesting that, at least for the first round of ORSA submissions in North America, very approximate techniques will be used for the capital projection (e.g., prorating capital by projected run-off of policies by number and size).

There are also other factors evident in North America that have hampered the wider use of proxy models to date: the use of replicating portfolios and the explanation of proxy models.

Use of replicating portfolios

A number of Tier 1 companies used a replicating portfolio (RP) approach a few years ago when the technique gained some initial popularity – again, primarily in Europe – as a way to avoid huge liability processing run times. Under RP, the objective is to establish a portfolio of assets that "replicate" the liabilities. It is the replicating portfolio of assets that is then used for valuation of the liabilities. The success of the method relies on the assumption that there is a portfolio of assets available in the market that replicates the behavior of the liabilities, but yet is simpler to value than the liability portfolio. In practice, this was very difficult to achieve, especially in the tails of distributions. This is where insurers are most interested for capital calculations. As a result, RP has fallen out of favor with practitioners. This in turn has created a presentational barrier for proponents of proxy modeling, as there has tended to be an initial perception at the senior management level that proxy modeling is just

another form of replicating portfolio "trickery" or "actuarial dark arts."

Explanation of proxy models

Another aspect affecting the adoption of proxy models is – because of the newness of the technique and the seeming complexity of the resulting functions – it is not always easy to explain it to senior management. There is no doubt that it is a skill to adeptly present to senior management about what a proxy model is and why it works. Although the math can be set up to avoid "overfitting" a function, some proxy functions can still be incredibly complex. Fitting to a multi-dimensional risk factor space and having to explain the resulting higher order polynomials to senior management can be a daunting task. This presentational issue is an obstacle that has not yet been 100% successfully overcome from what we have seen in the North American life industry.

Due to these regulatory and business drivers, the adoption of proxy functions in North America is in its infancy. That said, there certainly have been life companies in the US and Canada that have successfully implemented proxy modeling approaches. This looks like a growth area in the next few years, especially in the context of ORSA, as companies move from the formality of preparing and submitting the initial reports to potentially using more sophisticated methods for projection. For example, using their ORSA reports as a truly effective way to help manage and get value out of their business. Another area where proxy modeling is compelling is around hedge effectiveness testing, which is another form of a nested calculation with many stochastically generated real-world scenarios that may require multiple nested market-consistent simulations to calculate the Greeks at future points in time.

As a parallel development, there is interesting testing work occurring in the market that looks at emerging state-of-the-art hardware and software with a view to continue to do "brute force" calculations, yet using the best technology to run it as fast as possible. In particular, some life offices in North America have invested resources in developing test data and code to run on Graphics Processing Unit (GPU) based platforms. There is greater adoption of cloud-based computing in order to overcome some of the run-time issues that companies face. These developments hold tremendous promise, and could genuinely revolutionize how life insurers perform their valuations.

While cloud-based and GPU-based platforms hold great promise, there remain several stumbling blocks that firms need to overcome before there is genuine progress, including cost, legacy systems from acquisitions, and system updates.

Cost

There will be a short-term cost of developing a new platform using this technology. Thus, it will be tough for companies and vendors of existing platforms to make a financial decision to go down this road and essentially abandon its current platform – risking the loss of business. From an insurer's perspective, it is a difficult decision as it could entail a lengthy transition from an old to a new system.

Legacy systems from acquisitions

When new blocks of business are purchased, insurers will have to contend with legacy system issues. How can they then transition from the acquired company's system? Whenever this question comes up, the answer is often to leave the acquired block on the legacy system. And if a company achieves growth through acquisition, it is not uncommon to see them use multiple systems. In one instance, because of growth through acquisition, there was a large company that had every actuarial system that was commercially built in the last 25+ years.

System updates

Insurers testing the new GPU technology have been concerned that it is difficult to update the system with the introduction of a new product or product feature.

Data

Good data management seems almost too obvious to be part of a best practice process.

When implemented, however, it is often seen as a pitfall of an ERM program and can quickly render a program valueless.

There are three key aspects to risk data management: obtaining clean and accurate data, efficiently storing data, and performing historical trend analysis.

Getting data that is clean and accurate

Insurers should seek to get the data accurate as close to the original source as possible. This issue is one that insurers have done a great job of addressing in recent years, with many of the problems of manual entry for loading up new business greatly minimized. However, this still remains an issue for many companies, in particular reinsurers, where often data is arriving second hand.

Many insurers are building intelligent data platforms, in which risk data is run through multiple checkpoints, and intelligent routines to clean up data where there are obvious errors.

Efficient storage of data

Data storage is expensive and careful planning needs to be done to establish what information is genuinely needed and for what purpose.

Efficient data storage also means storing data in a way so that it can be easily accessed.

Ease of historical data analysis

A key requirement of ERM is the ability to perform historical trend analysis. Also, an analysis of change over time is a great check on the calculations and a useful indicator of what is contributing to risk and return.

The requirements will also involve being able to analyze data accordingly.

Process duplication

While speed of managing, processing, and disseminating information is critical to an ERM program, it may sometimes be difficult to quantify the cost-benefits of investing in data and speed. Therefore, it is difficult to establish the direct impact they will have on the bottom line. It is much easier to sell the benefit of cutting costs by eliminating duplicative processes.

Process duplication can be evident in many parts of the ERM process

With the duplication of underlying in-force data and product data for different applications, for instance, there may be one system doing asset and liability management and another system for ERM. Yet, essentially the same underlying in-force and product data will be needed for both.

Alternatively, consider the duplication of assumptions setting (i.e., multiple individuals in different areas looking at setting the same targets and assumptions). An example of this may be the setting of targets for economic scenario generation – there could be multiple individuals setting the same target depending on their department.

Having a common centralized platform and assumptions setting area avoids the diseconomies of scale and potential errors of having many people around the firm doing the same thing. It is not uncommon for an insurance company to have two or more systems that require duplication of effort in creating actuarial extract files.

Thus, a best practice process has a single platform for all the company's data, which flows through from administration – new business – to accounting and actuarial, as well as to investment and risk management. In practice, however, all these requirements are typically handled by different data platforms and applications. Even within each broad area, there may be vast numbers of databases in use and software applications. For example, consider a global ERM program for a large insurer; there may be many actuarial projection systems in use across the organization, perhaps different systems by territory and by product. Also, data may be collected in different places and handled in different ways (e.g., market risk versus credit risk versus operational risk).

Best practices for managing speed, data, and process duplication challenges

An integrated ERM platform, as depicted in Figure 3, represents a best practice approach to

1 Stephen Britt, Anthony Dardis, Mary Gilkison, Francois R Morin & Mary M Wilson, *Risk Position Reporting*, Society of Actuaries, special publication, October 2001.

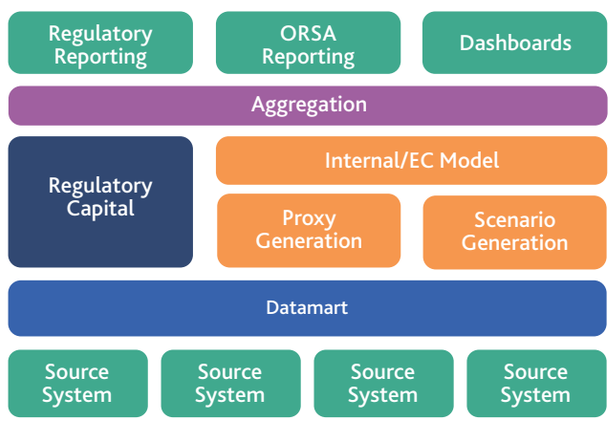
managing many of the speed, data, and process duplication challenges faced by insurance companies. Such a platform should be modular and flexible enough to readily permit the integration of potentially many different data sources and projection capabilities.

This platform affords an insurance company the ability to use a common datamart to normalize data across the entire organization and run a deep set of analytics on clean and accurate data.

Insurers can best extract value from their ERM program investment by defining risk and return in a way that genuinely reflects senior management objectives and by establishing ERM technology that focuses on three main challenges – the speed at which ERM information is processed and disseminated, the efficient handling of risk data, and the elimination of process duplication.

Insurers that embrace a Continuous Improvement Cycle and establish an ERM process that is built on a best practice foundation will unlock value creation across their organization – helping them overcome many of the speed, data, and process duplication challenges common in insurance ERM today.

Figure 3 Integrated ERM platform architecture



Source: Moody's Analytics

NEW INVESTMENT STRATEGIES IN INSURANCE

By Dr. Jamie Stark

This article investigates some of the challenges faced by insurers when choosing new investment strategies to increase their yields.

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Jamie has worked with insurers and banks all over the world, assisting them with their risk system implementations, risk modeling, calibration, and a variety of other challenging risk management projects.

Fixed income has long been an attractive asset class for insurance companies – they provide predictable cash flows that can be easily used to match expected liability cash flows. In the current low rate environment, however, the returns may be too small to enable insurers to meet minimum guaranteed returns. So many insurers are now increasingly looking to take on additional credit risk to increase their yields.

Why credit risk?

Of course, investing in credit risk is not something new – most insurers are active in the corporate bond market. In fact, you could argue that credit risk is at the heart of many fixed-type payment products, such as the multi-billion pound UK annuity market. There, insurers have traditionally matched the relatively predictable cash flows of annuities with a diverse portfolio of corporate bonds. As they are able to plan when the cash flows are needed, they do not need liquidity; and so, they can buy and hold these assets until maturity. Traditionally, the higher yield on corporate bonds has been partly shared with the customers, providing a win-win situation.

One of the reasons for the delay in Solvency II was the increased lobbying on behalf of the industry to ensure that this business model was not penalized. As Solvency II is built on the mark-to-market principles of market consistency and calculates capital on a one-year horizon, many insurers using this business model found they were penalized under the initial drafts. The results of this lobbying was the introduction of the Matching Adjustment, which provides capital relief for insurers managing a pool of credit risky assets that match fixed liability type products. Some observers, including the regulators themselves, believe that insurers will start to offer products that take advantage of the capital relief offered for the held-to-maturity backing of liabilities.

The current low interest rate environment, coupled with a favorable treatment under Solvency II, has led many insurers to revisit their asset allocation strategy in favor of credit risk. However, outside the US, bond markets are still dominated by financial institutions and very large corporates. So insurers have started looking elsewhere, including direct lending to corporates and financing long-term infrastructure projects. These asset classes require a long-term commitment of capital and are, by their very nature, even more illiquid than corporate bonds. At the right price, these are perfect investments for insurers, but rather costly for banks – who have been forced to reconsider their liquidity requirements following the events of the past few years and under Basel III.

This is not new – a similar process is already happening in economies where there are thinly traded bond markets, such as South Africa. There, the leading insurers all actively take part in direct lending throughout the region. Also, the largest insurers in the UK had negotiated favorable maturity dates with firms issuing bonds to ensure they could be used to best match their liabilities. While a move to these new asset classes makes sense, it comes with a set of challenges that

any insurer will need to overcome in order to effectively manage the risks.

Organization

Lending directly to companies and projects is very different than buying a bond over the counter. Organization is the first challenge an insurer will face when deciding to move into these new asset classes. This new organization will need to be able to do the following:

- **Search and compete for deals in a competitive market place.** This is neither easy nor inexpensive – it relies on strong networks, competent sales people, and it is time intensive to create these deals.
- **Originating deals requires an assessment of risks.** This entails setting up origination processes and governance. It requires that insurers process documents, assess applications, challenge assumptions, and record their decisions.
- **Ensuring the terms of a deal match the needs of the insurer.** For example, infrastructure loans are typically on a floating basis to match the needs of banks, but insurers would prefer a fixed rate to better match their liability profile.
- **Work is not finished once the deal is done.** Any lender will need to implement processes for dealing with loans that borrowers have problems paying. Can the deal be restructured to reduce the risk of full default? In the event of default, are there collateral, guarantees, or other assets that can be sold to reduce the loss and what are the processes required for managing this?

In addition, an insurer needs to be able to measure and manage risk. The better it can do this, the more it will be able to maximize its returns for a given risk appetite. The main risk management challenges are the measurement of default risk and measuring and then managing portfolio risk, which are covered next.

Measuring default risk

What is the probability that the borrower will repay the loan? This is the fundamental credit risk question. Currently, many insurers have outsourced this question to the rating agencies. To assess the bond markets, firms need the opinion of an expert and independent third party who will provide an opinion on the credit worthiness of a bond or issuer. These ratings have become so ingrained in the way the bond markets work that they appear directly in regulation.

For non-traded credit risk, there will be no rating to use, leaving insurers with the challenge of making their own assessments. Credit assessment has long been at the heart of corporate banking and Basel II allows banks to use an internal model to assess the probability of default. So there are a wealth of models and methods available for insurers to use.

For publicly traded companies, it is possible to use a Merton-type model to assess the probability of default from public information (e.g., book value of liabilities and market price).

A standard technique for assessing private companies is to use an econometric model that forecasts probability of default based on the past financial performance of the company. More sophisticated models incorporate additional information about the credit cycle into their assessment to take into account the fact the financial statements can quickly become stale. These models focus on financial ratios and are very similar to the fundamental analysis techniques long practiced by lenders, rating agencies, and equity analysts to understand company performance.

Banks will overlay a qualitative assessment on top of these purely quantitative models, allowing them to capture an assessment about the management, company prospects, and any other information they think are relevant. This qualitative overlay is typically built up from an internal knowledge of how to assess risk. This is similar to the manner in which the ratings agencies work. Over the past few years they have shared scorecards to help the market understand what makes up their ratings.

Assessing the credit risk of infrastructure and other project finance related lending is harder – these are typically special purpose vehicles set up for a given project and will

have no historic performance to use to predict performance. The standard technique is to assess the project cash flows under a number of scenarios. As you would expect, there is a spectrum of modeling approaches. At the more complex end, simulations can be used to assess potential cash flow scenarios; and at the simple end, a scorecard can be used to capture the assessment.

Gathering all the relevant data to build and calibrate their internal models has been a significant challenge faced by the banks. As defaults are typically rare events, it has taken many years and large portfolios for banks to have enough data to build reliable models. Many banks continue to rely on vendor data to help them build, calibrate, and validate their internal models.

Measuring and managing portfolio risk

Measuring default risk allows lenders to think about the standalone risk of a given asset. However, assets are held together in a portfolio. Modern portfolio theory can also be applied to credit assets. The challenge with any portfolio model is to understand the correlation between assets. For credit assets, this is the pairwise default dependency between different assets. Using a granular correlation model allows risk managers to quantify concentration/diversification.

An effective tool uses a granular correlation model to simulate joint credit events that capture the fat tails and asymmetrical loss distributions seen in credit portfolios. These loss distributions can be used directly within insurers' Solvency II internal models, allowing them to capture concentration risk/diversification benefits directly.

In addition to these new asset classes, all credit risk can be measured in the same way, including in government bonds and in concentrations understood and managed.

Banks use credit portfolios management tools to help them to not only understand the risk in their banking booking, but also to better manage their capital resources. Banks will use their portfolio models to set limits, price loans, and understand the risk-adjusted returns on their capital for new deals.

In summary, insurers need to carefully consider many things before increasing their exposure to this new asset class. Given the specter of an extended low-rate environment and what appears to be encouragement from the regulators, we expect this trend to continue.

Of course, there will be other ways that insurers can get involved without necessarily setting up a lending operation. One obvious change could be that as demand increases, corporates could start to issue more bonds. Another possibility would be for insurers and banks to work more closely together, either directly or via market makers. Here, the banks would originate the debt, but pass the risk on to the insurer, with the bank getting paid for its relationship and client management and the insurer paid for the liquidity they can bring. However, similar risk management structures have not been without their issues.

We continue to watch these developments with interest, but one thing is for sure – insurers interested in this asset class need to do more to build up their credit risk modeling expertise and models.

ARBITRAGE-FREE SCENARIOS FOR SOLVENCY II

By Dr. Juan Licari and Dr. José Suárez-Lledó

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This article discusses a macroeconomic forecasting model that is able to generate arbitrage-free scenarios. Even though these types of scenarios are relevant for all practitioners, insurance companies are specifically required to apply arbitrage-free scenarios in the context of real-world economic forecasting.

The process of calculating risk metrics in line with requirements for insurance companies may start with the development of macroeconomic scenarios that are consistent with the building blocks in the calculation of those risk metrics. In particular, consider macroeconomic scenarios that embed the arbitrage-free assumption. This covers the estimation of a macroeconomic Dynamic Stochastic General Equilibrium (DSGE) model built upon the economic theory of agents' decisions and responses to shocks. This article also describes how the model can be used to generate a range of internally consistent scenarios for stress testing purposes. For insurers, stress testing is essential for business planning and assessing capital coverage over a five-year period, as well as being a key component of the ORSA for Solvency II.

This article analyzes a New Keynesian model estimated with Bayesian techniques on seven key macroeconomic US time series as observable variables:

- Real GDP (quarterly growth rate)
- Real consumption (quarter-over-quarter growth)
- Real investment (quarter-over-quarter growth)
- Real wage (quarter-over-quarter growth)
- Log hours worked
- GDP deflator (quarter-over-quarter growth)
- Federal fund rate.

The scenarios around these variables can then be used as an input in the standard Economic Scenario Generator (ESG) engines that most insurance companies use.

The model is based on work by Christiano, Eichenbaum, and Evans (2005), who added various forms of frictions to a basic New Keynesian DSGE model in order to capture the dynamic response to a monetary policy shock, as measured by a structural vector auto-regression (VAR). The dynamics of the system are determined by a number of equations describing the relationships between real variables, the behavior of prices, and the exogenous processes.

Among these relationships, two in particular focus on the arbitrage question: pricing equations (Euler optimality equations) and market clearing conditions. Pricing equations in these models are derived from a set of conditions that ensure that there are no arbitrage opportunities when making investment decisions.

An example is the asset pricing equation for capital that precludes arbitrage (as a function of the real risk-free rate of the economy, expected inflation, and expected return on capital):

- Real risk-free rate = r_t
- Equilibrium risk-free rate = R_*
- Expected inflation = $E_t\, \pi_{t+1}$
- Expected return on capital = $E_t\, q_{t+1}$

The q_t in these models is just a proxy for a wide notion of capital in the economy and usually refers broadly to a range of investment assets, such as stock, bonds, or a firm's capital.

$$q_t = f(R_*)E_t q_{t+1} + \big(1 - f(R_*)\big)E_t r_{t+1}^k - (r_t - E_t \pi_{t+1} + \varepsilon_t^b)$$

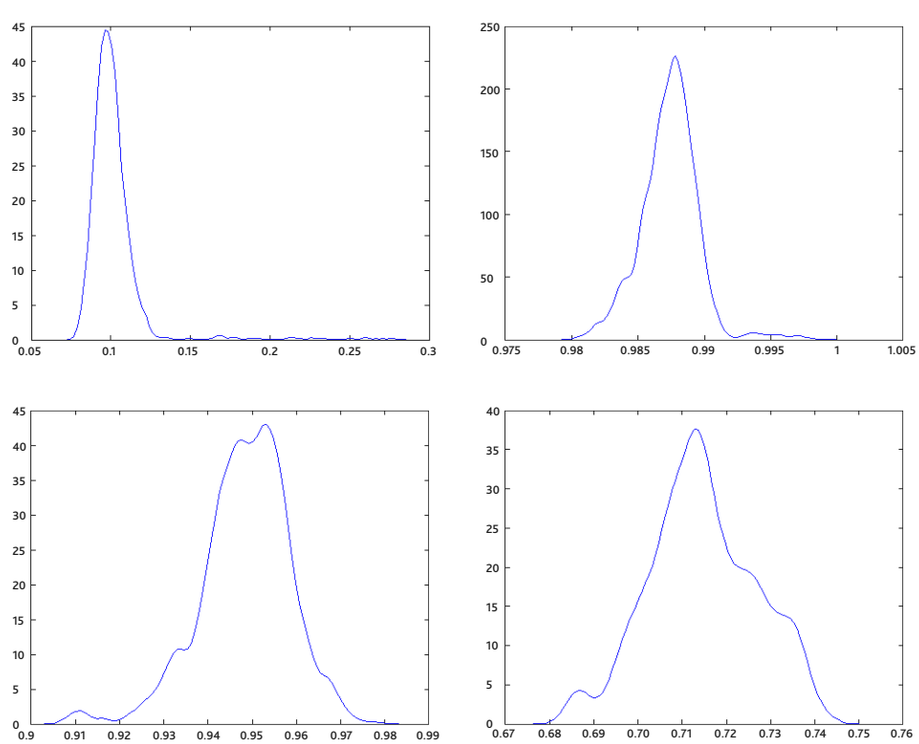
Standard economic scenario generation engines are based on simulations from the models that depict different paths for the variables, with random draws from the forecasting errors distribution. In a Bayesian world, however, there is another type of simulation that can be drawn from another set of distributions. Part of the estimation process consists of calculating a different class of uncertainty (parameter uncertainty), which is expressed in terms of posterior distributions for the parameters of the model. These distributions are computed by recording the iterative search over sets of parameters that take place when calculating the likelihood function. This analysis only reproduces the posterior distributions of a few relevant parameters: monetary policy reaction to GDP deviation from potential, discount rate, total factor productivity shock, and risk premium.

Obtaining forecasts

Models – in other words, the systems of equations that describe the behavior of a given economy – depend on parameters. That is, they are linked to the uncertainty around the true values of those parameters. There is a measure for that uncertainty because there is a (posterior) distribution for each parameter. Therefore, a baseline projection with a DSGE model can be obtained using different points of the distribution of parameters (e.g., mode, mean, and median). Depending on the point used, different forecasts are obtained.

It is worth mentioning that the model's equations reflect the General Equilibrium structure where the decisions of agents and their

Figure 1 Posterior distributions of parameters



Source: Moody's Analytics

Figure 2 US GDP projections (year-over-year growth rate)

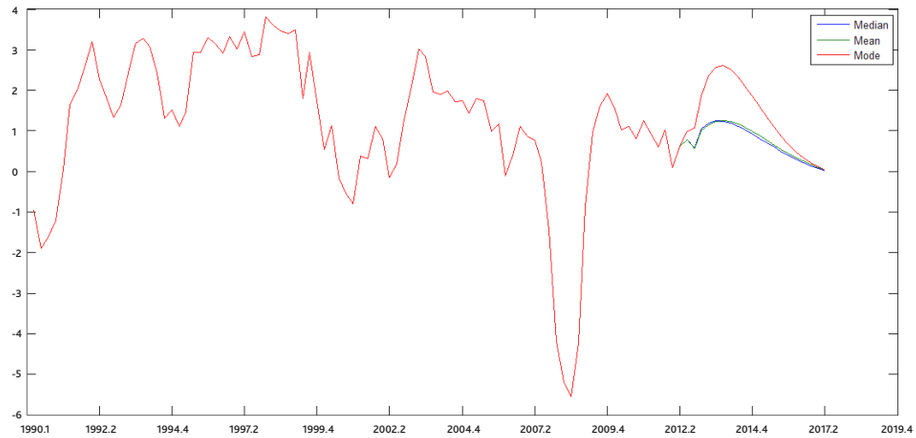


Figure 3 Real wages growth rate

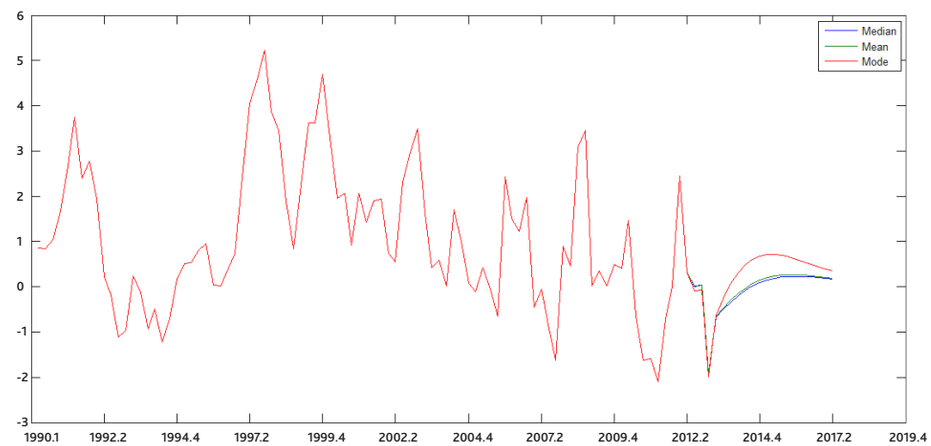
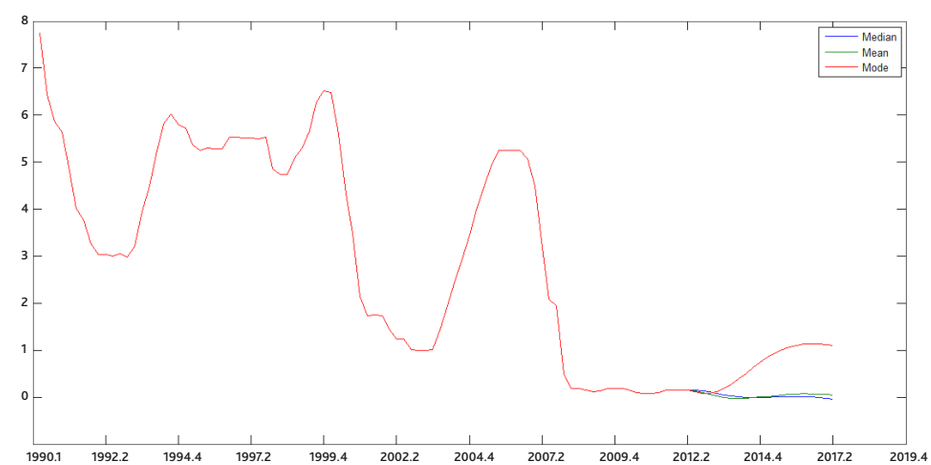


Figure 4 Fed funds rate



Source: Moody's Analytics

reactions to shocks are all tied up together to make those actions consistent with economic theory and with data (up to parameter estimation). Such consistency translates into the dynamic paths of each variable being consistent with each other. Thus, the path for GDP growth using the mode of the distributions of parameters will be consistent with growth in real wages, inflation, or interest rates.

Scenario generation

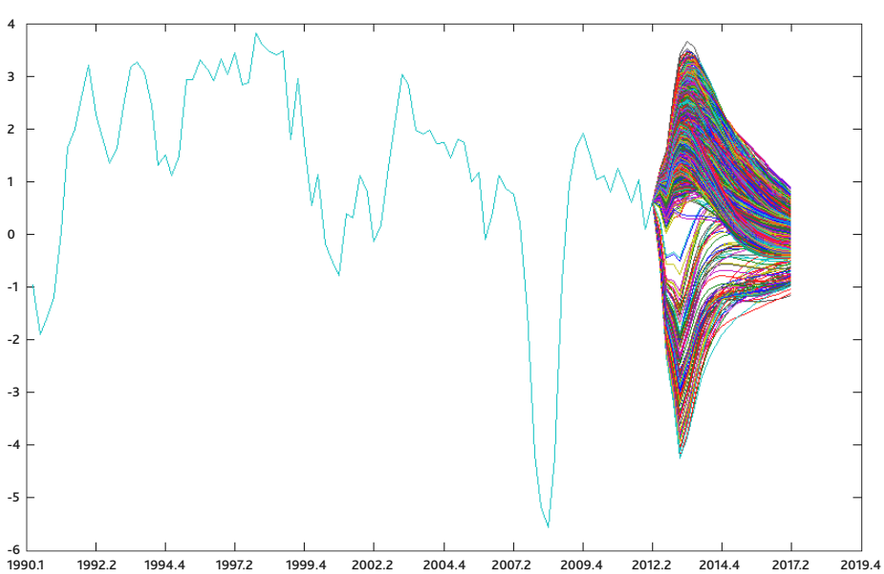
The next logical step would be to use the entire distributions of parameters to construct a more complete spectrum of simulations. The construction of the distributions of the model's parameters was coded in MATLAB and the algorithm produced a sample of 10,000 draws of sets of 26 parameters. Yet, consider the most complete exercise, which would also include the uncertainty coming from the forecasting errors. Such an exercise would involve incorporating simulations from the distribution of forecasting errors into each of the simulated paths for the observable variables (obtained from simulations on the parameters' distributions). To keep things simple, however, only the first 2,000 simulations from parameter uncertainty are shown here.[1]

Figure 6 illustrates the GDP shock distributions on the different forecast periods. In this particular set of draws, and since the last point in history near 1% GDP growth rate, a majority of simulations fall within the positive range. Most of the histograms at the different forecast periods present a higher concentration of positive GDP growth rates. However, a considerable number of simulations in each period also exhibit negative growth rates.

As can be seen in Figure 7, the interest rates consistent with those simulations of a stronger GDP growth would reach up to 2.5% in less than three years. On the other hand, negative GDP growth rates go with zero, or very close to zero, interest rates. Interestingly, even though some of the simulated recessions would be of similar magnitude to the 2008 crisis, this model only features moderate deflation rates for some periods.

This article has examined a macroeconomic forecasting model that is capable of generating arbitrage-free scenarios. Even though these types of scenarios are relevant for all practitioners, insurance companies are specifically required to apply scenarios that are

Figure 5 Scenarios from simulations on the GDP growth rate



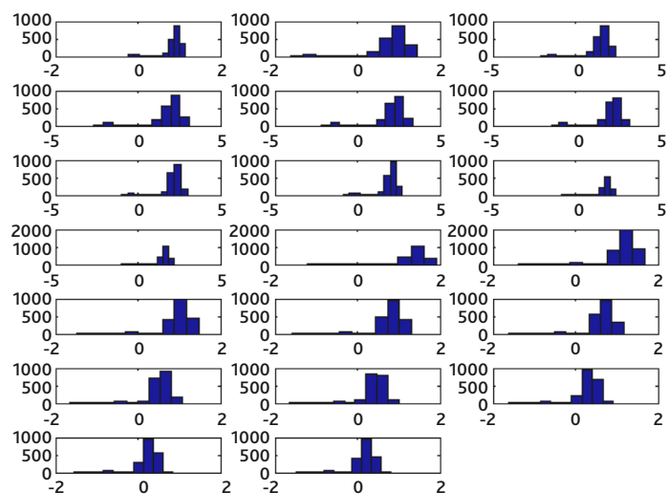
Source: Moody's Analytics

consistent with the arbitrage-free assumption.

Many insurers normally just take the path for a couple of macroeconomic variables to use as an input into their ESG. Their ESGs are typically calibrated so that, for instance, interest rates curves (and other risk metrics of interest) are generated with the arbitrage-free assumption embedded in them. However, in the previous step, those paths for macroeconomic drivers may not necessarily respect the non-arbitrage assumption, which may make the whole process slightly flawed.

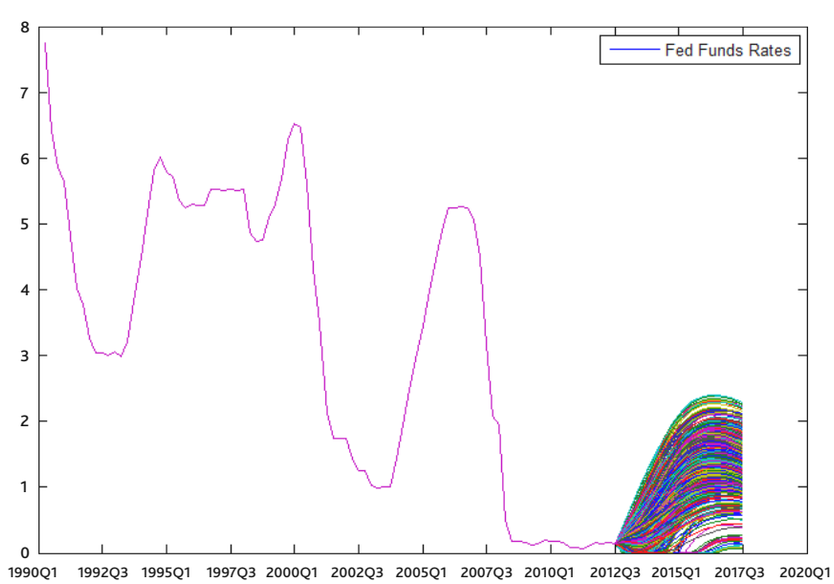
Scenarios are generated from simulations that add another layer of uncertainty by considering parameter uncertainty on top of forecasting errors. This scenario generation process is able to produce scenarios that go beyond the borders of what was observed in history while ensuring internally consistent paths across variables.

Figure 6 GDP growth simulation histogram: 2013:2-2017:2



Source: Moody's Analytics

Figure 7 Scenarios from simulations on the federal funds rate



Source: Moody's Analytics

Figure 8 Scenarios from simulations on the inflation rate, over a five-year projection

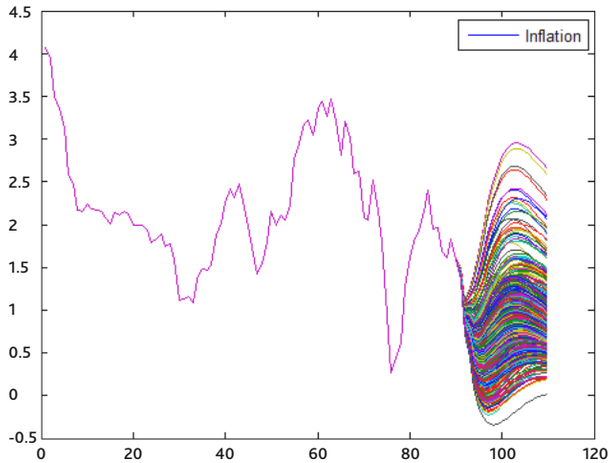
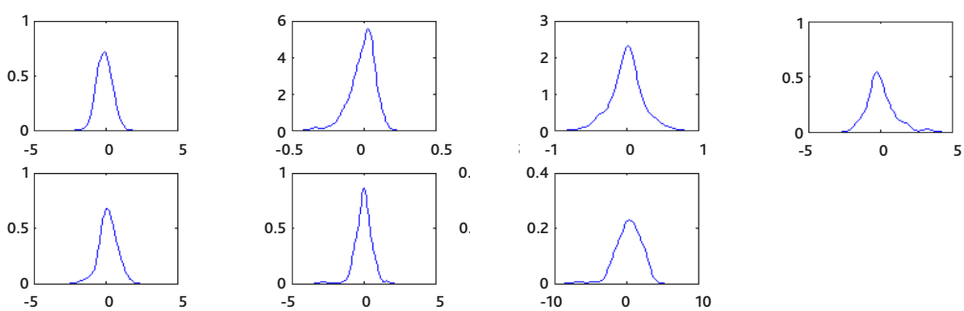


Figure 9 Forecasting errors distributions for the seven observable equations (standard deviations)



Source: Moody's Analytics

1 Convergence in the likelihood function is achieved within the first 2,000-3,000 simulations. Therefore, the first 2,000 simulations are a good approximation of such parameter uncertainty.

EFFICIENT ASSET ALLOCATION WITH LEAST-SQUARES MONTE CARLO

By Alexis Bailly and Romain Lombardo

Alexis Bailly
Director, Insurance Specialist

Alexis is responsible for the advancement of Moody's Analytics insurance activities in EMEA. He contributes to the development of Moody's Analytics Solvency II client propositions, particularly in internal models and ORSA.

Romain Lombardo
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Romain helps insurers model their financial risks and understand EIOPA transitory guidelines. He specializes in complex risk modeling and calibration, Solvency II internal models, economic capital, and ORSA challenges.

This article reviews the analysis of an asset optimization problem where risk is defined by the capital required under Solvency II principles, and where the portfolio performance is defined by the net asset value at time T=1.

Over the past decades, traditional asset allocation methodologies such as mean-variance optimization have been widely applied in the insurance industry. The benefits of such approaches for insurance portfolios have always been limited, due first to the complex interactions between assets and liabilities and second to the estimation difficulties and inappropriateness of asset portfolio returns and variances as target measures for portfolio optimization.

This paper analyzes an asset optimization problem where risk is defined by the capital required under Solvency II principles, and where the portfolio performance is defined by the net asset value (NAV) at time T=1. To overcome the technical challenges of relating the assessment of such measures in a market-consistent environment, the Least-Squares Monte Carlo (LSMC) approach as implemented in the B&H Proxy Generator was used.

The first section presents how firms can use LSMC techniques to generate allocation dependent proxy functions for the market-consistent value of asset and liabilities at both T=0 and T=1.

The second section builds on the concept to illustrate how firms can use these proxy functions to define an efficient asset allocation.

Presentation of the case study

By way of illustration, this article considers a book of with-profit insurance products with minimum guaranteed returns.

The initial asset allocation vector (sovereign bonds, corporate bonds, equity, property, etc.) is defined by A_{init}= (50%, 20%, 20%, 10%).

The initial position of the balance sheet at T=0 is provided in Table 1.

Table 1 Balance sheet for allocation A_{INIT} at T=0

Balance sheet (€)	T=0
Assets	110,000
Liabilities	-99,486
NAV	10,514

The best estimate value of the liabilities has been calculated using 5,000 simulations generated from the B&H Economic Scenario Generator.

Four different classes define the investment universe:

- 10-year government bonds
- 7-year BBB corporate bonds
- The DJ Eurostoxx50 equity index
- Pan-European property index

In addition, it is assumed that the asset portfolio is rebalanced every year to the starting asset allocation.

A change in asset allocation will not impact the value of Assets at T=0, but will impact the value of the liabilities at T=0, and hence the NAV at T=0 through the impact on the cost of options and guarantees underlying the product.

A change in the initial asset allocation will also impact future balance sheet positions due to the following dynamics:

- Changes in returns on invested assets will impact the total value of assets and the value of the liabilities following the impact on allocated bonuses.
- Rebalancing rules applied to move to the initial asset allocation will introduce a secondary impact on liabilities.

Any change in asset allocation will require calculating the liabilities based on 5,000 trials. For many insurers, a single stochastic run for liability valuation will take several hours. As a consequence, insurers are usually constrained to limit their ALM analysis to a reduced number of allocations. Such ALM analyses are usually based on trial and error and can be time consuming. The next section shows how these computational challenges can be bypassed by using the Least-Squares Monte Carlo approach.

Asset allocation impact on T=0 balance sheet

This section demonstrates how the Least-Squares Monte Carlo technique can fit, with a high level of accuracy, proxy functions replicating the market-consistent value of liabilities and the net asset value (NAV) of an insurance portfolio for any combination of asset allocation, depending on proportions invested in different invested classes.

The proxy for the net asset value can be expressed as a polynomial function:

$$NAV_{t=0} = f\left(\begin{array}{c}equity\ weight, property\ weight, sovereign\ bonds\ weight,\\ corporate\ bonds\ weight\end{array}\right)$$

To perform the fit of the proxy functions, there are a total of 40,000 fitting scenarios used.

Next, the full stochastic ALM model for the following asset allocation choices is run in order to validate the convergence of the fitting functions (Table 2).

By comparing full ALM runs with the results provided by the proxy function, the quality of fit for both the NAV and market-consistent liabilities is seen.

The analysis in Figures 1 and 2 shows that even for very extreme variations in asset allocations, the fitted functions provide accurate estimations for both liabilities and the net asset value.

Once the function is validated, it provides an efficient tool to analyze the sensitivity of the net asset value to any changes in asset allocations, as shown in Figure 3.

Table 2 Asset allocation for the different validation scenarios

Validation scenario	Government bonds	Corporate bonds	Equity	Property
1	25%	25%	25%	25%
2	50%	20%	20%	10%
3	20%	20%	50%	10%
4	20%	20%	10%	50%
5	20%	50%	20%	10%
6	40%	20%	10%	30%
7	30%	10%	40%	20%
8	20%	30%	20%	30%
9	10%	40%	30%	20%
10	10%	20%	30%	40%
11	40%	40%	10%	10%
12	40%	10%	10%	40%
13	10%	40%	40%	10%
14	20%	20%	20%	40%
15	60%	10%	20%	10%

Figure 1 Out-of-sample validation for the proxy function of the NAV

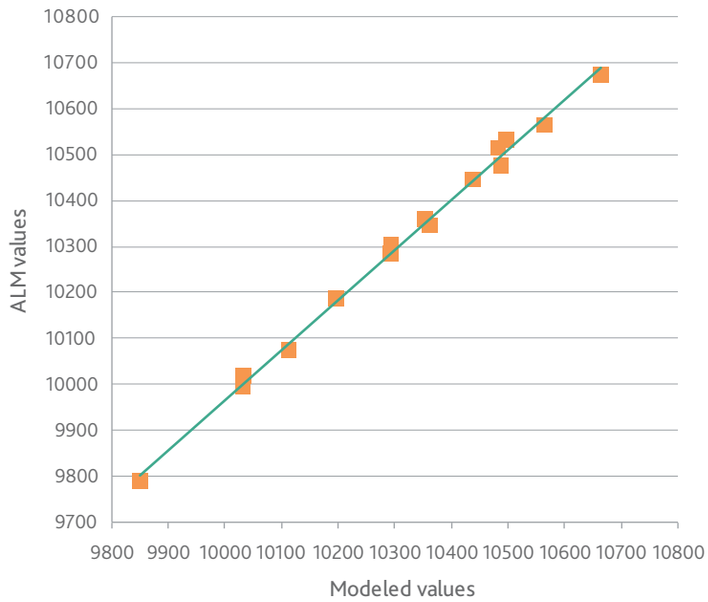


Figure 2 Out-of-sample validation for the proxy function of the liabilities

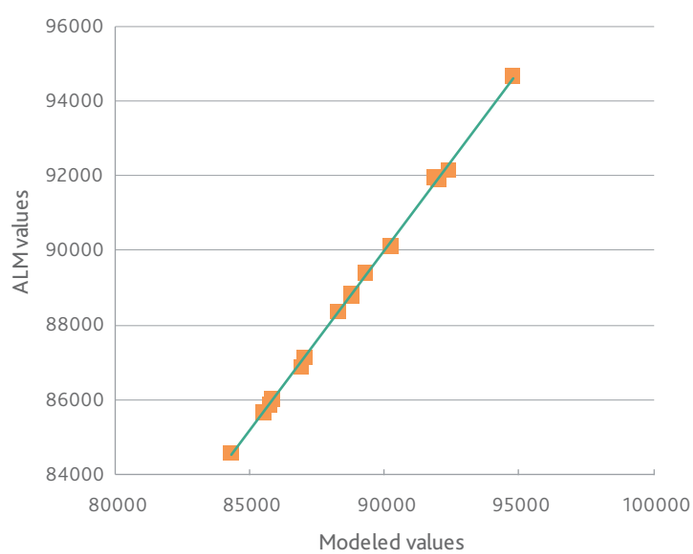


Figure 3 shows that, as expected, allocation in assets with low volatility reduces the cost of options and guarantees, which has a positive impact on the net asset value. The interesting element here is that we can now obtain fast estimations of the NAV following changes in asset allocation.

Proxy fitting for T=1 balance sheet

The value of the liabilities at T=1 will depend on a larger number of parameters than the value of T=0; in addition to asset allocation, liabilities will depend on the market conditions realized at T=1. This later component constitutes for many insurers the biggest challenge in the implementation of internal models, as the derivation of a probability distribution for net assets requires the execution of several thousand simulations.

To ensure that the LSMC technique converges with a high degree of accuracy, a number of mathematical conditions must be implemented with a high degree of precision. For the purpose of this case study, we used the B&H Proxy Functions Generator to generate both liability

Figure 3.1 Weight of sovereign bonds when corporate bonds = 15% and property are = 10%

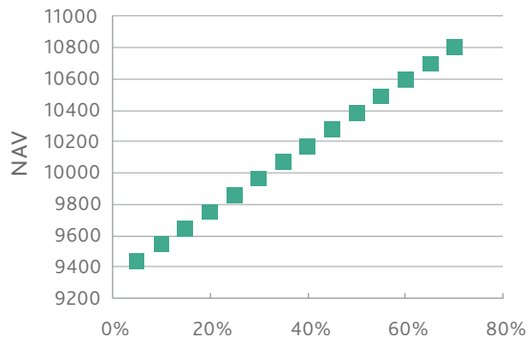


Figure 3.2 Weight of property when sovereign bonds = 20% and equity = 10%

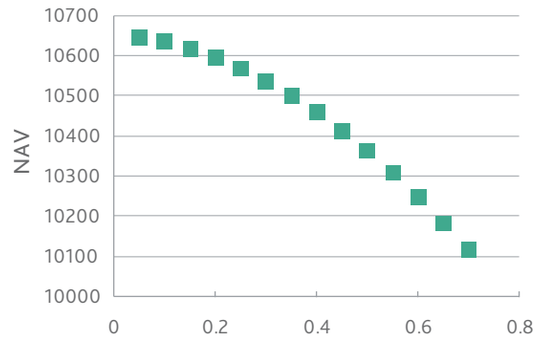


Figure 3.3 Weight of equity when sovereign bonds = 5% and property = 10%

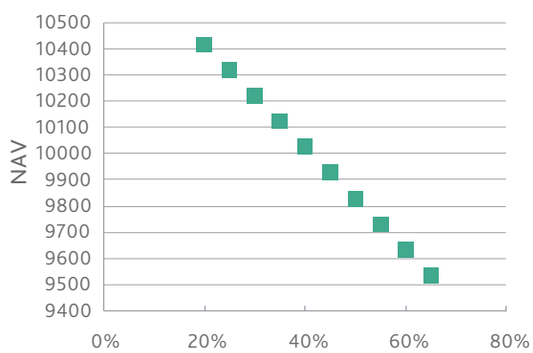
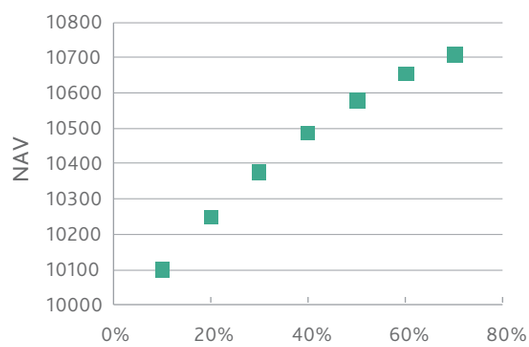


Figure 3.4 Weight of Sovereign bonds when corporate bonds = 10% and equity = 10%



proxies and the validation results.

The exposure to market conditions will be measured against the following six market risk factors:

1. Two factors representing the risk-free yield curve. It is convenient to reduce the behavior of the yield curve to fewer variables. Here, the short rate and the mean reversion levels of the Libor Market Model are selected.
2. An equity index stress
3. A property index stress
4. A factor representing the changes in volatility of equity
5. One factor representing the level of corporate credit spreads

Additionally, the number of risk factors is extended in order to include the proportion invested in each of the asset classes – sovereign bonds, corporate bonds, equity, and property.

The net asset value is then defined as a polynomial function that can be written as follows:

$$NV_{t=1} = f\left(\begin{array}{c} equity, property, yield\ curve\ short\ rate, yield\ curve\ mean\ reversion, \\ credit\ spread, equity\ weight, property\ weight, sovereign\ bonds\ weight, \\ corporate\ bonds\ weight \end{array}\right)$$

There were 40,000 fitting scenarios used to generate function-fitting assets, liabilities, and NAV. Scenarios have been generated using the Stochastic Volatility Jump Diffusion (SVJD) equity model, LMM interest rate model, and G2 corporate credit spreads and transition model as implemented in the B&H Economic Scenario Generator.

Table 3 Asset allocation for the different validation scenarios

Validation scenario	Government bonds	Corporate bonds	Equity	Property	Equity index[1]	Short rate level[2]	Mean reversion level	Property index	Equity volatility	Credit[3]
1	14%	38%	10%	38%	1	0	-2	1	1	3.555
2	22%	23%	25%	30%	1	-2	0	1	1	3.555
3	10%	10%	20%	60%	1	0	2.5	1	1	3.555
4	32%	10%	21%	37%	1	-1.5	0	1	1	3.555
5	8%	30%	47%	15%	2	0	0	1	1	3.555
6	40%	40%	12%	8%	1.5	0	0	1	1.2	3.555
7	19%	20%	31%	30%	2	0	0	1	0.8	3.555
8	30%	30%	25%	15%	1	0	0	2	1	3.555
9	20%	20%	20%	40%	0.3	0	0	1	1	3.555
10	77%	7%	10%	6%	1	0	0	0.3	1	3.555
11	30%	25%	38%	7%	1	-1.5	1.5	1	1	3.555
12	20%	25%	25%	30%	2	2	2	1.5	1.1	6
13	21%	23%	28%	28%	0.5	-1.5	-1.5	0.6	0.9	2
14	40%	20%	30%	10%	0.4	1.5	-2	0.8	0.8	8
15	30%	40%	10%	20%	2	1.8	-2	2	1.2	1

Figure 4 Out-of-sample validation for the proxy function of the NAV

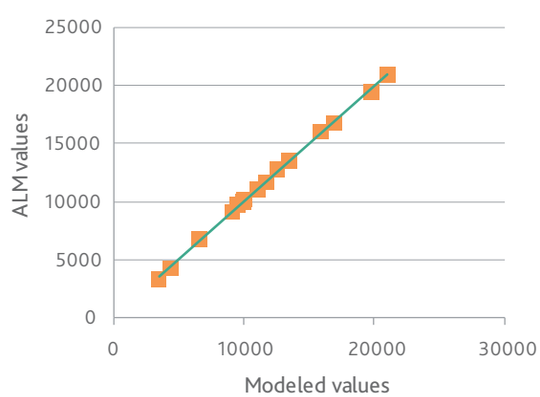
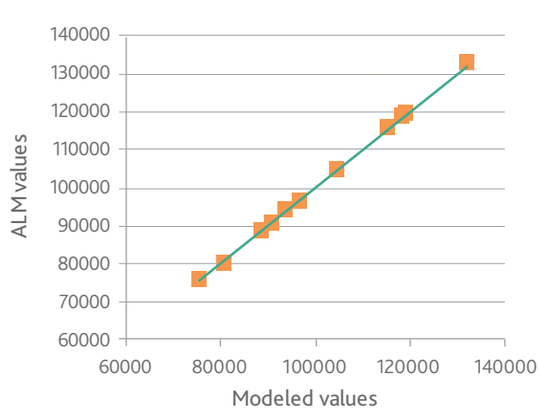


Figure 5 Out-of-sample validation for the proxy function of the liability



In order to perform validations, the proxy function is compared to accurate valuations provided by the stochastic ALM engine for the following selection of parameters in Table 3.

Figures 4 and 5 show the validation results obtained at 15 different points, including extreme variations in market risk factors and asset allocations. For each of these points, the accurate estimation is based on 5,000 market-consistent simulations.

An accurate estimation of proxy functions offers two main benefits, the ability to:

- Perform projections of a market-consistent balance sheet and capital requirement under stress scenarios – part of the forward-looking capital assessment required under the ORSA component of Solvency II.
- Obtain a probability distribution for any balance sheet item at T=1.

This analysis has used the probability distribution of net assets in order to calculate the SCR of this book of business.

The calculation of the distribution is based on 100,000 real-world scenarios generated from the B&H Risk Scenario Generator software. To reduce the sampling error in the estimation of the 99.5th percentile to an acceptable level, using at least 100,000 trials is recommended.

The probability distribution of the net asset value can be an effective tool to derive an objective and robust risk appetite framework. It will also represent a powerful element in putting in place dynamic risk controls or to set risk-based performance targets within an organization.

Asset optimization

Traditional asset allocations aim to maximize asset returns and minimize the volatilities of the same assets. Due to the complexities in the calculations mentioned in previous sections, the analysis is usually restrained to the investment portfolio without considering the implications on the net asset value. As a consequence of these simplifications, the impact of variations in asset allocations on the starting value of the balance sheet is ignored in the optimization problem.

This section illustrates how to resolve the optimization problem when net asset value is defined as an indicator of an insurer's wealth, and will analyze separately the cases where the expected value of the NAV and annual returns on

Figure 6 Distribution of the NAV of the initial allocation

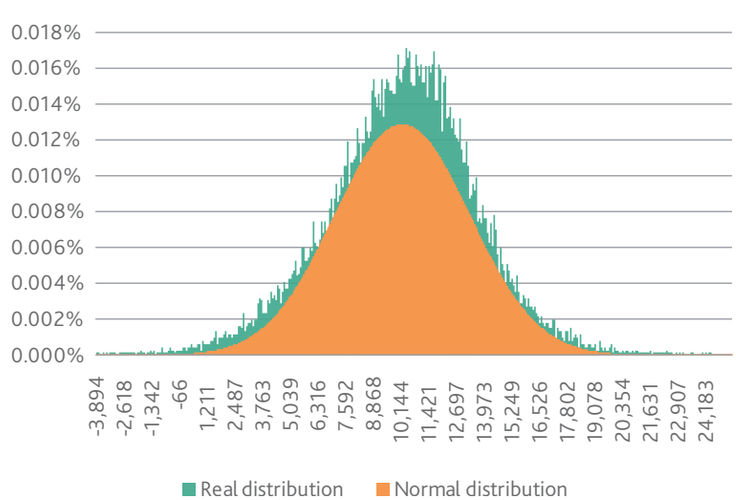


Table 4 Statistics on NAV based on 100,000 real-world scenarios

Statistics	Values
Average	10,184
Kurtosis	0.354313
Skew	-0.18264
Median	10,313
Standard deviation	3101
75th percentile	8237
99.5th percentile	1499

NAV are chosen in the maximization objectives. The riskiness of the NAV will be defined by the SCR calculated from a probability distribution.

The SCR at T=0 for a one-year forward capital assessment will be given by $SCR_{t=1} = E[NAV_{t=1}] - q_{99.5\%}[NAV_{t=1}]$.

Figure 7 shows NAV versus SCR when running simulations for different combinations of asset allocation.

These results show that NAV is maximized and SCR is minimized when the allocation is done in low risky assets. This is not surprising from a shareholder's point of view, as the impact of the risk on a market-consistent balance sheet is measured through the cost of options and guarantees. Depending on the relative size of the liabilities compared to the NAV, the cost of options and guarantees will dominate the expected risk premium on invested assets.

In the previous configuration, the optimization problem seems to be obvious; however, a with-profit insurer is also constrained when delivering minimum returns on assets in order to be competitive compared to cash investments or minimum rates offered by other insurers. This additional constraint requires the insurer to earn a minimum return on invested assets.

The colored circles in Figure 7 represent a different range of asset returns.

When we target a maximization of NAV, for instance, and if we assume that target investment return is 3%, then the optimal asset allocation is given by A = (25%, 15%, 50%, 10%), which corresponds to an expected NAV of 10,689 and SCR of 6,616.

An alternative approach to the optimization problem can be defined by maximizing returns on NAV instead of the absolute value of NAV.

Figure 8 shows the allocation diagram for returns on NAV versus SCR.

When looking at returns, instead of absolute value of NAV, the shape of the allocations have more similarities with the Markowitz efficient frontiers. The optimal portfolios are very different than the situation where absolute value of NAV is maximized, as optimal portfolios tend now to be those having the lowest starting NAV.

Table 5 shows optimal asset allocations under different optimization approaches, when the minimum investment return for policyholder bonuses is set at 3%.

Figure 7 NAV at T=1 / SCR for variation of two assets allocation

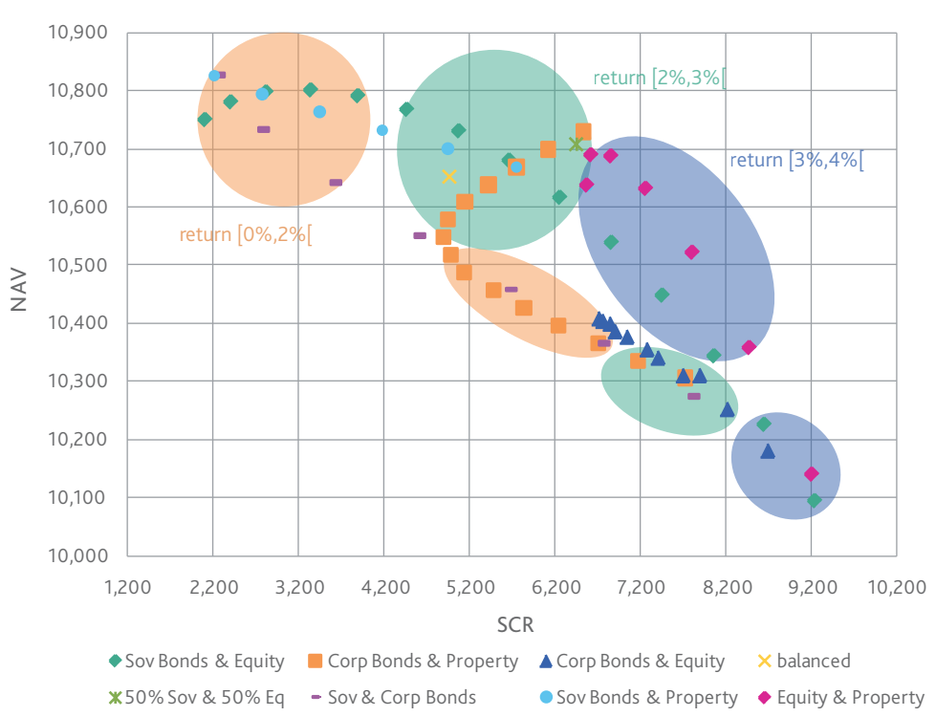


Table 5 shows that there can be significant variation in assets allocated depending on the measures considered for the risk/return couple. The choice of NAV vs. SCR provides, in this case, the highest NAV and the lowest SCR compared to other optimization approaches. An optimization based on return on investments vs. SCR provides the worst portfolio with the lowest value of NAV and the highest SCR.

Table 6 shows optimal asset allocations under different optimization approaches when the minimum investment return for policyholder bonuses is set at 2.5%.

A reduction in bonus rates lead to an increase in the proportion invested in government bonds given that a lower risk premium is required. Again, the optimization based on NAV vs. SCR provides the best allocation with this highest NAV and the lowest SCR.

An asset optimization focusing only on the distributional characteristics of an investment portfolio will often not lead to an optimal portfolio from the perspective of value creation for a life insurance firm. The use of simplifying assumptions that ignore asset and liability interactions is often driven by computational challenges in the valuation of the insurer's market-consistent balance sheet.

This article extended the use of LSMC technique beyond its usual application to the SCR calculation. The same single functional form can be used to maximize the net assets of an insurance firm for a wide range of asset allocations. The flexibility of the functional forms gives the ability to integrate a large number of constraints, such as regulatory/economic capital or targeted minimal bonuses for policyholders.

The internal models have become an effective decision-making tool, allowing management to assess the appropriateness of each strategic action under the numerous interdependent criteria that exist within an insurance company. The ability to embed the internal model within the decision process also provides a good proof on the use test criteria required under Solvency II for the validation of internal models.

Figure 8 Return on NAV / SCR for variation of two assets allocation

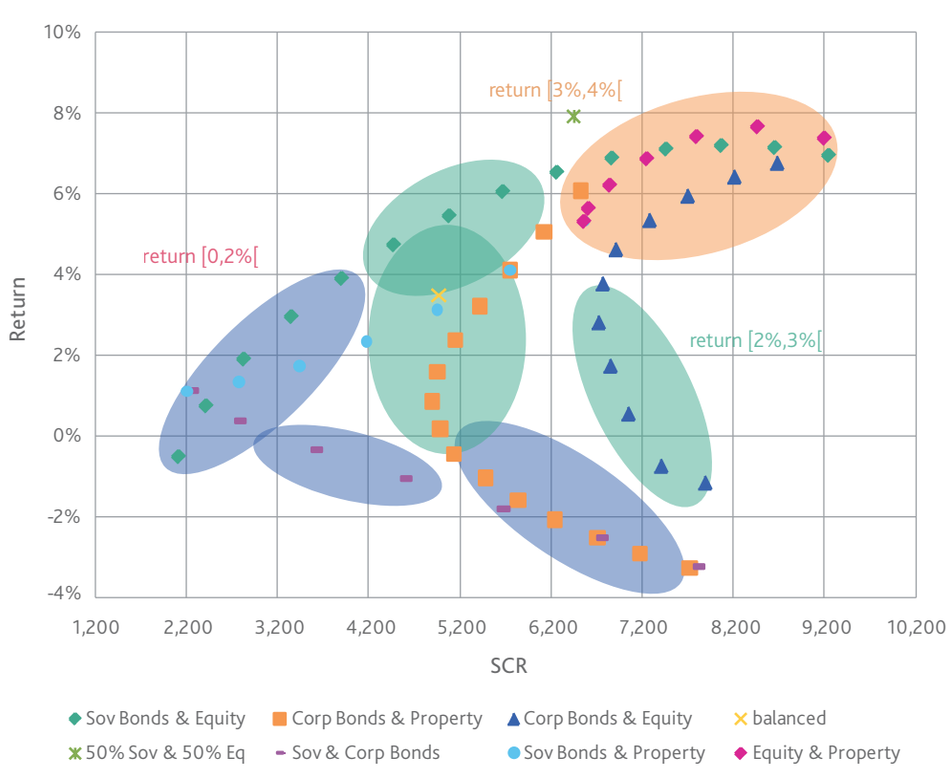


Table 5 Optimal asset allocation when minimum expected return on invested asset of 3% for policyholder bonuses

	NAV vs. SCR	Return on NAV vs. SCR	Return on invested asset vs. SCR	Return vs. variance of invested assets
Optimal asset allocation	10%, 10%, 20%, 60%	25%, 15%, 50%, 10%	5%, 15%, 70%, 10%	10%, 10%, 40%, 40%
NAV at T=0	10,118	9,859	9,438	9,949
NAV at T=1	10,689	10,539	10,095	10,631
SCR	6,616	6,866	9,245	7,255

Table 6 Optimal asset allocation when minimum expected return on invested asset of 2.5% for policyholder bonuses

	NAV vs. SCR	Return on NAV vs. SCR	Return on invested asset vs. SCR	Return vs. variance of invested assets
Optimal asset allocation	40%, 10%, 40%, 10%	50%, 0%, 50%, 0%	40%, 10%, 40%, 10%	35%, 15%, 40%, 10%
NAV at T=0	10,076	9,923	10,076	10,069
NAV at T=1	10,726	10,708	10,726	10,680
SCR	5,614	6,452	5,614	5,669

1 Multiplicative shock on the indices.

2 Multiplicative shock on the level of short rates and mean reversion.

3 Shock on the starting value of the spread CIR process.

SPOTLIGHT ON SUNCORP GROUP

In an effort to better understand some of the challenges facing industry leaders, Moody's Analytics discussed banking and insurance solutions with Martin Lalor, Executive Manager - Group Capital, of Suncorp Group. Mr. Lalor has 20 years of experience in risk modeling within insurance and banking organizations, specializing in actuarial analysis, financial engineering, structured and alternative investments, and trading.

He is responsible for the Suncorp Group risk-based capital (RBC) modeling framework and the Group's stress testing framework. Both frameworks incorporate the modeling requirements of the Group's general insurance entities, life insurance entities, and bank entity.

The need for a risk modeling solution

Suncorp was looking for a robust modeling solution to suit each of their businesses (Life, General, and Bank), rather than just one specifically designed for insurance. A key driver was the need for a "best practice" internal assessment of capital requirements (known as risk-based capital). It was also crucial that they establish a consistent approach to modeling risks within each of their businesses, as this would enable a robust assessment at the conglomerate (consolidated) level and would lead to the identification of the capital diversification benefits across their organization – and the potential to free up capital to yield higher returns.

Prior to Moody's Analytics, Suncorp was using multiple external and internal solutions, which had the potential to lead to inconsistent assessments of risk and internal capital requirements across the organization.

The search for a solution

After researching four to five Economic Scenario Generator (ESG) providers they selected a solution provided by Moody's Analytics, which would help them consistently model economic risks across their businesses. Moody's Analytics is well known in Australia and provides services in both the banking and insurance industries. The ESG service is particularly well known in the insurance industry, and staff at Suncorp had used the service at other institutions and regarded it highly.

Furthermore, Suncorp's assessment determined that the ESG had a long history of development and evolution, and a comprehensive online technical and research database of support. In addition, Suncorp determined that Moody's Analytics had significant ongoing research and model development capabilities, which Suncorp considered critical given the diversity of their businesses and a desire to continually evolve and enhance their own modeling frameworks.

Solution benefits

In addition to the comprehensive ESG solution provided to Suncorp, Moody's Analytics flexibility in adapting their models for Suncorp helped deliver a more suitable solution for the modeling of economic risks in each business. This was particularly relevant for their Bank line of business, which required significantly enhanced short-end interest rate models, as well as the development of models for key macroeconomic risk drivers for the bank.

The ESG solution for economic risks (both market and credit risk) could also be integrated with the modeling solutions for the other financial risk types (e.g., insurance risk and operational risk), which together provided the RBC modeling infrastructure required by each business.

The RBC modeling framework has enabled Suncorp to assess earnings and capital-at-risk metrics for each of its businesses consistently, as well as for the conglomerate as a whole. The framework is expected to provide management with a key tool to be used for strategic decisions, such as capital allocation

About Suncorp Group

Suncorp Group includes leading general insurance, banking, life insurance, and superannuation brands in Australia and New Zealand. The Group has 15,000 employees and relationships with nine million customers. They are a Top 20 ASX-listed company with $96 billion in assets. Suncorp has five core businesses: Personal Insurance, Commercial Insurance, Vero New Zealand, Suncorp Bank, and Suncorp Life. They are the largest general insurer of Australians by Gross Written Premium (GWP) and second largest general insurance company in New Zealand.

and strategic asset allocation. In addition, the framework is expected to significantly enhance Suncorp's articulation of risk appetite, and to facilitate improved risk measurement and monitoring processes.

Of particular importance, an enterprise-wide ESG applied consistently has supported Suncorp in its objective to make tangible the diversification benefits that exist across their organization. For example, the profitability and capital requirements of a general insurer, life insurer, and bank do not necessarily respond to movements in interest rates in the same way – there are offsetting influences across the balance sheets. A consistent modeling approach and consolidation of results have enabled Suncorp to identify those influences and assess their impact.

About ESGs

An ESG is the cornerstone of the stochastic modeling approach. In particular, an ESG provides a best practice tool to help robustly measure economic risk from an integrated perspective.

As well as being a tool for an efficient ALM strategy, it can be applied to the understanding of the market risk drivers embedded into complex life insurance products (e.g., variable annuities). ESG simulation forms the basis of a market-consistent valuation of the balance sheet and is a key prospective element in the context of Solvency II.

BIG DATA SMALL RISK

Achieving an enterprise-wide view of your risk requires a solution that not only provides massive amounts of information, but also the research, models, and software to interpret it.

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Risk 25 Firms of the Future | Risk Technology Rankings 2013 | FinTech 100 | RiskTech 100 2014 Top 10 | AsiaRisk Technology Rankings 2013

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Alexis Bailly

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Alexis is responsible for the advancement of Moody's Analytics insurance activities in EMEA. He contributes to the development of Moody's Analytics Solvency II client propositions, in particular with internal models and ORSA.

Before joining Barrie & Hibbert in 2008 – three years before its acquisition by Moody's Analytics – he had extensive experience in ALM and economic capital modeling at Towers Watson in London and previously worked in risk management and valuation roles at Zurich Financial Services. Alexis is a fellow of the actuarial associations in the UK, France, and Switzerland and has an MA in Quantitative Finance from ETH Zurich.

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Karim Ben Ayed

Actuary, Insurance Solution Specialist

Karim provides in-depth expertise to European insurance companies about Solvency II compliance and implementation of the different pillars, including ORSA. Prior to joining Moody's Analytics four years ago, he spent four years at AXA Group and B&W Deloitte. As an actuary in AXA's risk department, Karim helped launched their variable annuities product in the French market. His specialties also include the implementation of pricing models and embedded values. Karim holds a Master's degree in Actuarial Sciences from Paris Dauphine University.

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Stephen Carlin

Director, Insurance Product Management Team

Stephen has many years of experience working with scenario generators and stochastic modeling, including calibration, development, and support. Since 2010, Stephen has led the development of the B&H Economic Scenario Generator (ESG) product suite. Stephen has also spent three years leading the delivery of the ESG calibration services, technical support, and training.

Stephen joined Barrie & Hibbert in 2007 before the company was acquired by Moody's Analytics. Prior to that, Stephen had roles that covered capital markets, life insurance, and auditing. Stephen graduated from Heriot-Watt University in 2002 with a BSc in Actuarial Mathematics and qualified as an actuary in 2006.

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Gavin Conn

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Gavin helps support clients with their economic capital modeling needs. Prior to joining Moody's Analytics in October 2012, he worked for ten years at AEGON UK where he was Head of Risk and Capital Modeling and, more recently, Head of Investments. He was heavily involved in the Solvency II program, as well as the development of their economic capital model.

Gavin is an experienced practitioner in the field of stochastic modeling and its application to both shareholder and regulatory reporting in the UK. He is a Fellow of the Faculty of Actuaries and has an MA in Mathematics from the University of Cambridge.

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Tony has more than 30 years of multifaceted global experience in the financial services industry, specializing in insurance risk and capital management. He is recognized in the insurance industry as a go-to person for risk management and asset liability management issues.

Active in the actuarial profession, Tony speaks at industry events, and writes papers for trade journals and newsletters. He also chairs the American Academy of Actuaries' Modeling Efficiency Work Group, was a Chair of the Society of Actuaries' Investment Section, and is a founder of the Society of Actuaries' Annual Investment Symposium.

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Andy has more than 25 years of experience in the insurance, asset management, and pensions industries, and helps global insurers address their regulatory compliance and risk management needs. Before working for Moody's Analytics, Andy was the CEO of Barrie & Hibbert, a market-leading insurance risk management software and advisory business. Prior to that, he had a variety of senior leadership roles in large asset management and insurance firms. A qualified actuary, Andy has a BSc in Mathematics from Imperial College London and an MBA from the University of Hull.

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Based in London, Simon is responsible for the analytic teams that maintain Moody's ratings on European insurers and, since the summer of 2009, Nordic banks. He joined the Moody's European Insurance team in 1998, working on the analysis of UK and German life and non-life insurance groups. In his position as Managing Director, he is now responsible for the management and development of Moody's EMEA insurance and Nordic banking franchises.

Prior to joining Moody's, Simon was an actuary with Co-operative Financial Services in Manchester, England. Simon holds a BA in Economics from Leeds University, and is a Fellow of the UK Institute of Actuaries (FIA).

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Brian is an insurance and Solvency II specialist who has significant experience in technology solutions for the global insurance industry. He has an in-depth knowledge of the life and pensions business, coupled with a comprehensive understanding of enterprise technology in relation to the development and implementation of core administration, actuarial/risk, data and Solvency II systems.

Brian has previously worked with many insurance companies across the world and has run administration and sales divisions. He also has considerable experience in strategic planning. Brian is a noted conference speaker on insurance technology, actuarial modeling, and data governance and has previously authored tutorial material for both the CII and PMI.

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Vall leads a team of industry subject matter experts and product specialists who help insurance companies in North America address their capital and risk management needs. Prior to Moody's Analytics, Vall spent his career in capital markets and financial technology – including Regional Head of Barrie & Hibbert (acquired by Moody's Analytics in 2011), Co-Founder of Alpha Square Financial Technologies LLC, Director, Hedge Fund Financing and Risk at UBS Investment Bank, Fund Analyst at Bank of New

SUBJECT MATTER EXPERTS

York Mellon, and Derivatives Analyst at Paribas Capital Markets. Vall holds degrees in Economics and Computational Finance.

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Juan and his team are responsible for generating alternative macroeconomic forecasts for Europe and for building econometric tools to model credit risk phenomena. His team develops and implements risk solutions that explicitly connect credit data to the underlying economic cycle, allowing portfolio managers to plan for alternative macroeconomic scenarios. These solutions are leveraged into stress testing and reverse stress testing practices.

Juan communicates the team's research and methodologies to the market and often speaks at credit events and economic conferences worldwide. He holds a PhD and an MA in Economics from the University of Pennsylvania and graduated summa cum laude from the National University of Cordoba in Argentina.

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Romain helps insurers with the modeling of financial risks and to understand EIOPA transitory guidelines. He works with insurance companies in France, Belgium, the Netherlands, Luxembourg, and Southern Europe regarding complex risk modeling and calibration, Solvency II Internal Models, economic capital, and ORSA challenges.

Romain joined Moody's Analytics with the acquisition of Barrie & Hibbert. Prior to his current role, he was a life actuary consultant. He has an engineer's degree in Financial Mathematics from EISTI and a post-graduate in Econometric and Statistical modeling from ENSAE ParisTech. He is a fully qualified actuary of the French Institute of Actuary since 2011.

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Sandy Sharp

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Sandy maintains a close interest in regulatory developments worldwide and has presented to various EIOPA working parties on the minutiae of Solvency II. Sandy has worked for Moody's Analytics (formerly Barrie & Hibbert) for more than three years.

Previously, he was Head of Profit Reporting at Scottish Widows, one of the largest UK Life Offices, and before that he worked for General Electric, Citibank, and Ernst & Young. Sandy is a Fellow of the Institute of Actuaries and has co-authored papers presented to the Institute of Actuaries on the *Modeling of Extreme Market Risk Events and Embedded Values*.

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Dr. Jamie Stark

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Jamie is a Credit Portfolio and Valuation and Stress Testing Services Practice Leader in EMEA and has worked with insurers and banks all over the world, assisting them with their risk system implementations, risk modeling, calibration, and a variety of other challenging risk management projects.

In addition to his work at Moody's Analytics, Jamie volunteers as Regional Director for PRMIA's Edinburgh chapter. Prior to his current role, Jamie worked at both Barrie & Hibbert and Moody's KMV. He holds a PhD in Computer Science from Heriot-Watt University and

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José is a Director in the Economic and Consumer Credit Analytics team, responsible for the research and implementation of Moody's Analytics risk management solutions and managing projects with major banks and investment firms globally.

He is directly involved in modeling, forecasting, and stress testing, including retail and corporate credit portfolios, key market risk indicators, structured finance, rating migrations against different macroeconomic scenarios, and designing macroeconomic models that generate scenarios. José is also a frequent speaker at credit risk events.

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Christian is responsible for providing thought leadership on credit risk management and strategic business development in the EMEA region and functions as a main contact for regulators and senior management of financial institutions.

With more than 15 years of experience, Christian has worked with numerous financial institutions in the EMEA region on Basel II implementation, risk management, stress testing and portfolio advisory projects, and in the process has become an internationally-known expert on credit risk management.

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Craig Turnbull

Managing Director, Enterprise Risk Solutions

Craig leads the research, thought leadership, and advisory activities in global insurance and pensions, particularly in valuation, capital modeling, and hedging. A Fellow of the Institute of Actuaries, Craig has been actively involved in the development of global principal-based regulatory capital assessment implementations and has been a member or adviser to actuarial professional working groups in this area throughout the world. He had been with Barrie & Hibbert for 11 years, prior to the company being acquired by Moody's Analytics in 2011.

Craig's risk management research papers have been featured in publications such as the *British Actuarial Journal* and *US Contingencies*.

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Andrew Waters

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Andrew helps develop the Moody's Analytics Advisory Services offering, working across multiple teams to deliver tailored enterprise risk management solutions for insurers. He is dedicated to providing Solvency II internal models, and is experienced in liability approximations (replicating portfolios, curve fitting, Least-Squares Monte Carlo), ALM, hedging, economic capital optimization, and stress testing. Andrew has more than 10 years of experience in risk management for pensions, banks, asset managers, and insurers.

Before joining Moody's Analytics, he worked at Markit/QuIC, Algorithmics, Mercer, and RBC. Andrew is a CFA Charterholder, and holds a variety of designations, including the FRM, PRM, and CAIA.

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- Improve strategic business planning and facilitate meeting regulatory requirements
- Assist with defining both macroeconomic and business-specific scenarios
- Offer a comprehensive and granular credit risk, economic, and financial data set
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- Deliver an integrated risk management software solution to calculate performance indicators across the risk and finance functions

For more information, contact our insurance risk experts at RiskPerspectives@moodys.com.

INFRASTRUCTURE

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Provides a comprehensive and modular solution to manage all aspects of Solvency II compliance, ranging from centralized data management, internal model development, solvency capital requirement calculations, risk type aggregation, and integrated regulatory and business reporting.

Regulatory Reporting for Solvency II

Integrated with our end-to-end insurance regulatory capital solution, the easy-to-use and cost effective Regulatory Reporting module produces accurate management and regulatory reports in local supervisors' commonly used formats and languages.

B&H Economic Scenario Generator

Provides Monte Carlo simulation paths for the joint behavior of financial market risk factors and economic variables. The automated, market-leading Economic Scenario Generation for life insurance offers modeling capabilities and calibration content for many levels of user sophistication.

B&H Market-Consistent Economic Scenario Generator

Addresses the challenges of market-consistent liability valuation required in Solvency II. It includes the award-winning B&H Scenario Generator (ESG).

B&H Capital Modeling Framework

Comprised of three products: B&H Economic Capital Calculator, B&H Proxy Generator, and B&H Risk Scenario Generator. Together, they provide a rapid and highly flexible approach to calculating economic capital for complex liabilities in the life insurance industry, and establish the processes required by Solvency II and ORSA for assessing insurance capital solvency.

B&H Proxy Generator

Creates proxy functions that can be used to meet a range of business needs, such as interim valuation, capital calculations, and hedge effectiveness.

B&H Property & Casualty ESG

Provides automated Economic Scenario Generation solutions for P&C insurers with modeling capability and calibration content. It is specifically developed to meet the needs of P&C insurers, as part of an internal capital model or for asset portfolio risk management.

B&H Defined Benefit ALM

Is a sophisticated ALM solution underpinned by the B&H Economic Scenario Generator and calibration content. Provides a comprehensive risk modeling framework that allows advisors, asset managers, and in-house pensions teams to measure and manage the risks facing defined benefit pension funds.

B&H PensionsLite

Differs from B&H Defined Benefit ALM in that it has a simpler, more accessible user experience that enables interactive meetings with trustees or corporate sponsors, and a slightly less sophisticated modeling engine.

RiskFrontier™

Produces a comprehensive measure of risk, expressed as Credit VaR or Economic Capital, which comprises the basis for deep insight into portfolio dynamics for active risk and performance management.

B&H Scenario Service

Is an alternative to ESG software and provides insurers with scenario sets on an annual, semi-annual, or quarterly basis. Insurers and reinsurers can decide between the control and flexibility of a software installation or the simplicity and ease-of-use offered by the scenario service.

DATA

RiskFoundation™

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Moody's Content Licensing Services

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Provides a comprehensive view of global economic conditions and trends. Our database covers more than 180 countries with more than 260 million time series from the best national and private sources, as well as key multinational data sets.

Moody's Analytics Credit Research Database (CRD)

Is the world's largest and cleanest database of private firm financial statements and defaults, built in partnership with over 45 leading financial institutions around the world.

PD Time Series Information

Offers time series of observed default rates and calculated PDs, covering more than two economic cycles. This data is collected and calculated for both public and private firms.

Credit Migration Data

Enables users to construct detailed credit migration (transition) matrices. This detailed private firm data allows users to be more granular with segmentations across industry, region, and asset size using several different PD rating calculation methodologies.

Credit Cycle Adjustment Data

Combines financial statement ratio information of private firms with credit cycle factors in the public equity markets to derive a dynamic, through-the-cycle PD measure.

Structured Finance Data and Analytics

Offers loan, pool, and bond level performance data for RMBS, CMBS, ABS, and CDOs. Structured Finance Analytics assist in evaluating structured credit portfolios and securitization data that needs to be reported to regulators.

Default and Recovery Database

Allows users to look at how default experience varies at different points in the economic cycle, and which factors made default experience in each economic cycle unique. The data includes detailed rating histories, 30-day post default pricing, and three views into ultimate recovery.

INVESTMENT ANALYSIS / SURVEILLANCE

Moody's CreditView

Research and data to assist insurance companies and pension funds with investment analysis, creation of internal risk scores and meeting due diligence requirements.

MODELS

CreditCycle™

Incorporates regional economic forecasts with alternative scenarios to improve various credit functions, enabling profit and loss forecasting, stress testing, sensitivity analysis, and benchmarking.

CreditEdge Plus™

Bridges the equity, bond, and credit derivative markets, enabling an in-depth understanding of their impact on credit risk.

Stressed EDFs™

Estimate PDs for public firms using a range of macroeconomic scenarios, including EBA and user-defined scenarios.

LossCalc™

Calculates the Loss Given Default (LGD) for loans, bonds, sovereigns, municipals, and preferred stock using a range of asset classes and a comprehensive database of defaulted instruments.

Portfolio Analyzer (PA)

Is a loan-level capital allocation and risk management tool providing stressed PDs, LGDs, and prepayments for RMBS, auto ABS, and mortgage and auto loans.

RiskCalc™ Plus

Enables clients to calculate forward-looking PDs for private firms across different regions and industries and measure how borrowers would be affected by stressed scenarios versus a baseline scenario.

WSA Platform

Is a risk management and cash flow platform which is used by structured finance investors and risk managers to monitor, price, and stress test their portfolios. WSA integrates macroeconomic scenarios, credit models, pool, and loan-level performance data to forecast cash flows, PDs, LGDs, and prepayments.

SERVICES

Enterprise Risk Solutions Services

Create, validate, and streamline regulatory capital management models and procedures.

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Provide valuations, analytics, and support services to manage portfolios of hard-to-value securities and to respond effectively to management, auditors, and oversight authorities.

B&H Calibration Service

Is a market-leading calibration service that provides prompt quarterly updates for Moody's Analytics models, reflecting the latest market conditions and economic outlook. Also provides a range of calibration types for specific applications.

CONNECT WITH US

Are you LinkedIn to our Insurance Risk group?

Great things happen when people from across the globe join forces to share ideas, best practices, and new ways to overcome their enterprise risk management and regulatory challenges.

Join the Moody's Analytics Insurance Risk group on LinkedIn. Connect with the Risk Perspectives™ magazine authors and your peers, discuss key topics, and keep up with the latest trends and news. With nearly half of the group's membership at senior level or above, it offers an opportunity to learn more about leveraging best practices to support your core risk management objectives.

Contact Brian Heale to join the Moody's Analytics Insurance Risk group: Brian.Heale@moodys.com

ABOUT US

Moody's Analytics offers award-winning solutions and best practices for measuring and managing risk through expertise and experience in credit analysis, economic research, and financial risk management. By providing leading-edge software, advisory services, data, and research, we deliver comprehensive investment, risk management, and workforce solutions. As the exclusive distributor of all Moody's Investors service content, we offer investment research, analytics, and tools to help debt capital markets and risk management professionals worldwide respond to an evolving marketplace with confidence.

We help organizations answer critical risk-related questions, combining best-in-class software, analytics, data and services, and models – empowering banks, insurers, asset managers, corporate entities, and governments to make informed decisions for allocating capital and maximizing opportunities. Through training, education, and certifications, we help organizations maximize the capabilities of their professional staff so they can make a positive, measurable impact on their business.

More information is available at moodysanalytics.com.

GLOSSARY OF TERMS

ABS	Asset-Backed Securities
ALM	Asset and Liability Management
APRA	Australian Prudential Regulatory Authority
BaFin	Federal Financial Supervisory Authority (Germany)
BMA	Bermuda Monetary Authority
CDS	Credit Default Swap
CERA	Certified Enterprise Risk Analyst
CFO	Chief Financial Officer
CIC	Complimentary Identification Code
COSO	Committee of Sponsoring Organizations
CRM	Customer Relationship Management
CRO	Chief Risk Officer
DSGE	Dynamic Stochastic General Equilibrium
EIOPA	European Insurance and Occupational Pensions Authority
ERM	Enterprise Risk Management
ESG	Economic Scenario Generator
ETL	Extract, Transform, and Load
EUC	End User Computing
FSA	Financial Services Authority
FSB	Financial Services Board
GAAP	Generally Accepted Accounting Principles
GDP	Gross Domestic Product
GPU	Graphics Processing Unit
G-SIFI	Global Systemically Important Financial Institution
G-SII	Global Systemically Important Insurers
IAIG	Internationally-Active Insurance Groups
IAIS	International Association of Insurance Supervisors
ICA+	Individual Capital Assessments
ICAS	Individual Capital Adequacy Standards
ICP	Insurance Core Principles
IFRS	International Financial Reporting Standards
IFSR	Insurance Financial Strength Ratings
IGT	Intra-Group Transactions
IMAP	Internal Model Approval Process
LMM	LIBOR Market Model
LSMC	Least-Squares Monte Carlo
M&A	Mergers and Acquisitions
MCEV	Market Consistent Embedded Value
MCR	Minimum Capital Requirements
MTM	Mark-To-Market
NAIC	National Association of Insurance Commissioners
NAV	Net Asset Value
OLAP	Online Analytical Processing
ORSA	Own Risk Solvency Assessment
OSFI	Office of the Superintendent of Financial Institutions
P&C	Property and Casualty
P&L	Profit and Loss
PRA	Prudential Regulation Authority (UK)
QRT	Quantitative Reporting Templates
RAROC	Risk-Adjusted Return On Capital
RBC	Risk-Based Capital
RDR	Retail Distribution Review
RORAC	Return On Risk-Adjusted Capital
RP	Replicating Portfolio
SAM	Solvency Assessment and Management
SCR	Solvency Capital Requirement
SIFI	Systemically Important Financial Institution
SST	Swiss Solvency Test
SVJD	Stochastic Volatility Jump Diffusion
VaR	Value-at-Risk
VAR	Vector Auto-Regression

Breaking Silos
Forecasting
Capital adequacy
Reinsurance
Capital
ORSA
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