Survey on Market Risk

Sponsored by
Society of Actuaries
Committee on Finance Research

Prepared by

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June 2012

Foreword

PwC would like to acknowledge the people who participated in the development of this research paper, especially the survey respondents who shared their insights and who remain anonymous.

We'd also like to thank the Society of Actuaries Project Oversight Group (POG), which provided advice and guidance during the course of the project. We also would like to thank the research coordinators from the Society of Actuaries for their efforts in organizing and coordinating the project.

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Executive Summary

In order to determine current market risk practices, we surveyed several insurance companies. This survey report contains information on a general range of industry practices and areas for further consideration.

The majority of survey respondents' companies have enterprise risk management (ERM) committees that monitor risk management activities, as well as define risk tolerance levels. Their risk management objectives are to maintain specific credit ratings, manage capital and reduce earnings volatility. Generally, market risk, credit risk and insurance risk are their key risks.

Most participants use defined ERM strategies to measure risk and return, define risk metrics, and set mitigation plans. Balancing the cost of these ERM strategies has always been a challenge for survey respondents, primarily because the former have an economic capital instead of an accounting focus.

Duration, scenario analysis, stress testing, conditional tail expectation and worst case scenario analysis are the most common measurement metrics. Primarily modeled risks include both market related risks and policyholder behavior. Cash flow models (if used) typically cover the life of the products. Usually, economic scenarios have both real world and risk neutral scenarios, and TAS CAP, Barrie-Hibbert Economic Scenario Generator, and American Academy of Actuaries (AAA) scenarios serve as the most common sources.

Measurement of risk across asset classes generally includes measurement of correlation between various asset classes and market-related risks. In terms of modeling interaction between insurance and market risks, the approach varies from catastrophe modeling, cash flow testing, market consistent embedded values measures, economic capital modeling and scenario analysis.

Respondents use hedging for products with guarantees or options to minimize volatility in economic liabilities and GAAP earnings, as well as maintain certain levels of statutory surplus. Most respondents use both risk-neutral and real-world models to determine hedging strategies. Because of system limitations, most participants struggle to model hedging at a company level. Therefore, they usually model hedging on a product basis by monitoring how assets and liabilities move against equity performance, changes in interest rates, and market volatility. Most participants are satisfied with monitoring hedge effectiveness on a period by period basis by performing detailed attribution analysis. However, there are concerns about cost-benefit trade-offs.

Generally, market risk reports contain multiple segments (e.g. risk and value reports, hedging reports, asset liability matching reports). Chief Risk Officers or Chief Actuaries evaluate them, and focus on the impacts of liquidity, capital adequacy, earnings risk, and risk tolerance level. In terms of measuring and monitoring risks at individual business unit level, none of the respondents has staff that focuses solely on market risk, but instead performs this task as a collaborative effort throughout the organization.

Respondents use in-house mainframe systems and third-party industry standard packages when managing market risk data. In anticipation of upcoming new reporting standards, most participants are updating their data management systems. Systems for market risk measurements and hedging strategy development are a combination of in-house developed programs, Excel, and third-party software/systems. Periodic internal cross checks and outside controls monitor the risk measurement systems. Hedging strategy systems usually adopt base policy information for key approximation and respondents' risk management committees approve assumptions before implementation.

Introduction

The Society of Actuaries (SOA) sponsored a project to develop industry benchmarks related to market risk practices at insurance companies with evolving market risk practices. While collecting industry benchmarks, a survey was issued in an attempt to understand market risk practices among several insurance companies. Participants responded to a series of questions about their key products, how they define and understand market risk, enterprise risk management, risk measurement, hedging practices and how they monitor and report risk.

The survey does not encompass all industry practice or benchmarking and was limited to a small number of companies with the goal of providing insight into a general range of industry practices.

Overview

This section addresses questions about product mix and how companies understand market risk, in particular:

- *Descriptions of products written;*
- *Which lines of business market risk impacts and how;*
- *Why and how survey respondents measure market risk;*
- *Market risk team characteristics.*

The majority of survey respondents are insurance companies with no international subsidiaries or parents. These respondents are split between two tiers, where Tier 1 companies are those with $50 billion total assets or less, and Tier 2 companies are considered to be $50 billion - $150 billion. (Figure 1-1 below shows a breakdown of participants by size.) For the purposes of this report, the collective understanding of market risk includes interest rate risk, credit risk, equity risk and liquidity risk. Survey respondents focus on universal/interest sensitive life insurance and annuities (immediate, deferred fixed, deferred variable and equity indexed) when measuring market risk. Some participants also look at traditional and term life insurance, participating traditional life insurance, health, long-term care and non-life product lines when determining market risk.

Total asset size of survey respondents

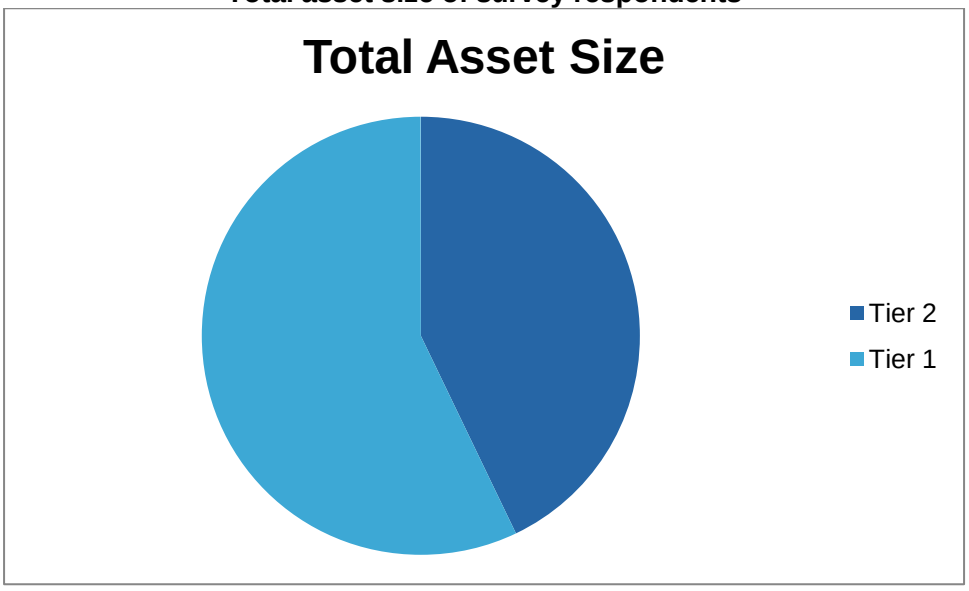

Figure 1-1

Figure 1-2 shows the mix of respondents' business.

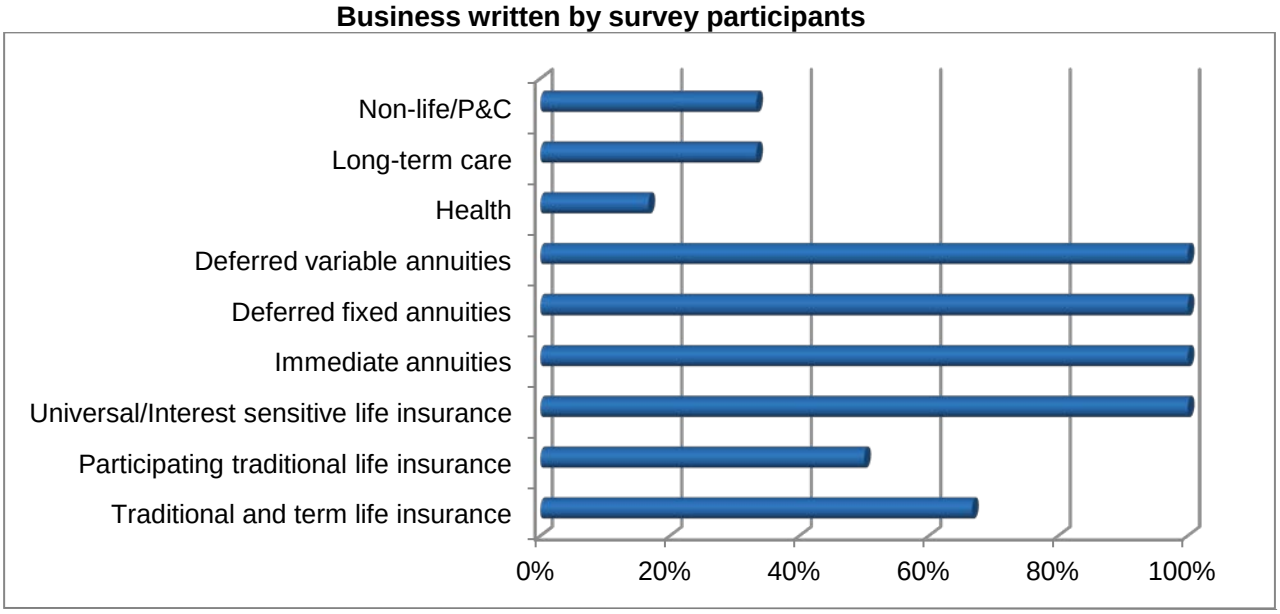

Figure 1-2

To understand who is responsible for managing market risk, survey respondents were asked a range of questions about risk management strategy, including:

- *Risk committee and risk management responsibilities;*
- *If market risk is managed centrally or within product lines and integrated among business functions;*
- *Reporting on the market risk process;*
- *Objectives of measuring market risk.*

Most respondents have an ERM committee. Either Chief Risk Officers (CROs) or Chief Financial Officers (CFOs) chair most committees. The committees typically include management from the major business units, a corporate function, CFOs, Chief Investment Officers (CIOs), and Chief Actuaries. The ERM committee's primary responsibility is overseeing risk management activities, defining risk tolerance levels and defining policies. Individual businesses or risk groups (including corporate finance, actuarial, investment, or other subcommittees within each business unit) typically perform day-to-day measurement and management of risk or reports. However, in most cases, respondents indicated that market risk management is a collaborative effort among business units and has a central function. Joint responsibilities include pricing, liability valuation, asset valuation, asset management and specific risk management functions. At those respondents employing a CRO, it was typical for the CRO to receive ERM reports. The CRO and its team are responsible for consolidating business unit output and findings and developing a central dashboard and writing risk reports. Otherwise, each business unit reports its own market risk to the central risk committee.

The primary objective in measuring market risk is to maintain a specific credit rating, manage capital, and reduce earnings volatility. Respondents analyze market movements to understand their impact on solvency and brand reputation. Sometimes, market risk objectives are based on a broad statement of purpose; sometimes, respondents follow specific plans that include well defined risk tolerances (e.g. through ERM governance process, Derivative Use Plan, and rating targets from A.M. Best, S&P and Moody's).

Most respondents noted that they base the frequency with which they update risk tolerances on objectives. Generally, they measure risk tolerances quarterly and review and define the overall tolerance level annually. When they use dynamic hedging, this measurement is performed more frequently (i.e., daily or weekly).

To understand company priorities in managing market risk, survey respondents were asked to rank their risk categories in order of importance (see Figure 1-3 for results). If a respondent stated that their answers vary by product line, we asked them to answer according to their most significant product line. Risk categories are as follows:

- Insurance Risk: Risk of loss due to mortality, morbidity or policyholder persistency.
- Credit Risk: Risk of loss due to a decrease in asset value related to increased risk of default.
- Market Risk: Risk of loss due to movements in the market (see Figure 1-4 for details).
- Operational Risk: Risk of loss resulting from inadequate or failed internal processes, people and systems or from external events. This definition also may include legal risk other than compliance risk, but excludes strategic and reputational risk.
- Compliance Risk: Risk of loss resulting from noncompliance or violation of laws, regulations, prescribed practices or ethical standards.
- Liquidity Risk: Risk that a given security or asset cannot be traded quickly enough in the market to prevent a loss (or make the required profit).

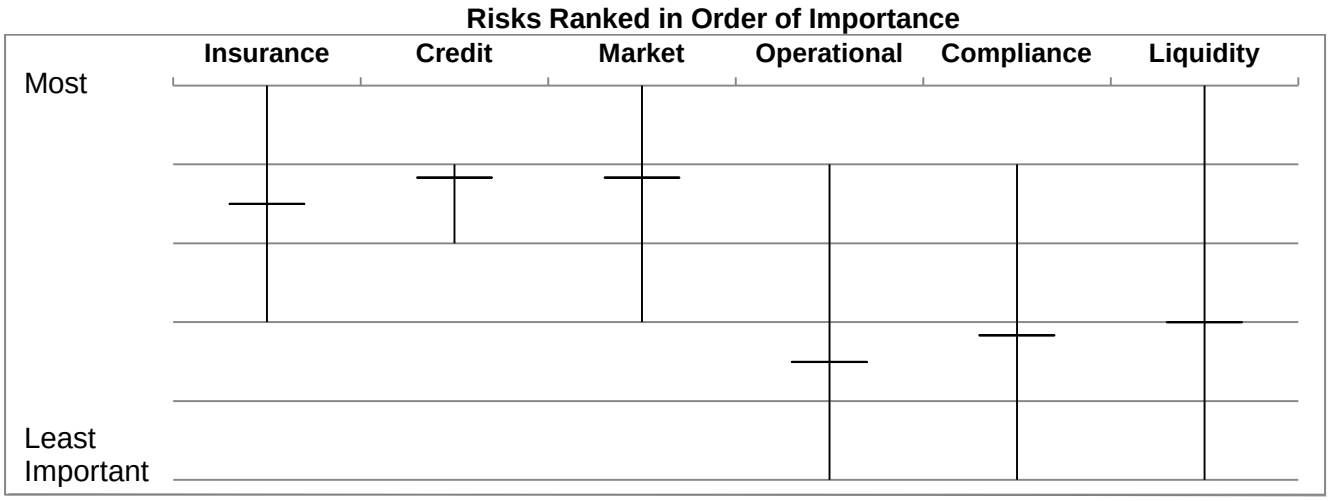

Figure 1-3

Generally, respondents rated market risk and insurance risk as the most important risks; credit risk is third (and was in all respondents' top three); operational and compliance risks are the least critical. In most cases, liquidity risk ranked towards the bottom of the list, likely because most respondents focus on traditional products such as whole life or term life. Those participants who sell primarily interest sensitive products rated liquidity risk as the most important risk.

We asked respondents to state which of the categories shown in Figure 1-4 they considered to be part of market risk. Figure 1-4 illustrates the proportion of each category they selected. Unsurprisingly, they all selected interest rates, equity prices and counterparty risk. Some also selected credit spread/risk premium, implied volatility, liquidity risk, execution risk on trades, and concentration risk. They seldom chose foreign exchange rate risk because the majority of participants do not have international parents or subsidiaries.

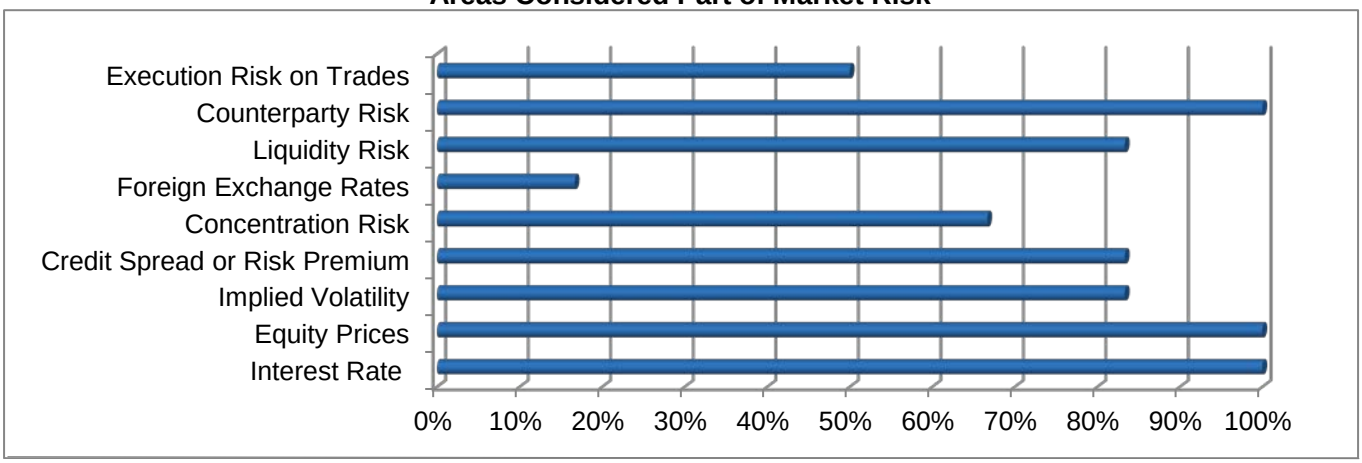

Figure 1-4

We asked survey respondents about their companies' ERM strategy, namely:

- *If they have a defined ERM strategy and if it is related or affects how the company views, measures, and manages market risk;*
- *The challenges they face managing market risk;*
- *If there are any recent or foreseen associated changes;*
- *If there is a defined risk tolerance level and if it is part of the decision making process;*
- *If they are planning to implement Solvency II.*

Generally, the participants have a defined ERM strategy in place. (However, there are several companies that fit the targeted profile for this survey but declined to participate because they did not have a defined ERM strategy and process.) Respondents have developed their strategies to measure risk and return, define risk metrics, set tolerance limits and determine action and mitigation plans. While the focus of strategies varies by company, there are a number of common themes:

- Optimize capital deployment;
- Maintain current or higher ratings;
- Produce risk adjusted earnings; and,
- Analyze business and growth strategies.

Respondents' greatest challenge is balancing the cost of measuring risk, mitigating risk, managing liquidity, and maintaining competitiveness of the products. Many respondents also noted that their ERM strategy focuses primarily on an economic capital outlook, and secondarily on accounting considerations.

Several respondents noted that they recently have taken action to improve their ERM function. Improvements include hiring a dedicated risk manager, adopting better practice methods (including better documentation, and developing risk tolerance around equity volatility), improving projection models (refining credit economic capital modeling), and focusing more time and resources on riskier products (statutory risk based capital and statutory earnings factors). Although most respondents are not planning to implement Solvency II, some of them noted they are following National Association of Insurance Commissioners' (NAIC) requirements (e.g. ORSA--Own Risk and Solvency Assessment).

Measurement approach

We asked survey respondents how their companies measure market risk. These questions addressed:

- *Metrics and measurement time horizon;*
- *If a scenario-based approach was adopted to model market risk;*
- *How these scenarios were developed;*
- *How respondents allow for risk interactions, aggregate risk across business units, and cross-product diversifications.*

Respondents use a number of measurement metrics to measure market risk. The most common ones are:

- Duration / key rate duration mismatch: Monitoring the duration mismatch between assets and liabilities. In some cases, this also took place for underlying asset and liability cash flow mismatches.
- Scenario analysis: Respondents use statutory asset adequacy scenarios, interest rate shifts, equity shocks, stochastic scenarios, and cash flow testing.
- Stress testing: Respondents generally performed this on risk based capital levels (for example, fixed annuity lapses, interest rate parallel shift up and down, interest rate steepening and inversion, increase in interest rate volatility, increase in equity volatility, decrease to equity levels and increase to credit spreads).
- Conditional tail expectation (CTE): Some respondents perform analysis that focuses on cash flow strain in tail scenarios. For all variable annuity blocks subject to Actuarial Guideline 43, they perform a CTE 70 analysis.
- Worst case scenario analysis: This is similar to scenario and stress testing, except that a worst case scenario combines many different scenarios or stresses a number of assumptions at the same time (rather than focusing on one movement), for example a "Japanese economy scenario."

Generally, participants use all or some combination of these (rather than relying on one particular measure). Other less commonly used measures are value at risk (VAR), economic capital, and solvency levels. However, several participants who do not currently use economic capital did note that they were analyzing the use of economic capital models both for risk management analysis as well as other benefits (e.g. if the models might be used for principles based reserves or other measures).

The primary modeled risks include both market related risks (e.g. interest rate risk, credit risk, equity risk, and counterparty credit risk-related to both hedges and reinsurance) and policyholder behavior (e.g. mortality and persistency).

Where respondents use cash flow models to measure product market risk, they typically conduct measurement over the life of the products (or a materially equivalent number of years). For analysis relating to economic capital or thresholds related to the surplus levels, results are analyzed for between one and five years. The most common threshold is either one year or three to five years.

To develop economic scenarios, most participants use a combination of in-house systems and third-party software. Depending on the purpose, they use both real world and risk neutral scenarios. (Real world scenarios reflect the real probability distribution of market movements and include a risk premium. On the other hand, risk neutral scenarios are based on an arbitrage-free model that assumes all financial assets have the same rate of return. This occurs through the use of risk-free rates. Respondents generally use risk neutral scenarios for pricing and replication.)

The most common sources of economic scenarios are:

- TAS's CAP: This scenario generator is a cascade structured mean reversion model that is based on the Brennan Schwartz two factor interest rate model;
- Barrie-Hibbert Economic Scenario Generator: This produces arbitrage-free risk neutral and real world scenarios covering a broad asset base;
- American Academy of Actuaries (AAA) scenarios.

In terms of measuring risks across various asset classes, participants generally include a measure for correlation between various asset classes and market-related risks (e.g. economy, dynamic lapse, inflation). The most common approaches are correlation matrices, prescribed formulas (e.g. Actuarial Guideline 43), and stochastic modeling to combine all risks. Some establish scenarios that allow different correlations between anticipated behaviors and monitor these over the years to check the appropriateness of assumptions.

When asked which approach they use to model the interaction between insurance and market risks, respondents provided a variety of answers. Their modeling approaches include use of catastrophe modeling, cash flow testing, market consistent embedded value measures, economic capital modeling and scenario analysis. Under these measures, some respondents also noted that they incorporate dynamic policyholder behavior formulas into their projection models. They apply dynamic policyholder behavior to fixed annuity lapses, and withdrawal and annuitization on guaranteed living benefits for variable annuities.

We asked survey respondents how their companies use hedging to mitigate market risks. This addressed

- *Key hedging objectives;*
- *Product or company level;*
- *Measurement basis for measuring market risk;*
- *Risk neutral or real world;*
- *Attribution analysis (if any);*
- *Effectiveness measurements and any limitations (if any);*
- *Hedging basis (Delta, Vega and Rho);*
- *Frequency of hedge metrics rebalancing;*
- *Approaches (and their measurements) for mitigating market risk.*

All respondents indicated that they use hedging for products with guarantees or options. They noted that they develop hedging strategies separately for specific products; for example, equity indexed annuities, variable annuities with guaranteed minimum living benefits, and long term care. They hedge to minimize the volatility in economic liabilities, maintain certain levels of statutory surplus or minimize volatility in GAAP earnings. In addition to hedging specific products, some participants employ macro hedges to cover interest rate risk or to protect statutory earnings in certain scenarios, particularly if they base their product hedging approach on economic capital projections and earnings (rather than an accounting basis). This might reflect a desire to maintain a specific credit rating.

To determine hedging strategies, most participants use both risk neutral and real world models. However, most of them use a risk neutral model, while a few others also have real world models. Respondents noted that their risk neutral models typically are stochastic in nature and are used primarily for economic hedging. They use real world bases particularly when analyzing specific scenarios or as part of what-if cases.

When asked about how to aggregate product risk to potentially realize diversification benefits across the company, most respondents said that they struggle to model hedging at an aggregated company level. Many of them added that system limitations are the primary reason for modeling the hedging on a product rather than a company basis. Those who are able to hedge on a company basis stated that they use a common set of economic scenarios between products and run them separately. By using the same set of economic scenarios, they are able to include some diversification benefits because market movements affect cash flows differently for various products. It was also noted that some companies are reviewing their economic scenario generators in order to develop a uniform set of scenarios.

When asked to describe their current hedging strategy, most respondents indicated that they monitor how assets and liabilities move against equity performance, interest rate movements and changes in market volatility. They aim to hedge a number of "Greeks" including Delta, Vega and Rho. A few respondents indicated that they intentionally do not hedge (or only partially hedge) some interest rate risk (Rho) because the cost of hedging outweighs the risk mitigation benefits.

To analyze hedge effectiveness, most respondents monitor hedge breakage on a period by period basis. Most of them perform some form of attribution analysis that categorizes hedge breakage into key economic factors. Their attribution analysis is somewhat to very detailed, and they are comfortable with the level of their analysis. Many respondents stated that their attribution analysis focuses on hedge breakage on a period-by-period basis, with consideration of longer term effectiveness.

When asked about how effective their hedges are, most respondents commented that they are very successful in their hedging results. However, some mentioned that there are trade-offs over the cost of hedging and the benefits it brings. For measuring the effectiveness of the hedges, most respondents look at how the underlying hedge derivatives move relative to the liability. Some pointed to the ratio of hedge costs to capital costs or the stability of return on capital by business unit as additional performance measures or the stability of the return on capital requirements by business unit as additional performance measures. Some noted other objectives that include managing the hedging program so that the company can maintain liquidity and adequate capital, and reduce volatility in earnings.

We asked what other approaches companies use to manage risk. Many respondents noted that their risk mitigation techniques start with product design and establishing conservative investment practices (which they monitor frequently). Others purchase interest rate floors or develop macro strategies to allow for derivative use if risk tolerance approaches yellow or red zones.

Reporting and Risk management staff

We asked survey respondents to describe their risk management function and how they report market risk. Questions addressed the following:

- *To whom market risk management metrics are reported;*
- *If reports are produced at legal entity level;*
- *The CRO's key focus;*
- *The content and frequency of risk management reports;*
- *The background and size of the market risk team.*

Most of the time, market risk reports contain multiple segments: risk and value reports, hedging reports, dashboard which summarizes results and positions, risk based capital (RBC) reports, asset liability matching (ALM) reports from the actuarial department, and operational risk management reports. Some reports are generated at the legal entity level while others are at the product grouping level. Depending on the nature of these reports, some are updated on a daily basis (e.g. dashboard) and some are updated monthly or quarterly (e.g. ALM and investment pack). The CRO, C-Suite, Board of Directors, and audit committee review these reports at most survey respondents' companies. Some respondents also provide these reports, or a summary of them, to rating agencies, the investment committee, the Chief Actuary, and ERM governance groups (see Figure 1-5 for details). Executive management (e.g. the Board of Directors and the C-Suite) generally review condensed versions of these reports while ERM Governance Groups receive more detailed findings.

Reviewers of Risk Reports

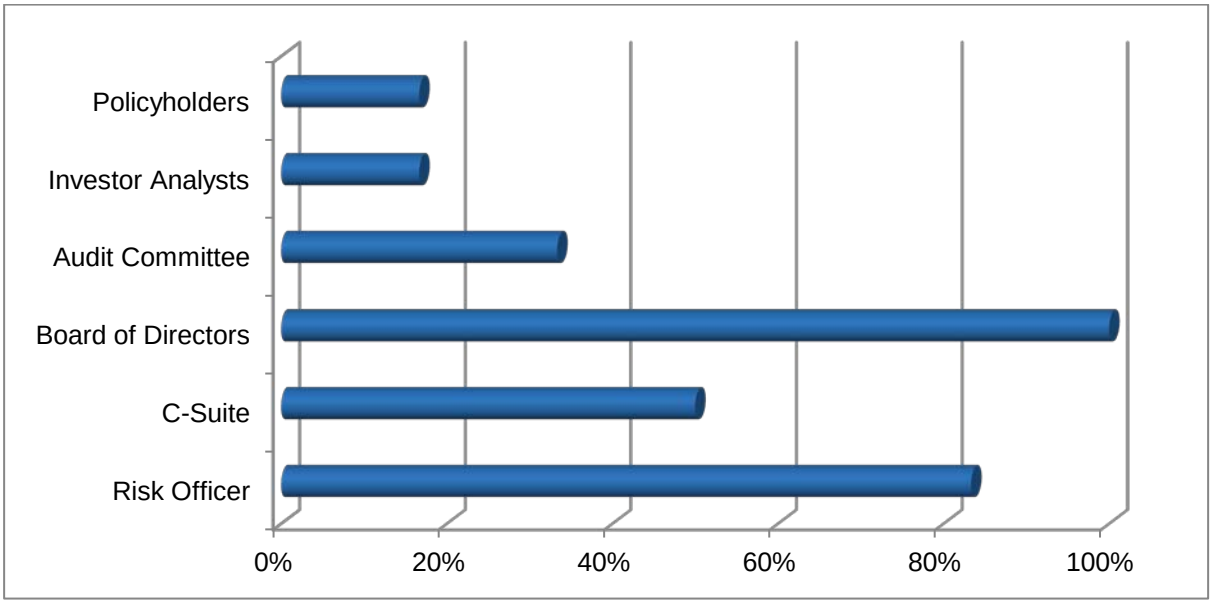

Figure 1-5

For some respondents, the CRO was also the Chief Actuary or was the former Chief Actuary. When evaluating these reports, CROs focus primarily on:

- Managing liquidity, capital adequacy and earnings risk;
- Closely coordinating work with the Chief Actuary, CIO and head of each business unit; and,
- Communicating and overseeing risk tolerance for the entire company.

In terms of staff governance and oversight, most survey respondents have risk management report to the CFO or CRO. At the corporate level, the risk management committee usually contains a handful of representatives of each business unit.

At the individual business unit level, various groups within the organization (e.g. finance department, investment department, actuarial department) conduct risk measurement and monitoring. None of the surveyed companies have full-time staff who focus only on managing market risk. They usually manage risk via a collaborative effort throughout the organization. For respondents who hedge, hedging staff generally are responsible for market risk measurement. As a result, it is almost impossible to exactly determine the size of the market risk team. Most employees within these market risk committees have more than ten years of experience and have acquired FSA (Fellow of Society of Actuaries), CERA (Chartered Enterprise Risk Analyst), CFA (Chartered Financial Analyst), CPA (Certified Public Accountant), MBA (Masters of Business Administration), FRM (Financial Risk Manager), PRM (Professional Risk Manager), FLMI (Fellow, Life Management Institute), or similar designations. Management (e.g. C-Suite) appears confident that risk management staff have more than sufficient expertise to manage market risk.

Systems and data

We asked survey respondents about the systems they use to measure market risk, including:

- *Who oversees data management system quality;*
- *Modernization of valuation systems in light of new reporting standards;*
- *Who produces market risk measures and which systems are used to do so;*
- *Controls in place to monitor the accuracy of results and the systems adopted;*
- *Key assumptions and sources referenced in setting assumptions; and,*
- *The process for approving assumptions.*

When managing market risk data, most survey respondents use in-house mainframe systems together with outside sources or industry standard packages. The majority of respondents believe that these systems are adequate. However, they think improvements are needed to modeling capabilities for asset and liability integrations, hedging and valuing variable annuities riders, speed of data access, and the ability to centrally collect data. With the upcoming new reporting standards, most respondents are in the process of modernizing their valuation and data management systems. Some of them plan to move to new systems, others plan to update their current systems, and still others are updating their systems as an ongoing effort to improve their interaction, investment, tail risk, and stress testing capabilities.

In terms of the systems they use to develop market risk measures, most respondents use a combination of Excel models, in-house developed programs, and third party software (i.e., actuarial systems and market measurement systems). Sometimes, these data measurements take place centrally and sometimes they are a collaborative effort of people from each business team. Regardless, these systems produce data that generally are consistent with the data companies use for financial reporting. Respondents' companies use a combination of internal controls (e.g. SOX control, government standards, Derivative Use Plan (DUP), cross-check, and independent reviews) to monitor these systems. These typically include developing a Sarbanes-Oxley framework, internal audit reviews and external consultant reviews. In the process of determining hedging strategies, most respondents use the same systems listed above. Generally, a combination of in-house systems and third party systems also determines hedge strategies. Respondents usually combine and group policies to generate base information (e.g. policyholders' behavior, fund mapping, index exposures, and equity class movements) for their key approximations. Some of them also use closed-form solutions to obtain statutory reserves for variable annuities.

They use all available information, mostly from external sources (e.g. Bloomberg) -- including the firms with whom they do business -- to evaluate these assumptions. Meanwhile, although different respondents use different processes, they all require assumptions to be approved before implementation. Some participants have their financial risk management committee approve their assumptions, some assign this task to their Chief Actuaries, and others have individual product lines approve their own assumptions.

Conclusion

We limited the survey to a select number of insurance companies. This survey does not encompass all industry practice or benchmarking. The goal was to provide general insight into industry practices and identify topics of further consideration. Survey results show that there is a variety of practices in measuring and managing market risk. They range from rudimentary, where there is very little in place to measure and manage risk, to highly developed, where dedicated staff and committees are responsible for measuring and managing risk. In all cases, it is clear that respondents see measuring and monitoring risk as a subject of continued focus and an area of growth.

We believe the following areas are worthy of further research:

- Interest rate volatility modeling and thresholds;
- Policyholder behavior and the related, potential effects of economic risks;
- Aggregation techniques and analysis of diversification benefits to monitor and manage risks at the company level, rather than at the product or business unit level;
- Comparison of approaches in modeling market risk between insurers and banks; and,
- Comparison of approaches in modeling market risk between smaller and larger insurance companies.