How Should Insurers Optimally Manage Market Risk ?

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This Chapter Covers:

- What market risk is.
- Market risk in different companies and countries.
- Market risk governance and policy.
- How market risk is identified.
- Modeling and measuring market risk.
- Appetite for market risk.
- Monitoring market risk.
- Management of market risk.

Introduction

Market risk is a key risk for most life insurers, many of whom need to manage guarantees on volatile portfolios of assets. For general insurers, the importance of market risk varies depending on the tail of the business, but investment income is a key driver of profitability and market risk encompasses variations in this income. The author's experience is of the life insurance market in the United Kingdom, where there is a bias in coverage toward this market, but it is hoped that the points made are applicable to other insurers.

What is Market Risk?

Any framework for market risk should start from clear definitions of market risks as part of a comprehensive risk universe. There is no definitive classification of market risk *per se*—each company will use one that suits its needs, but the market risk classification should be suitably

granular to address the many different types of risks. It should also identify areas of overlap with other risks, not least as there may be separate accountabilities for these within a firm. The actuarial profession in the United Kingdom has published a paper on risk classification (Kelliher *et al.*, 2011), together with a spreadsheet of detailed risk categories, which may be of use in this regard.[1] This defines market risk as "the risk that as a result of market movements, a firm may be exposed to fluctuations in the value of its assets, the amount of its liabilities, or the income from its assets," and then identifies 11 high-level categories and nearly 100 subcategories of market risk.

Market Risk in Different Companies and Countries

There are wide divergences between the market risk exposures of insurers in different countries. In the United Kingdom, life insurers have exposure to guarantees which are in effect under "with-profits" policies, where part of the assets is invested in equities, effectively giving rise to an exotic put option position. Unit-linked funds offered by life insurers are a key investment vehicle for pensions. These generally contain no guarantees, with market risk borne by the policyholder, but the life insurer is exposed to fluctuations in fund-related fees. Until recently, pension funds have had to be converted into an annuity for life, and UK life insurers have substantial liabilities to this type of business, typically backed by corporate bonds to avail themselves of the liquidity premium on these (there being little need for liquidity as the annuities cannot be encashed), but this gives rise to exposure to movements in credit spreads.

By contrast, in the United States, with-profits or participatory business has evolved differently than in the United Kingdom, in part because of guaranteed surrender value requirements imposed by US regulators. Market risk exposure relates more to corporate bonds than to equities. Mutual funds rather than insurer unit-linked funds are the key vehicle for pension saving. Life insurer unit-linked offerings typically come as "variable annuities" with guarantees which are dynamically hedged.

Conversion to an annuity for life is not mandatory, so this business is not as important as it is in the United Kingdom.

If we were to look at life insurance markets in the European Union and elsewhere, we would find further diversity—what is notable about market risk in life insurance is its heterogeneity between different countries.

There are further differences in the case of general insurers, which typically have a more short-term investment outlook, although certain long-tail lines of business may have a similar time-frame of investment to that of life insurers. Typically, assets held will be mainly cash and bonds, reflecting the nature of the liabilities, but some general insurers invest in equities and other risky assets to boost investment returns and profits. Indeed, one of the most famous equity investors, Warren Buffet's Berkshire Hathaway, is primarily a property and casualty insurer.

As well as market risks relating to policy liabilities, insurers may be exposed to market risk in respect of staff pension schemes. The accounting and regulatory capital treatment of staff pension schemes may vary, but the economic risk posed by such schemes should be captured in the market risk framework. Similarly, there is an economic value associated with the value in-force (VIF) of future fund-related charges, and while this may not be reflected in accounts or regulatory capital, the market risk framework should capture fluctuations in VIF due to market risks.

Market Risk Governance and Policy

The insurance company's board is ultimately responsible for ensuring that risks are properly managed and for putting the risk management framework in place. The board should approve the market risk policy that dictates how market risk should be managed. In the United Kingdom, the insurer's market risk policy should comply with the Financial Services Authority's *Prudential Sourcebook* guidelines, which are actually quite sensible in outlining what market risk policy should cover.[2]

The market risk policy may encompass derivative risks (if these are permitted), setting down limits on how derivatives are to be used as well

as minimum requirements for derivative risk management. Alternatively there may be a separate, yet associated, derivative risk policy that encompasses not just market risks associated with derivatives but also counterparty and operational risks.

Market risk will generally be managed according to the "three lines of defence" model, with business units accepting primary responsibility for managing the risk as the first line, an independent risk management function forming the second line providing review and challenge on market risk, and internal audit providing assurance on market risk controls as part of the third line.

Most insurers will devolve the management of assets to fund managers who may or may not be part of the same financial group. Either way, while the task of managing assets and the risks associated with these is devolved, the responsibility for managing market risk remains with the insurer.

Market risk policy requirements should be embedded in investment management agreements (IMAs) with the fund manager. The life insurer should have an investment oversight committee to monitor whether the fund manager is adhering to the IMA as well as to monitor the manager's investment performance.

Identification of Market Risk

Based on the insurer's market risk classification system, the insurer should maintain a register of the market risks it faces. This should be reviewed at least annually to ensure that all market risks faced are captured. It should also be continuously updated as new risks are identified.

New risks may emerge due to new product offerings, investment in new asset classes, use of new derivative instruments, and/or changes in the nature of existing asset classes. New product offerings should be subject to risk assessments that include market and other risks. As well as seeking to identify new market risks associated with the product, these assessments should also consider how well current models of market risk address existing risks associated with the new product.

Whether an asset is truly "new" can be subjective, particularly for bonds where there is frequent innovation in terms of collateral, structure, etc. Fund managers may not consider an asset as new, but such judgments should be reviewed as part of the fund manager oversight process. The new asset class/derivative instrument assessment process should consider whether existing market risk models can be extended to cover the new asset or instrument, or whether a completely new model is required.

Insurers also need to be aware of changes in the nature of existing assets held. Again, bonds may be a problematic area, for example due to subtle changes in the quality of collateral offered on different issues.[3] Collateral may also vary under derivatives. This overlaps with credit risk, and there is a case for having a credit risk/counterparty risk committee regularly review bond holdings to pick up on such changes.

Insurers should carry out regular stress and scenario testing which may highlight market (and other) risks that have not previously been considered. They should also have a process to try to identify emerging risks, for example by holding regular workshops where participants are encouraged to think "outside the box."

Market Risk Modeling and Measurement

Having identified a risk, the next stage is to try to model it. There is often a wide range of techniques, statistical distributions, and data sets that can be used to model market risks. Whichever is chosen, it is important to illustrate the sensitivity of the result to alternative models, data, and assumptions so that senior management understand the weaknesses and limitations of the model.

Solvency II holds out the promise that an insurer's own model of market risk could form the basis for setting regulatory capital under the "internal model" approach. One of the requirements for this is the "use test," which requires that the internal model should be widely used across the business. Ideally, it should form the "house view" of that particular risk, being the default for modeling that risk for pricing, risk management, or other purposes. There will be some purposes for which an internal model is not suitable, but the reasons for this should be fed back into model development.

Another requirement for internal model approval—and good practice in any case—is that the model should be independently validated by a separate function. For example, the second-line risk management function might validate models proposed by the first-line actuarial function. Validation should consider qualitative aspects as well as quantitative techniques, such as back-testing.

It is important to note that there is no perfect model. Risks change over time and insurers should have a continuous cycle of model validation and improvement to ensure that models remain a reasonable approximation to reality.

Once we have models of market risks, we can measure these risks. There are many ways of doing this. At the heart of Solvency II is a "value-at-risk" (VaR) approach, which looks to ensure that we have enough economic capital to withstand risks over a one-year period at a 99.5% confidence level. By contrast, US regulatory capital requirements are based on a "conditional tail expectation" approach, which looks at the expected losses arising from a risk above a certain confidence level.

These capital figures can serve as risk measures: for example, the insurer may measure market risks as the one-year 99.5% VaR figures calculated for Solvency II. Alternatively, we may use a lower confidence level—for instance, 95% one-year VaR—as a measure, focusing on less extreme, more likely events that may occur.

Using internal models to measure market risk helps to satisfy the use test, but we could use other metrics either in addition to or in place of figures from internal models. For instance, we may have a measure of corporate bond spread risk based on the sensitivity of the corporate bond portfolio to a one basis point increase in spread. Whatever measure is chosen, the insurer should be able to update risk measures regularly in line with market conditions, using approximations if necessary.

Risk Appetite

Being able to measure a market risk helps a firm to determine its appetite for that risk; few if any firms will have an appetite for unquantifiable risks.

At the heart of any risk appetite framework is the concept of economic profit and whether rewards offset the risks involved. However, this is generally assessed at an aggregate level, allowing for diversification between market and other risks. Assessment should be supplemented by a separate consideration of risks on an undiversified basis, as market risks which may make a marginal contribution to diversified requirements may be significant on a stand-alone basis.

Undiversified Solvency II or other economic capital figures could be used as the basis for this assessment. Furthermore, projections of undiversified requirements as part of business planning could help serve as a basis for setting limits based on measures of undiversified requirements.

For example, the projected requirement at the end of the business planning period plus a margin could form the basis of a draft limit. This reflects the trajectory of undiversified market risk exposure that is implicit in the business plan. When this is presented to the board, it is made aware of the impact of the business plan on exposure to market risk, and it has the opportunity to amend the plan if it is not comfortable with the consequences. Quantitative limits on market risks can be set iteratively. Note that current exposures may be in excess of the board's long-term desired level. The board may set a tolerance for this excess exposure, accepting it in the short term, but indicating its desire to eliminate excess exposure over the medium term.

As well as quantitative risk appetite limits, the market risk appetite assessment process should also seek to elicit the board's view of individual risks in the form of appetite statements. This process should consider qualitative aspects, such as whether the insurer considers it has a core competence in managing a market risk, or whether it considers the risk to be adequately rewarded. For example, Berkshire Hathaway is a company which believes that it has a core competence in managing market risk, while many insurers would consider interest rate mismatches to be unrewarded as these can be readily addressed by matching cash flows and using swap overlays.

Below quantitative limits and qualitative statements, there will be lower-level requirements that should be codified in a market risk policy. For example, equity risk models typically assume a well-diversified

portfolio, but a policy will need to stipulate tolerances for how (un) diversified a portfolio may be, particularly when some stocks may account for more than 5% of an index.[4]

Finally, risk appetite assessment needs to consider not just economic impacts but also the regulatory capital impacts of risk, and the impact of these on distributable cash flow. This will typically be assessed at an aggregate level across all risks, but market risks will influence the capital buffer that a firm needs to hold to keep the possibility of breaching regulatory requirements to an acceptable level.

Monitoring Market Risk

Having determined the means to measure and set appetite limits for risk, the next stage is to monitor risks to ensure that exposure remains within appetite, to assess the impact of market risks crystallizing, to identify new risks and issues emerging, and to refine the model of market risk and hence the "house view" of that risk.

If risk appetite limits are based on capital figures, ongoing estimates of these for capital management could also be used to see if exposures are within limits. Otherwise the measures on which limits are based will need to be reassessed regularly to ensure that the insurer stays within appetite.

This exposure monitoring process should be supplemented with key risk indicators (KRIs), which may serve as a proxy for market risk exposure and impacts. For instance, annuity liabilities may serve as a quantum of the market risk implicit in an annuity portfolio, while the S&P 500 Index level may serve as an indicator of the impact to date of US equity market movements.

It may be an idea to consider relative valuation-based metrics, such as rental yields and price–earnings ratios (PERs), as KRIs which may warn of market bubbles and hence a greater risk of a fall. For instance, the average UK PER since 1988 has been 17, with a standard deviation of 4.[5] A PER of 25 (i.e. two standard deviations above average) may flag possible overheating of equity markets, while a PER of 9 may indicate

an undervalued market, and hedging out—and thus locking in—at this level may not be wise.

As well as quantitative limit monitoring, there needs to be a robust compliance process to ensure that fund managers are adhering to investment management agreements and that market risk policy is being adhered to across the organization. A sophisticated internal model and limit structure will count for nought if excessive concentrations in individual stocks and/or sectors are allowed to develop.

Managing Market Risk

Insurers will often have access to well-developed markets to hedge most market risks, or they may be able to match cash flows to minimize market risk. However, it is worth noting the following limitations.

- Equity risk exposure can be hedged using futures and options. However, the latter requires an up-front premium, while the latter has a hidden cost in that it typically locks in equity-related growth to the risk-free rate, foregoing any equity risk premium. This may have adverse reporting consequences if operating profits include this premium.
- Hedging using index derivatives gives rise to basis risk related to the tracking error between actual portfolio and index performance. On an unhedged basis, this basis risk may be diversified away against broader market risk, but it can be quite significant on a hedged basis.
- Equity basis risk will also arise between benchmark indices (like the FTSE All Share in the United Kingdom) and indices on which hedges are based (with the FTSE 100 being the most common in the United Kingdom).
- Basis risk also arises between credit default swap (CDS) premiums and spreads on bonds, and the current financial crisis has seen spreads on the latter rising faster than CDS premiums; this leads to greater falls in bonds than the rise in offsetting CDS positions, although to the extent that this relates to a greater liquidity premium there may be offsetting benefits in liability valuation.

- In hedging currency risk, if we are hedging a "risk-free" asset like US Treasury bonds, the hedge should compensate for movements in overseas yields as well as currency movements. However, if we hedge a corporate bond with a variable spread over risk-free, residual overseas interest rate risk will arise, while changing spreads can lead to under-/overhedging, resulting in quite a volatile combination of asset and hedge, which needs to be closely monitored.
- Dynamic hedging of options and guarantees will break down when markets move faster than the insurer can rebalance positions, as on "Black Monday," October 19, 1987. Ultimately, dynamic hedging can only mitigate, not eliminate, market risk exposures.

Finally, hedging using derivatives poses operational challenges in terms of: documentation, particularly for over-the-counter transactions; monitoring and rebalancing hedges; and valuing positions and managing collateral. Margin and collateral calls give rise to liquidity risk, which needs to be managed. Any program to hedge or otherwise manage market risk needs to have regard to the operational capabilities of the insurer and its fund manager.

Case Study: Interest Rate Risk

Here we will take the main points considered in this article and apply them to interest rate risk (defined here in terms of nominal rates and excluding risk relating to real yields on index-linked bonds and swaps).

Risk definition

Interest rate risk is typically defined in terms of movements in risk-free rates, but what are these—the yields on government bonds, or swap rates? Whichever is chosen should be communicated to all involved in interest rate risk management to ensure that there is no ambiguity.

There is a residual risk relating to differences between government bond yields and swap rates which may be considered under interest rate risk or as a separate risk category in its own right. (It may be considered as the spread over or under swaps of sovereign bonds.)

Risk identification

As an example, as part of the new product risk assessment of a variable annuity offering, a life insurer may identify a risk relating to the sensitivity of guarantee costs to interest rates (known as "rho"). This will be typically be hedged dynamically, but there may be exposure to interest rate changes between rebalancing. Given the short-term nature of exposure, existing models of interest rate risk looking at a one-year perspective may not be suitable.

Scenario analysis may generate scenarios that affect interest rates, and the insurer should consider what it may do to mitigate such changes. The scenarios should also be fed into interest rate risk models to see whether they invalidate these models—though this should be a two-way process as models could highlight unrealistic impacts under the scenario.

Risk modeling

Modeling nominal interest rate risks is complicated by the need to model separate yet correlated changes at different points of the yield curve. A common approach to modeling the different parts of the curve is to use principal components analysis (PCA). This decomposes the variance–covariance matrix of rates at different terms into uncorrelated components, which generally turn out to be changes in the level, slope, and shape of the yield curve. Separate stresses for changes in the slope and shape of the yield curve can highlight mismatches at particular durations of the curve and exposure to nonparallel yield curve shifts, even if the portfolio is matched by duration.

Risk measurement

The impact of PCA stresses at a 99.5% or 95% one-year level could be used as a risk metric. Another possible metric may be the "PV01," or the change in present value of assets and liabilities with a 1 bp change in yields. This will be linked to the duration of assets and liabilities. Ideally, risk measures would capture exposure to nonparallel as well as parallel yield curve movements.

Risk appetite

Interest rate risk is often considered as unrewarded risk as it can typically be hedged by matching cash flows. However, matching may not be possible for long-term cash flows, while matching on an economic basis may lead to a mismatch on a regulatory capital basis and vice versa due to margins (e.g. for life expectancy) in the latter.

The insurer may also permit a degree of investment freedom to bond fund managers to benefit from their skills but at the expense of modest divergences from a matched position. Ultimately the resulting exposures will need to be fed into interest rate risk appetite.

Risk monitoring

Aside from monitoring exposures against appetite, insurers may monitor KRIs such as benchmark yields (e.g. a 10-year swap rate) as a proxy for interest rate changes to data; and the average duration of assets and liabilities separately as a measure of how well these are matched. Note that average duration may mask mismatches at different points of the curve and there needs to supplementary monitoring of matches by term bands.

Risk management

Insurers may be able to match liability proceeds exactly with cash flows, thus hedging out interest rate risk. Alternatively, they may use immunization techniques to guard against changes in the yield curve, choosing assets with the same duration as and wider convexity than liabilities. Although easier to implement, this approach requires assets to be regularly rebalanced. It is also vulnerable to nonparallel yield curve shifts. A compromise approach would be to split asset and liability cash flows into term bands and ensure that cash flows in each band are matched.

Interest rate swaps increase the flexibility available to insurers to match cash flows. Often they can be applied as an overlay to nonbond assets, hedging out interest rate risk in respect of liabilities while leaving a residual mismatch between asset proceeds and cash obligations under the swap.

Note that even if assets are in cash, there will be residual risk to differences between deposit rates and the LIBOR and other benchmark rates in which obligations are expressed. As well as swaps, interest rate swaptions can be used to hedge the cost of interest rate-related guarantees such as guaranteed annuity rates.

Summary and Further Steps

The article has set out some pointers as to how an insurer may optimally manage market risk, but there is no single ideal framework. Insurers will face a wide variety of risks depending on the countries and markets in which they operate. Whatever framework they put in place should be commensurate with the amount and complexity of the market risks they face.

However, the financial crisis taught many insurers bitter lessons about their market risk exposures, and there are no grounds for complacency. Market risk frameworks should be robust enough to identify and cope with new risks that emerge. Insurers should never consider their framework to be final but should always be looking to improve it.

It is recommended that insurers consider the following.

A market risk classification should be reviewed for granularity and for any ambiguity between market risks and other risks. The UK actuarial profession's classification system (Kelliher *et al*., 2011) could help in this assessment.

- Are market risk policy requirements embedded in investment management agreements? How strong is the governance over asset managers?
- How are new market risks relating to products identified? How would the insurer identify new asset types or material changes in existing classes?
- What process is in place to identify emerging market and other risks?
- How integrated are internal models with the wider risk management framework? How are these reviewed and updated for new products and asset types, or for changes in existing risks?
- How is market risk monitored? Does this consider breaches of market risk controls as well as quantitative KRIs?
- What are the limitations of the techniques used to manage market risk?

More Info

Market risk is a very broad topic and it would be impossible to list all relevant papers and texts. The author recommends the following sample of books and papers to those wishing to know more about market risk and its management.

Books:

Ferguson, Adam. *When Money Dies: The Nightmare of Deficit Spending, Devaluation, and Hyperinflation in Weimar Germany*. New York: Public Affairs, 2010.

Galbraith, John Kenneth. *The Great Crash 1929*. New York: Houghton Mifflin, 2009. A classic account of financial disaster.

Hull, John C. *Options, Futures, and Other Derivatives*. 8th ed. Upper Saddle River, NJ: Prentice Hall, 2011. Seminal textbook covering derivatives and the risks associated with these.

Reinhart, Carmen M., and Kenneth S. Rogoff. *This Time Is Different: Eight Centuries of Financial Folly*. Princeton, NJ: Princeton University Press, 2011. Excellent coverage of financial crises, putting these into their historical and geographical perspective.

Sweeting, Paul. *Financial Enterprise Risk Management*. Cambridge, UK: Cambridge University Press, 2011. Textbook on market risk and wider financial risk management, giving a sound grounding in quantitative techniques for modeling these.

Taleb, Nassim Nicholas. *Fooled by Randomness: The Hidden Role of Chance in Life and in the Markets*. New York: Random House, 2005. An interesting read with some profound insights into financial market behavior.

Reports:

Besar, D., P. Booth, K. K. Chan, A. K. L. Milne, and J. Pickles. "Systemic risk in financial services." Institute and Faulty of Actuaries, November 27, 2009. Online at: tinyurl.com/ms2brou. Paper on systemic risks and how market and other risks may be amplified.

Derivatives Working Party of the Institute and Faculty of Actuaries. "Credit derivatives." Institute and Faculty of Actuaries, January 26, 2006. Online at: tinyurl.com/lw66pe8

Eason, Scott, William Diffey, Ross Evans, Paul Fulcher, and Tim Wilkins. "Does your hedge do what it says on the tin? Hedging strategies for insurers: Effectiveness in recent conditions and regulatory treatment." Staple Inn Actuarial Society, April 13, 2010. Online at: www.sias.org.uk/view_paper?id=April2010talk

Frankland, Ralph, Andrew D. Smith, Timothy Wilkins, Elliot Varnell, Andy Holtham, Enrico Biffis, Seth Eshun, and David Dullaway. "Modelling extreme market events." Institute and Faculty of Actuaries, October 22, 2008. Online at: tinyurl.com/mvycwyd. Paper by the UK actuarial profession's benchmarking stochastic models working party, with particularly good coverage of equity market falls.

Kelliher, P. O. J., D. Wilmot, J. Vij, and P. J. M. Klumpes. "A common risk classification system for the actuarial profession." Institute and Faculty of Actuaries, October 31, 2011. Online at: tinyurl.com/mgrz82j; accompanying spreadsheet: tinyurl.com/jvtdxvl

Lazzari, Shaun, Celine Wong, and Peter Mason. "Dimension reduction techniques and forecasting interest rates." Staple Inn Actuarial Society, July 17, 2012. Online at: www.sias.org.uk/diary/view_meeting?id=SIASMeetingJuly12. Includes useful coverage of the PCA technique widely used in modeling yield curves.

Maher, J., J. Corrigan, A. Bentley, and W. Diffey. "An executive's handbook for understanding and risk managing unit linked guarantees." Institute and Faculty of Actuaries, October 20, 2010. Online: tinyurl.com/m6tfahd

1 Disclosure: I lead the working party which produced this paper and accompanying spreadsheet.

2 See SYSC 16.1 of the sourcebook: fsahandbook.info/FSA/html/handbook/SYSC/16/1

3 See Anna Katherine Barnett-Hart, "The story of the CDO market meltdown: An empirical analysis," March 19, 2009. Online at: tinyurl.com/m3mqhd9 [PDF].

4 On October 31, 2012, for example, HSBC accounted for 7.6% of the FTSE 100 Index and 6.5% of the FT All Share Index; see www.ftse.com/Indices/UK_Indices/index.jsp

5 Based on quarterly FT All Share Index price–equity ratios from 1988 to 2011; see tinyurl.com/mu6jmgt