Actuaries Institute Australia

LIFE INSURANCE AND RETIREMENT VALUATION

MODULE 14: CAPITAL MANAGEMENT

Education Program
ACTUARIES INSTITUTE

Education that Counts

Fellowship Program

Module 14

CAPITAL MANAGEMENT

Education that Counts

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14. Capital management

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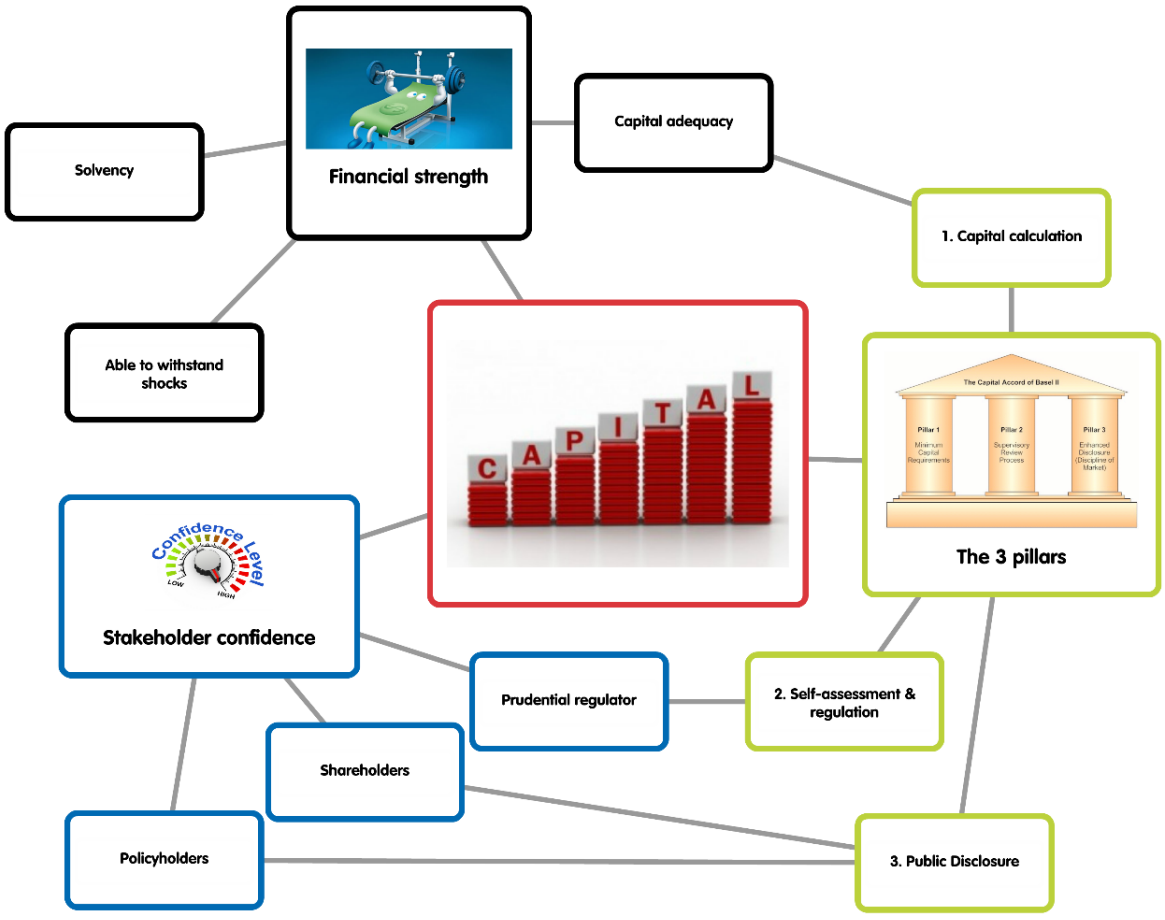
Figure 14.1 provides a visual mind map, summarising the key topics to be covered in this module. You should take a moment to look over this and think about what each of the topics might mean before starting to read the module. As you read through the module, think about other concepts that you would like to add to this mind map to create a more detailed visual summary of your learnings.

Figure 14.1: Module mind map



14.1. Introduction

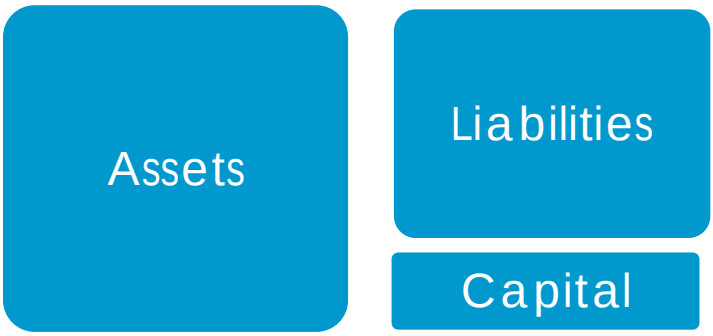
The fundamental objective for any retirement fund or life insurance company is to meet liabilities as they fall due. An entity is only able to continue operating if it is solvent, meaning that, on the balance of probabilities, it is likely to be able to pay all its debts when they become due.

Module 5 (Life valuation) discussed a variety of techniques for placing values on policy liabilities in a life company and Module 9 (Retirement valuation) discussed similar concepts for defined benefit retirement funds.

The purpose of the valuation drives the choice of method and assumptions. The strength of the valuation basis determines the present value of the liabilities and provides a certain level of confidence that assets will be sufficient to back liabilities. For example, a best estimate basis using a gross premium cash flow method may translate into a 50% probability of sufficiency[1]. In this scenario, there is clearly a risk that actual experience will be worse than expected and the fundamental objective won't be met (i.e. assets held will be insufficient to support liabilities).

As set out in Module 7 (Balance sheet), capital is defined as the amount by which assets exceed liabilities, as illustrated in Figure 14.2.

Figure 14.2: Capital



[1] Technically, a best estimate basis will approximate the mean value of the liability, which will be different to the median (50% probability of sufficiency) if the liability distribution is not symmetrical, which it often isn't.

All material presented in this module is attempting to answer the following question about the capital adequacy of a company:

> *"What value of assets is required to cover liabilities with a stated level of confidence, if actual experience is much worse than expected within a stated time horizon?"*

The question above is normally expressed as:

> *"How much capital is required to cover liabilities, with a stated level of confidence, in the event of shocks or extreme events?"*

This module focuses on what is meant by assets, liabilities and shocks. There is a lot of material to learn, but essentially the content describes a comparison of a balance sheet in 'normal' circumstances and one in 'shocked' or 'stressed' circumstances, as well as discussing how to construct the stressed balance sheet.

For example, Table 14.1 lists three assumptions which may be part of a term insurance policy valuation and suggests changes that may be made to these assumptions under a stressed basis.

Table 14.1: Normal vs. stressed bases

Assumption	Normal basis	Stressed bases
Mortality	120% of standard table	1. 1.5 x Normal for one year to allow for randomness over one year 2. 1.1 x Normal in Year 2 onwards to allow for misestimation of the normal basis and future trend 3. Normal + 400 per million for 2 years representing a pandemic scenario
Maintenance expenses	$50 p.a. plus CPI	1. 1.2 x Normal in Year 1 2. Normal CPI + 1% for one year
Fixed interest yields	10-year government bond yield	1. Normal + 2% p.a. 2. Consider additional reserve to allow for duration mismatch between assets and liabilities

A stressed scenario can have an impact on either side of the balance sheet. For example, the mortality shocks in Table 14.1 may increase the liability (through higher claim rates for term policies) but are unlikely to impact asset values. On the other hand, the first fixed interest yield shock in Table 14.1 is likely to reduce the value of both bond assets (through a drop in prices) and liabilities (through the use of a higher discount rate).

In practice, a wide range of risks are taken into account in determining stressed scenarios appropriate for the company or fund. In Module 13 (Risk management), risks were classified into:

- Financial risks, such as:
  - insurance risk (mortality, morbidity, persistency, expenses);
  - credit risk;
  - market risk (including mismatch between assets and liabilities); and
  - liquidity risk; and
- Non-financial risks, including:
  - operational risk (poor business decisions, inadequate or failed internal processes, people and systems, or external events impacting on the business's operations)
  - strategic risk; and
  - application/execution risk.

The definition of risk in Module 13 (Risk management) covers upside as well as downside risk. However, in this module, we focus mainly on the impact on capital of extreme downside deviations from objectives (shocks).

Exercise 14.1

The purpose of life insurance is to transfer risks contingent on the health status of an individual to a life insurance company. Explain why it is challenging to assess insurance risk. (Hint: Set out an answer that considers assumptions, timescales and actual experience.)

Risk-based capital is a method of measuring the minimum amount of capital appropriate for a company to support its overall business operations, taking into account its size and risk profile. A risk-based capital method limits the amount of risk a company can take as it requires a company with higher risk to hold more capital.

The simplified example shown in Table 14.1 introduces the discussion to follow throughout this module, which relates to the following key steps in a risk-based capital calculation process:

- select suitable stressed scenarios and assumptions;
- calculate assets and liabilities under each of the stressed scenarios; and
- aggregate the overall impact of each of the stresses, allowing for correlation and diversification between them.

Capital required under each stressed scenario is the difference between net assets calculated under the 'normal' valuation basis and under the 'stressed' basis. Under each individual stressed scenario, a new net asset calculation is performed, with capital required calibrated to the chosen confidence level.

Total capital required is unlikely to be the simple sum of capital required under each individual stressed scenario because:

- the various stresses are likely to be inter-related; and
- it is extremely unlikely that all stresses tested will occur at the same time.

In combining the impact of all stresses (or risks) tested, there is a need to understand how the risks relate to and depend on each other. This will be discussed in Sections 14.4.18 and 14.4.19.

This module considers the history and development of risk-based capital, including comparisons to other methods of calculating capital, with content drawn from 'A Global Framework for Insurer Solvency Assessment'[2] and from 'Measuring and Modelling of Dependencies in Economic Capital'[3]. Whilst published capital standards have solved some of the issues raised in these papers, the papers provide a useful outline of why various models should be considered. The intention in this module is to prepare students to think about the general themes contained in capital standards, ahead of learning detailed Australian capital standards in the Application subjects.

Many of the discussions in this module have a life insurance focus. While life insurance regulations require companies to hold enough capital to avoid the need to seek recourse to finance in future years, defined benefit retirement funds rely on the fund employer to make up any future shortfalls. Therefore, fewer capital constraints apply for retirement funds, where holding reserves (assets greater than member liabilities) is often focused only on operational risk.

While we don't make explicit reference to retirement funds in this module, the concepts can (and should) also be applied in this context. Members and employers of defined benefit funds are probably exposed to more risks than they realise. Shortfalls in accumulated funds arise from several sources of risk, including lower than expected investment earnings, higher than expected increases in member salaries and higher than expected longevity of retired members receiving annuity benefits. These risks can cause volatility in the level of contributions required by employers and, in some cases, may place the employer in financial difficulty and see them unable to contribute at the level required to support guaranteed retirement benefits. As you read through this module, you should think about how the concepts covered also apply in a retirement fund setting.

[2] "A Global Framework for Insurer Solvency Assessment: Research Report of the Insurer Solvency Assessment Working Party", 2004, International Actuarial Association.

[3] Shaw, R., Smith, A., & Spivak, G. (2012). Measurement and Modelling of Dependencies in Economic Capital. *British Actuarial Journal, 16*(3), 601-699.

14.2. Background to capital management

This section outlines a series of considerations relevant to the calculation of capital. Each of these are important concepts to explore before moving on to consider how capital is calculated in practice today.

14.2.1. Purpose of capital

Capital is the cornerstone of a life company's financial strength. It supports operations by providing a buffer to absorb unanticipated losses from activities and, in the event of such losses, enables a company to continue to meet its obligations to policy owners and other creditors. Defining a capital target for a company provides comfort to these stakeholders. In addition, it motivates the board not to take on undesirable risk, as capital is a finite resource and increased levels of risk increases the amount of capital required.

It is important for a life company to be adequately capitalised as there is often significant uncertainty in the amount and timing of future policy-related cash flows. The value of the assets of a life company might currently exceed the best estimate of its liabilities, but the liabilities could turn out to have been underestimated and, by the time liabilities become payable, assets may have fallen in value. For life insurance to be a sensible purchase, policy owners need to be reasonably certain that the life company will be able to honour claims which might not occur until many years into the future.

Life companies are also an important part of the wider financial system. The failure of a major life company would cause instability throughout the local and possibly broader financial system.

Exercise 14.2

In what ways could the failure of a life company cause problems throughout a financial system? Consider the impact of such a failure on a range of the life insurer's stakeholders, including its employees, shareholders, policy owners, reinsurers, creditors etc.

14.2.2. History of capital standards

Module 5 (Life valuation) showed that there are a variety of methods and strength of bases that may be used to place a value on future obligations, including:

- **Realistic:** a realistic liability which represents a best estimate and may be used when attempting to calculate a measure of profit over a defined period;
- **Conservative:**
  - a liability based on realistic assumptions but adjusted to satisfy prudential regulations. These regulations may require higher values to be placed on reserves, such as for profitable contracts in Australia where the policy liability is adjusted to ensure it isn't negative at policy outset;
  - a net premium method using conservative mortality and interest rates.

Up until relatively recently, for solvency purposes, prudential regulations for insurance companies across most of the world required a comparison between the realistic value of assets and a *conservative* valuation of liabilities, including, potentially, a relatively arbitrary additional adjustment to the liability. For example, in the EU, liabilities for conventional business had to be increased by a further 4%, irrespective of the strength of the conservative basis used. Such methods addressed some areas of risk, such as insurance risk and possibly some asset/liability mismatch risk.

A common approach was to use a net premium method, with conservative mortality and interest rate assumptions. The use of this method caused endless debates in actuarial communities, especially as many reasons for its development were not applicable shortly after its adoption in the 1850s. This approach and the debates around its use are discussed further in Module 5 (Life valuation)[4].

[4] A detailed historical review of the net premium method is in the paper: P.M.Carroll. (1975). The Net Premium Method of Valuation. *Journal of the Staple Inn Actuarial Society,* 21(2), 121-138.

Life insurance companies were concerned with both solvency and equitable distribution of surplus to participating policy owners but were not as concerned about reporting profit. Products were much simpler than those available today, primarily because of the lack of computing power. The conservative net premium method was suitable in a world dominated by participating business that allocated profits via declared reversionary bonuses and where assets held were predominately bonds. When other contracts were developed, simple margins were added to best estimate liabilities to allow for shocks in future experience.

Exercise 14.3

Why is a net premium valuation method compatible with reversionary bonus participating contracts? (Hint: Consider the build-up of reserves for an endowment policy. Consider the effect on profit distribution if the valuation basis is conservative.)

The problem with simple but conservative methods for measuring capital adequacy is that they may not adequately recognise all material risks faced and they do not give an accurate, explicit measure of the overall financial strength of a company.

Capital requirements for life companies around the world have evolved over many years, albeit very slowly, in response to:

- financial crises;
- the introduction of new types of products; and
- a trend towards increasing sophistication in financial reporting and capital risk measurement.

Capital calculation methods in use today in Australia, USA, UK and the EU are risk-based, and incorporate:

- insurance, credit, market liquidity, operational and other non-financial risks;
- a quantitative analysis of each risk;
- consideration of the dependence amongst risks;
- a check on how the risks are managed;
- strong supervisory intervention powers; and
- appropriate disclosure of results to the market.

The methodology prescribed by capital standards in these countries is:

- principle based rather than rule based; and
- flexible, offering either a standard approach or a specific company model approach.

Each financial crisis tends to have different features. For example, one of the most notable features of the global financial crisis, which commenced in 2007, was the extreme increase in credit spreads for fixed interest assets. Increases of this magnitude had not been seen previously, but neither had the increase in the pool of available fixed interest securities, which changed from USD 36 trillion in 2001 to over USD 80 trillion by 2007. Regulators did not foresee credit spreads of the size seen in 2007 and had not thought to include these increases in prudential regulations. If they had proposed such spreads, industry participants may have complained that the proposal was too severe.

This provides an example of historical information not necessarily being the most suitable predictor of the future, particularly when it comes to selecting suitable shocked scenarios on which to base a company's capital adequacy calculations. Because prudential standards cannot foresee all future unknowns, they are often reactive to actual events. For this reason, prudential standards often change over time as actual experience unfolds.

Companies set capital targets for themselves (and are usually required to do so under prudential regulations), balancing the need for adequate capitalisation against the cost of holding too much capital.

In a risk-based solvency regime, capital targets should be a function of actual economic risk, rather than arbitrary targets that can be measured but do not vary by risk (an example of such an arbitrary target is a fixed solvency margin applied to liabilities across the industry, regardless of actual risks faced by individual organisations or the strength of valuation basis used to calculate the liability).

Capital targets should promote a risk measurement and management culture within an organisation, although this can be difficult in practice. As discussed in Module 13 (Risk management), the culture of an organisation is the outcome of the behaviours of all people in the organisation. Culture won't automatically respond to targets set for the organisation, but rather requires the right level of focus and reaction to company performance against those targets, particularly by those 'at the top'.

Capital targets are discussed in more detail in Section 14.5.2.

Prudential supervisors, whose primary interest is the protection of consumers, are interested in the strength of individual companies. Supervisors are also interested in how both internal and external factors affect a company's ability to meet its capital targets. Regulators can use capital targets in several ways, including to:

- assess the relative financial strength of insurers across the industry;
- identify the need to intervene, such as by assisting a financially stronger entity take control of a failing entity; and
- observe emerging trends in the market.

Regulators are also interested in the existence of a viable, competitive and innovative market. Owners of capital require a return on their capital invested. In theory, if capital requirements are such that policy owners are unwilling to pay premiums that lead to acceptable capital returns then the market will not develop. The regulator will therefore work with regulated entities to find the right balance between protecting policy owners and generating an efficient market.

Exercise 14.4

What other factors affect investors' decisions? Research Australia's prudential insurance supervisor (APRA) and its investigations into the Disability Income Insurance (DII) market and consider these investigations as you work through this module.

14.2.3. Economic and regulatory capital

Economic capital is the minimum amount of capital a company decides is appropriate for ongoing operations, having regard for the risks in the business, the company's access to further capital and its risk appetite.

A key metric for measuring the success of a company is its return on capital employed. This provides an incentive to maintain actual capital as close as possible to economic capital (because higher capital levels, for a fixed amount of return, will reduce a company's return on capital employed (ROCE)).

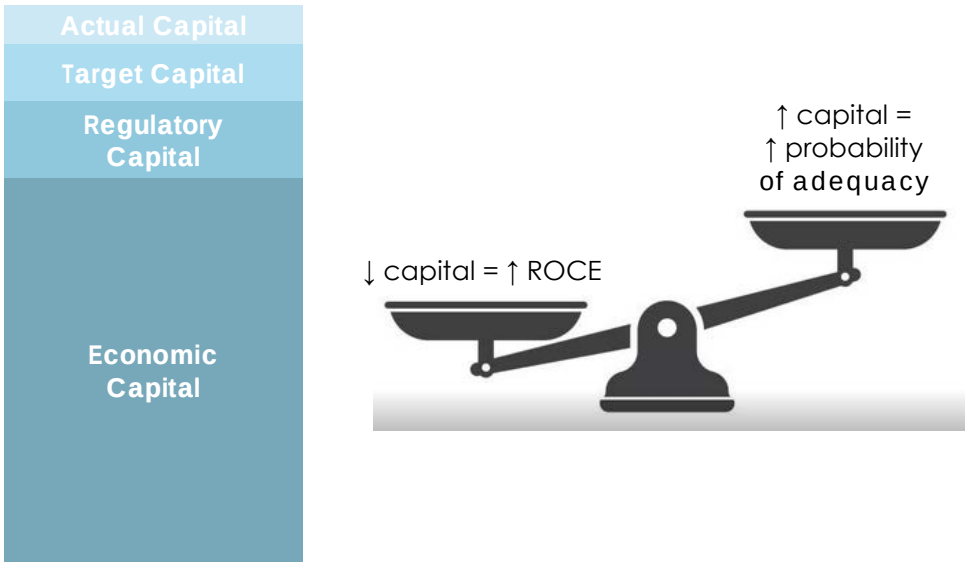
On the other hand, companies must hold, at a minimum, capital which meets regulatory capital requirements. Regulatory capital is the amount calculated in accordance with the rules set by a regulator. These rules apply across all entities within a jurisdiction. Regulatory capital usually exceeds economic capital for an entity as regulatory capital has assumptions appropriate to all entities within a jurisdiction. Typically, a regulator holds a more conservative view than an individual entity on items such as intangible assets and diversification benefits.

Regulatory capital is intended to support the winding up of a company's affairs in the event of insolvency. However, companies are constantly changing, thus the actual required capital is a function of the business mix immediately before insolvency. Companies need to be aware of changing capital requirements as their business mix changes.

It is difficult for a company to be successful in a market if it sets its economic capital higher than regulatory capital. For example, a company may consider entering an annuity market but has a pessimistic view on longevity (e.g. when calculating regulatory capital, it believes future longevity risk is significantly understated by the rest of the market). Assuming it seeks a similar return on capital to its competitors, it will struggle to find a competitive price.

A balance must therefore be struck between protecting the interests of policy owners and the stability of the financial system (through an increased capital adequacy) and allowing the continued development of a viable, competitive and innovative life insurance industry (by minimising the amount of capital required). This balance is depicted in Figure 14.3.

Figure 14.3: Balancing capital requirements



Many regulators aim to achieve this balance by targeting a very low, but not zero, failure rate for the life companies it supervises. It is not possible to guarantee a zero-failure regime. Trying to achieve such a regime would likely stifle the industry with excessive capital requirements.

A typical figure is to target a 0.5% failure rate over a one-year horizon. This is often referred to as the company being able to 'survive' a one-in-two-hundred-year event. The reason for a time horizon is explained in Section 14.2.5. As you read through the detailed sections on stresses throughout this module, you should think about whether you agree that each stress measures a 0.5% failure rate.

14.2.4. Confidence levels

Policy liabilities on a best estimate basis can approximate a level of reserves that will be sufficient 50% of the time[5]. No one would pay for insurance with such poor odds of receiving payment for valid claims. Prudential regulation is concerned with decreasing those odds to a very low level.

Regulators in the USA, Australia and the EU have independently decided on setting capital standards such that insurers are 99.5% confident they can withstand shocks (as defined by the regulator or the company) and have sufficient assets to cover liabilities at the end of one year. Note that the three regimes adopt different assumptions in this calculation and hence it is not obvious that the 99.5% confidence interval is equivalent across the jurisdictions.

The confidence level is related to the specified shocks. Regulators use information to calibrate each shock, predominantly using a value-at-risk method (see Section 14.4.5), at the 99.5% confidence level. It is outside the scope of the subject to validate whether the models and assumptions used produce a 99.5% confidence level and whether the preciseness of the statement is meaningful. It is more likely that regulators are interested in the combination of a standard comparable calculation and the resulting risk processes within a company, as discussed under the three pillar approach below.

[5] This will be true if the liability distribution is symmetrical, such that the mean value of the liability is the same as the median. However, this property often doesn't hold for liability distributions, which can be heavily skewed.

14.2.5. Time horizon

As mentioned previously, capital adequacy for a life insurer is usually measured over a specific time horizon, such as one year. This time horizon allows for delays between a stressed situation emerging and the ability of a company and/or its regulator to respond to the situation.

Information flow within a company and from a company to a regulator is not immediate. It often takes a few months after year-end to produce required information for the regulator. The regulator needs a few months to analyse the results. If a company appears to be in a weak position, plans need to be formulated and actions issued, while ongoing communications with the company increase. The company will usually continue to conduct business during this period. The exact period before a regulator can take control of a weak company depends on local business practices, resources available to the regulator, relevant legislation and the legal system, but less than one year is probably unrealistic.

The period between year-end and the regulator taking control of the company, if required, must be considered when setting capital standards. A typical period is to assume a one-year delay before control is passed to the regulator. Capital required thus allows for the potential delay and should allow the insurer to survive the extreme events at any time for at least one year post year-end.

14.2.6. Allocation of capital to business lines

Larger life companies are usually subdivided by business lines for management purposes. In order to improve management's understanding of the usage of capital resources across business lines and drive better decision making on the use of capital, a life company may allocate capital resources to individual business lines.

Under this approach, each business line is given an allocation of target capital and is expected to achieve a target return on new investments of capital. If the target return cannot be achieved, the business line would be expected to return capital to a central unallocated pool.

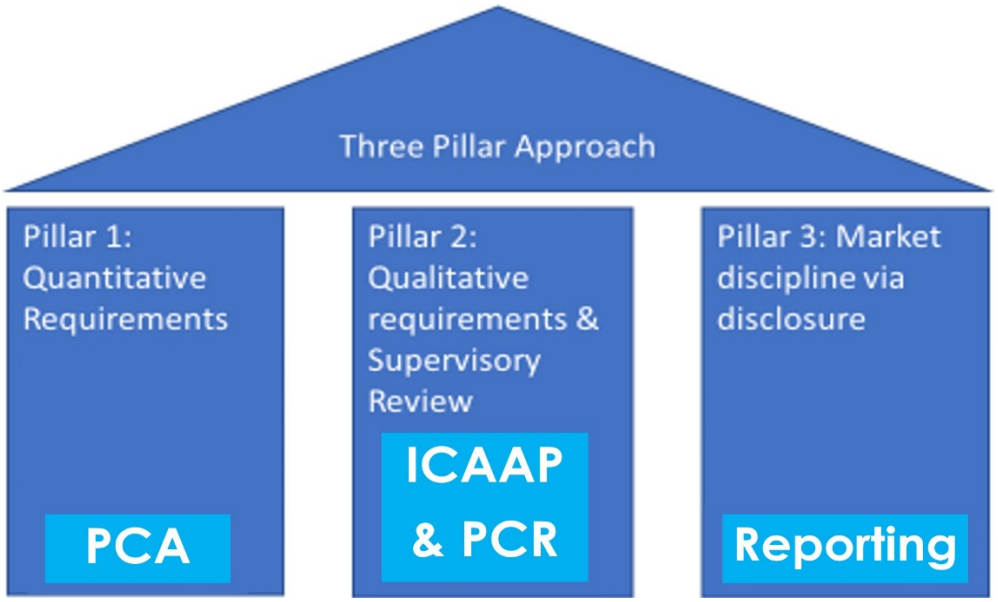
It may not always be obvious how capital should be allocated to business lines. In particular, where multiple business lines give rise to diversification benefits, the allocation of these benefits can be fairly subjective and there is no clear theoretical model that is universally accepted.

Capital allocation to individual business lines has pricing and profitability implications for each of those business lines. These interactions between capital and pricing will be explored in the LI&R Product Development subject.

14.3. Three pillars of supervision model

The banking sector has developed a three pillar approach to supervision[6]. This concept has been adopted by insurance prudential regulators within the last decade and is depicted in Figure 14.4. The rest of this module considers capital management within this three pillar model.

Figure 14.4: Three pillar approach



[6] Basel Committee on Banking Supervision 2004, "International Convergence of Capital Measurement and Capital Standards: A Revised Framework (Basel II)", Bank for International Settlements,

14.3.1. Overview of Pillar 1

The first pillar is the detailed quantitative requirements of a company in relation to:

- quantity of capital;
- any adjustments to assets and liabilities; and
- quality of capital.

Our focus in this subject is the determination and measurement of the stresses that drive the quantity of capital required. In this module, we will refer to the minimum capital determined by the company through the Pillar 1 process as the Prescribed Capital Amount (PCA), in line with Australian practice:

Prescribed Capital Amount (PCA) = minimum capital determined through Pillar 1 process

The PCA consists of risk charges for each of the major risks faced by a life company, a combined stress scenario adjustment, less an aggregation benefit to allow for diversification between different risk types. These are discussed in depth in Section 14.4.

Adjustments to policy liabilities are often required under Pillar 1 capital calculations as the purpose of the valuation (determining required capital in the event of a wind-up) may not align with the purpose of determining policy liabilities (e.g. for inclusion in company accounts, which are usually compiled on a going concern basis). A variety of other technical reasons for adjustments are discussed in Section 14.4.1.

The quality of capital required is also discussed briefly in Section 14.4.1.

14.3.2. Overview of Pillar 2

The second pillar is the entity's review of its internal processes (ICAAP—Internal Capital Adequacy Assessment Process) followed by the supervisory review process. This includes supervision of the risk management and capital management practices of life companies.

Section 14.5.1 discusses a general approach to ICAAP, and sections 14.5.6 and 14.5.6 describe the various powers that regulators may have when reviewing an entity.

A significant power granted to regulators is the ability to adjust the PCA. In this module, again using Australian terminology, we will refer to the sum of the 'supervisory adjustment', if any, and the company's PCA as the Prudential Capital Requirement (PCR):

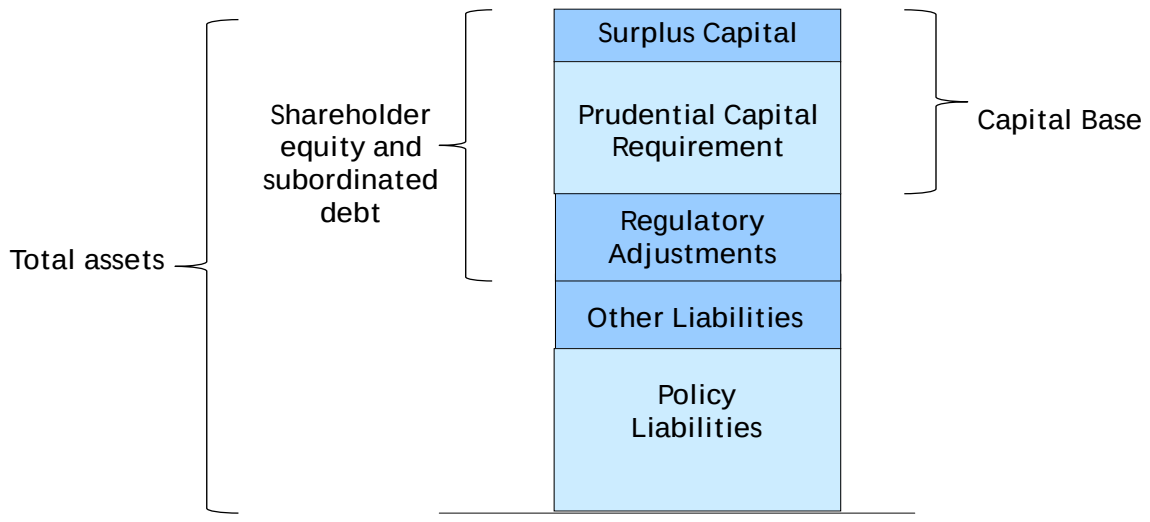
Prudential Capital Requirement (PCR) = PCA + supervisory adjustment

The PCR is intended to provide a certain probability (typically 99.5%) that a company will have sufficient capital to absorb unexpected shocks or losses that may arise over a stated time horizon (typically one year). During this time horizon, the company must also continue to meet its obligations to policy owners (in the form of the 'adjusted policy liabilities') and other creditors. Any supervisory adjustment (and therefore the PCR) is determined by the regulator through extensive discussion with the regulated entity.

The need for a specific time horizon was discussed in Section 14.2.5 and represents a 'breathing space' during which remedial action to restore capital adequacy can be taken if there is a breach of the PCR. A life company will normally have a level of capital significantly exceeding the PCR, so that the probability of being able to meet its obligations to policy owners in one year's time is, in almost all cases, considerably more than the target probability of, say, 99.5%.

Figure 14.5 shows a company's capital requirements in the context of the balance sheet.

Figure 14.5: Capital components on the balance sheet



As depicted in Figure 14.5, 'Capital Base' refers to the sum of the PCR and any surplus capital held in excess of the PCR:

Capital Base = PCR + Surplus Capital

14.3.3. Overview of Pillar 3

The third pillar is disclosure requirements of a company, which are intended to encourage market discipline. Disclosure of the financial strength of a company assists potential policy owners, financial advisors, share market analysts and other interested parties in deciding which company they should recommend or maintain relationships with. Mandatory disclosure of their capital resources gives life companies an added incentive to maintain a strong financial position.

Regulators typically require that the capital base and PCA be published at least annually, or at least in line with the time horizon considered for capital purposes. The capital base must be broken down by the different types of capital, together with any regulatory adjustments that arise as a consequence of moving from an ongoing to a winding-up basis. An example of such a capital disclosure is provided in Figure 14.6.

Figure 14.6: Capital disclosure example (source: ClearView's 2018 annual report p 53)

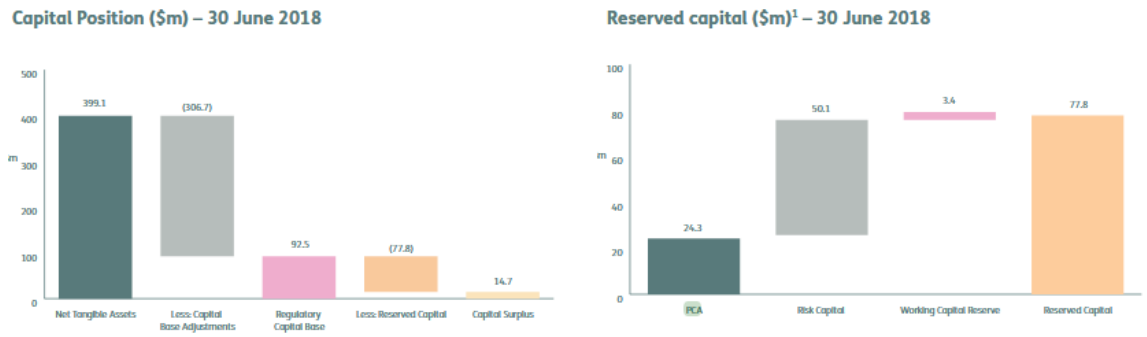
Capital position

ClearView is fully capitalised with Common Equity Tier 1 capital to fund its current business plans and anticipated medium-term growth.

The Company entered into a three-year, $60 million Debt Facility Agreement with National Australia Bank in July 2017 for the following key reasons:

- To provide future capital funding in the event that growth is materially above what is currently anticipated; and
- To meet the liquidity needs of the Group or to capitalise on other opportunities should they arise. This replaced the $50 million facility that was due to expire in December 2017.

Chart 1: Capital Position as at 30 June 2018



1 Reserved capital includes the minimum regulatory capital, risk capital which is additional capital held to address the risk of breaching regulatory capital and a working capital reserve held to support the capital needs of the business beyond the risk reserving basis.

In addition, companies are usually required to show the PCA broken down into the various risk charges (e.g. insurance, market, credit and operational).

It is unusual for a regulator to require, or even allow, life companies to disclose any supervisory adjustments, as disclosure of the supervisory adjustment could have unintended or adverse consequences. For example, external observers may over-react to such an adjustment. In addition, disclosing the supervisory adjustment could inhibit the prudential supervisor, in that it would have to consider the market reaction or over-reaction to each of its actions.

Disclosure requirements are continuing to evolve in line with a goal to provide greater transparency to stakeholders. 2017 was the first year that many European insurers released audited statements on capital requirements. In these statements, they disclose:

- descriptions of their business and performance, organisation structures and governance processes;
- the risk-based capital balance sheet and valuation methodologies, judgements and assumptions, and differences from those used for the insurer's financial statements;
- disclosure on adjustments to the technical liabilities;
- the insurer's capital base and restrictions on the use of capital;
- the insurer's PCA split by risk module or risk category (for internal models);
- where the PCA is calculated using an internal model:
  - the scope and use of the model;
  - methods used;
  - the nature and appropriateness of data; and
  - the main differences from the standard formula;
- risk exposures and concentrations across risk categories together with stress testing and sensitivity analysis; and
- organisational, governance and (where applicable) group structures.

The following sections provide further detail about the processes and requirements under Pillar 1 and Pillar 2. We do not discuss Pillar 3 further in this subject.

14.4. Pillar 1 — quantitative requirements

Regulatory capital requirements under Pillar 1, which focus on calculating the amount and quality of capital required, appear to be complex. However, they are really just asking a series of questions about the factors that affect assets, liabilities and the relationship between assets and liabilities.

14.4.1. Capital base

On a company's balance sheet, shareholders' net assets represent the difference between the value of assets and liabilities. This value is dependent on how assets and liabilities are defined.

To ensure that the capital of a life company provides adequate support for its activities, regulators impose some restrictions on the composition of an insurer's 'capital base' (i.e. what it can count as 'capital' for solvency purposes). It will normally differ, sometimes significantly, from the shareholders' net assets shown on the balance sheet.

For example, one of the key accounting concepts is to measure items on a 'going concern' basis, but capital calculations are likely to measure components of the balance sheet on a 'discontinuance' or 'wind-up' basis. Under a wind-up basis, intangible assets such as deferred tax and capitalised expenses may be excluded from the value of assets.

In addition, throughout this subject, we have discussed different purposes for building models leading to different values being placed on both assets and liabilities. Some approaches, such as a conservative net premium valuation, place a high value on liabilities. However, the quantity of hidden capital underlying such an approach isn't clear to either the regulator or investors. Other approaches may place what appears to be a realistic value on policy liabilities but there may be significant accounting differences between jurisdictions that mask the underlying amount of capital.

There is a new international standard for Insurance Contracts (IFRS 17), under development since 2017, which is due for implementation from 2021. IFRS 17 should improve consistency in measuring assets and liabilities in different jurisdictions. The requirements of IFRS 17 (once finalised) will be explored within the Application subjects.

The different assumptions and methods used to place values on assets and liabilities impact the disclosed value of capital. The purpose of measuring solvency is to have a degree of belief that an insurer can withstand extreme shocks and still have assets to back policy liabilities at the end of the time horizon. It may therefore be necessary to alter the value of assets and liabilities when recognising the amount of available capital.

Adjusted asset values

When considering a company's level of capital adequacy, the change to a wind-up basis may require a change in the value of assets. The principle is to consider the value of the asset if it were to be sold immediately. Various potential changes are described below:

- assets should be revalued at fair value, or at least at market value;
- adjustments to market value to allow for a 'fire-sale' may be required, although one can argue that this is too extreme as capital standards are designed to allow for an orderly exit;
- some assets will have little or no value in a wind-up, including:
  - intangibles such as goodwill;
  - miscellaneous items dependent on the continued existence of the company, such as future income tax benefits, deferred acquisitions costs and specialised computer software;
  - loans to brokers, employees and directors as well as premium balances on broker accounts which may be difficult to recover; and
- legal claims on assets that affect the company's ability to sell the assets will force the assets to be disallowed when considering their availability on wind-up.

Adjusted policy liabilities

A regulatory adjustment to capital may be made by adjusting the policy liabilities. One purpose of adjusting policy liabilities is to separate policy owner interests and shareholder interests. Examples of adjustments are:

- removal of future shareholder profits from policy liabilities and instead including them in capital (usually in CET1—see below);
- setting the minimum policy liability equal to the approximate pay-out to policy owners in the event of a wind-up of the company, which may not equal the surrender value; and
- adjusting liabilities to ensure policy owner entitlements, e.g. future bonuses in participating business or interest credits for non-participating business are not treated as part of the capital base. The actual payment to policy owners in the event of a liquidation is often determined by a government official. The regulator may define a method to calculate an approximate value for these payments.

When determining capital, there may be more direction given by the regulator in the specification of the valuation basis. For example, the regulator may require best estimate liabilities to be discounted using a specified discount rate when calculating capital requirements. There may be a need to have tighter definitions of, for example, risk discount rates, to provide consistency across companies in a particular jurisdiction.

Types of capital

Life companies can include various types of capital instruments within their capital base. There are differences in terminology used across jurisdictions. In this module, we use the following Australian terminology:

- **Tier 1 capital:** eligible capital provided by shareholders, consisting of:
  - Common Equity Tier 1 capital (CET1); and
  - Additional Tier 1 capital (AT1).
- **Tier 2 capital:** subordinated debt.

Tier 1 capital is an insurer's 'core' or highest quality capital. It is permanent capital which doesn't impose any ongoing servicing costs on the insurer. Tier 1 capital can be used when an insurer must absorb losses without ceasing operations. On the other hand, Tier 2 capital is considered to be 'supplementary' or lower quality capital as it is less reliable than Tier 1 capital and may have a limited life and/or ongoing servicing obligations. Total capital is calculated by adding Tier 1 and Tier 2 capital together.

Each of these types of capital are explained further below.

Common Equity Tier 1 capital

CET1 is the highest quality component of capital. It includes paid-up ordinary shares and retained earnings and must include any regulatory adjustments to policy liabilities (see discussion above on adjusted policy liabilities). CET1 must be subordinated to all other forms of funding (meaning that it has lowest priority in the winding-up of the company). CET1 absorbs losses as and when they occur (through deduction of losses from retained earnings), has full flexibility of dividend payments and has no maturity date (i.e. never has to be repaid to shareholders).

Regulators require that CET1 comprises a minimum stated percentage (e.g. 60%) of a life company's prescribed capital amount at all times.

Additional Tier 1 Capital (AT1)

The most common type of AT1 instrument is perpetual preference shares. These shares typically pay shareholders a fixed rate of dividend and have priority over ordinary shareholders in the wind-up of the company. A life company normally has the right to cancel dividend payments to preference shareholders, but only if it also cancels payment of dividends to ordinary shareholders.

Perpetual preference shares can absorb losses because the life company has no obligation to pay dividends or to repay the amount invested by shareholders. Some forms of preference shares also include non-viability options where the regulator can trigger a write down of the nominal value or conversion to equity.

Regulators require that CET1 and AT1 together comprise a minimum stated percentage (e.g. 80%) of a life company's prescribed capital amount at all times.

Tier 2 Capital

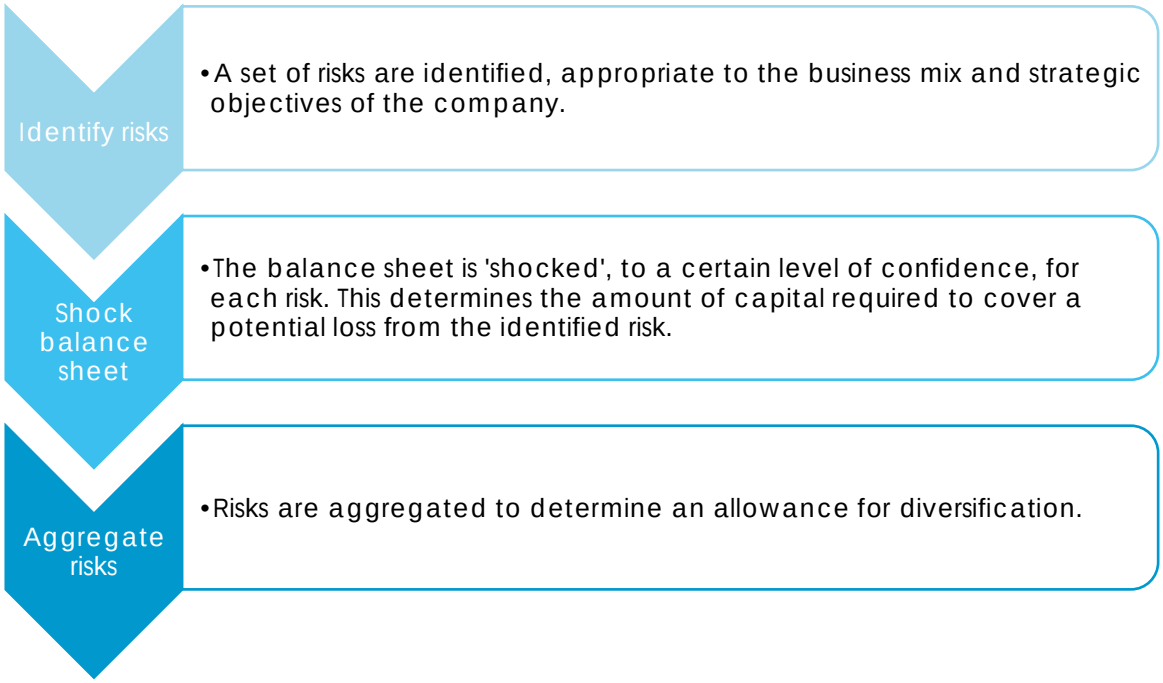
Tier 2 Capital is the lowest quality form of capital that can be included in the capital base. It must be in the form of a debt and it must be subordinated to the policy and other liabilities (i.e. in a wind-up, it must be repaid only after policy and other liabilities have been discharged). The subordinated debt will appear as a liability on the company's balance sheet. However, in assessing the capital base of the company, it is not treated as a liability.

Tier 2 capital only absorbs losses if the life company becomes non-viable or is wound-up. Losses incurred by a life company are normally borne by the Tier 1 capital but if Tier 1 capital becomes small or negative, further capital raisings may become impossible. Shareholders may be unwilling to commit new Tier 1 capital because the risk that the company will fail and the capital will be lost may be too high relative to potential returns on the capital. In this situation, a life company would be unable to continue operating and the Tier 2 capital could bear part or all of any further losses after the Tier 1 capital is exhausted. The investors in Tier 2 capital would suffer a partial or full write-off of their investment.

Because of its limited loss-absorbing qualities, regulators only allow a relatively small proportion (e.g. 20%) of the prudential capital requirement to be met by Tier 2 capital.

14.4.2. Quantifying capital

A simple algorithm for quantifying capital requirements under Pillar 1 is shown below:



In practice, there will be refinements to the above algorithm to allow for:

- inadequacies in the method used to aggregate the risks; and
- some shocks causing changes to other shocks.

This section considers shocks in isolation, shocks that affect other shocks, dependencies between risks and risk aggregation.

Pillar 2, discussed in Section 14.5, describes how the Pillar 1 calculation is adjusted to allow for less-quantifiable risks (e.g. quality of management).

14.4.3. Standardised vs. internal model approach

Supervisors often set up dual systems where regulated companies may elect to measure their capital requirements using a standardised approach or an internal, non-standard model. If there were no constraints on budgets and all companies had access to the required skills, each company would calculate a capital value by building an appropriate internal model, reflecting its own specific circumstances, rather than the risks faced by the industry as a whole. Companies could model their own risks using methods ranging from simple factor approaches applied to best estimate liabilities through to a full stochastic simulation exercise.

A company adopting an internal model approach gains a greater understanding of the capital required and expects to have a lower capital requirement than if a standardised approach is used. However, the internal model approach is not viable unless a company has enough technical staff and an effective risk management framework. It also introduces two further risks:

- the regulator may not approve the internal model; and
- the calculated capital amount may be higher than that under a standardised model.

The second risk above is unlikely, as any standardised model will necessarily require some element of conservatism because the method applies to all entities in a jurisdiction. However, capital is used to cover extreme events and there is significant subjectivity in choosing relevant models and parameters. An actuary who independently views the data and calibrates a company's capital to a specified confidence level may not conclude that the regulator's standardised approach is a conservative one.

This introduces an important point on the purpose of the three pillared approach to capital management. Typically, regulations focus on determining the amount of capital required to be sufficient to cover liabilities at the end of one year with a 99.5% confidence level. The capital requirement calculations are a mix of statistics and expert judgement. While the calculations required under Pillar 1 are technical in nature, the Pillar 2 qualification process allows the regulator to form a view on the sufficiency of the capital determined in Pillar 1, adding an extra layer of judgement to the process.

Exercise 14.5

Suppose you are acting as the capital management actuary for a life insurer. You believe an extreme event at the regulator's required confidence level (e.g. a well-regulated, deep equity market has a 0.5% probability of falling below 40% over one year) is more extreme than the regulator's published view (e.g. the regulator suggests a scenario involving only a 20% fall in the equity market). How would you respond to this discrepancy when calculating the company's PCA?

With a standardised approach, capital is determined using the same method and assumptions for all companies under the control of a regulator. The regulator identifies and categorises sources of risk. For each source of risk, a standardised measure of a company's exposure to that risk is multiplied by a standardised factor. For example, the exposure to asset values falling is likely to be the total value of assets. A standardised factor used to calculate capital requirements for this risk might be a 30% reduction in those asset values.

There is a balance needed between adopting factors that are suitably conservative but also not too onerous, thus avoiding difficulties in the continued operation of a competitive market. Similarly, the standardised factors should not lead to inadequate risk control and measurement within a company, although such inadequacies should be picked up in the supervisory review under Pillar 2.

14.4.4. Prescribed Capital Amount (PCA)

There is no world-wide standardised method for calculating the Pillar 1 capital amount, although methods in different jurisdictions have many similarities. This section is a review of the general principles of calculating capital under Pillar 1, rather than a specific method.

Terminology varies across the different jurisdictions for the calculated Pillar 1 capital amount. As mentioned in the previous section, in this subject, we refer to the Pillar 1 capital amount as the Prescribed Capital Amount (PCA).

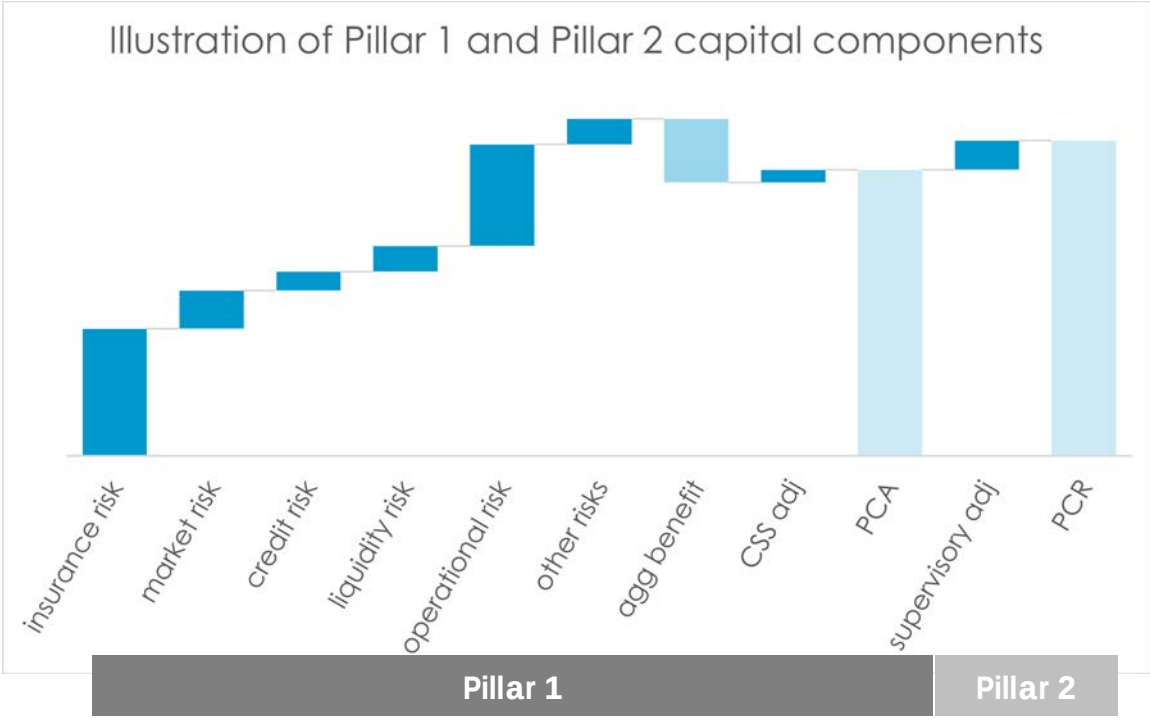
The PCA is calculated using risk-based methods, predominately Var and Tail Var (as described in Section 14.4.5). It is common for the PCA to be subject to a minimum amount (for example $10m). This minimum capital requirement prevents start-up life companies from operating without a minimum level of capital resourcing.

The PCA is defined as the sum of:

- capital to cover:
  - insurance risk (mortality, longevity, morbidity, lapses, expenses);
  - market risk (including mismatch risks between assets and liabilities);
  - credit risk;
  - liquidity risk;
  - operational risk; and
  - other risks identified by the entity; less
- an aggregation benefit; plus
- a combined stress scenario (CSS) adjustment.

These various components of PCA are illustrated in Figure 14.7. For completeness, Figure 14.7 also shows a supervisory adjustment which may be added to the PCA under Pillar 2 to arrive at the company's PCR.

Figure 14.7: PCA and PCR components



We will examine each of these components of a company's PCA, including the risk aggregation benefit, in the subsequent sections.

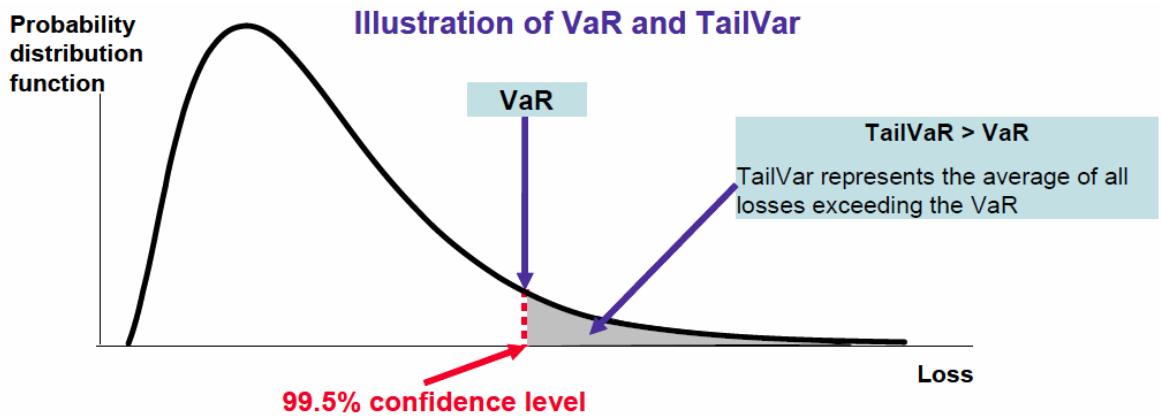
In this subject, we consider capital at an entity level. In practice, life insurance companies have separate statutory funds supporting different lines of business and capital requirements are usually set at this statutory fund level. The concept of statutory funds will be explored in the Life Insurance Applications subject.

14.4.5. Measuring stresses (VaR and TailVaR)

The PCA is set at a level such that there is only a small probability, 0.5%, say, that a company will incur a loss greater than the PCA over the selected time horizon. This is an example of a 'Value at Risk' (VaR) method of setting capital requirements. A weakness in this method is that it ignores the size of the losses in the tail of the loss distribution beyond, in this case, the 99.5% confidence level.

An alternative risk measure to VaR is 'Tail Value at Risk' (TailVaR). The TailVaR is the expected value of losses in the tail of the loss distribution beyond the specified confidence level. Figure 14.8 illustrates the difference between Var and TailVaR measured at the same confidence level.

Figure 14.8: VaR and TailVar



If losses have a normal distribution, VaR at 99.5% is the same as TailVaR at 98.7%. In a sample of 10,000 scenarios, VaR would be determined using the 50th worst scenario, whereas TailVaR would be determined using the expected value of the 130 worst scenarios. The point of equivalence between VaR and TailVaR will change if the loss distribution is not normal.

In practice, the tail of the loss distribution for life companies is unlikely to be normal and can be very skewed if a life company has exposure to rare, but potentially large, asymmetric risks. For example, non-proportional catastrophe reinsurance might protect a life company from smaller, foreseeable catastrophes, but if the treaty caps the reinsurer's liability to the life company, it will not provide protection against additional losses if a very severe but extremely rare catastrophe occurs.

TailVaR is used by some regulators for setting minimum capital requirements. It can also be used by life companies in setting their own internal capital targets. An accurate calculation of both VaR and TailVaR requires the use of a stochastic model but approximate deterministic models are common.

Three approaches to calculating a VaR are:

- a parametric stochastic model, where the underlying distributions are assumed to be known;
- a non-parametric model that samples from the past data and assumes the past is indicative of the future; and
- a variance-covariance approach, where the VaR can be approximated using a single scenario with appropriately chosen parameters.

The variance-covariance approach has been adopted by many insurance prudential regulators. This approach is described in section 14.4.19.

A weakness of TailVaR is that it depends on assumptions made about the likelihood of extremely rare events and the size of the resulting losses. These assumptions must, by their nature, be very subjective.

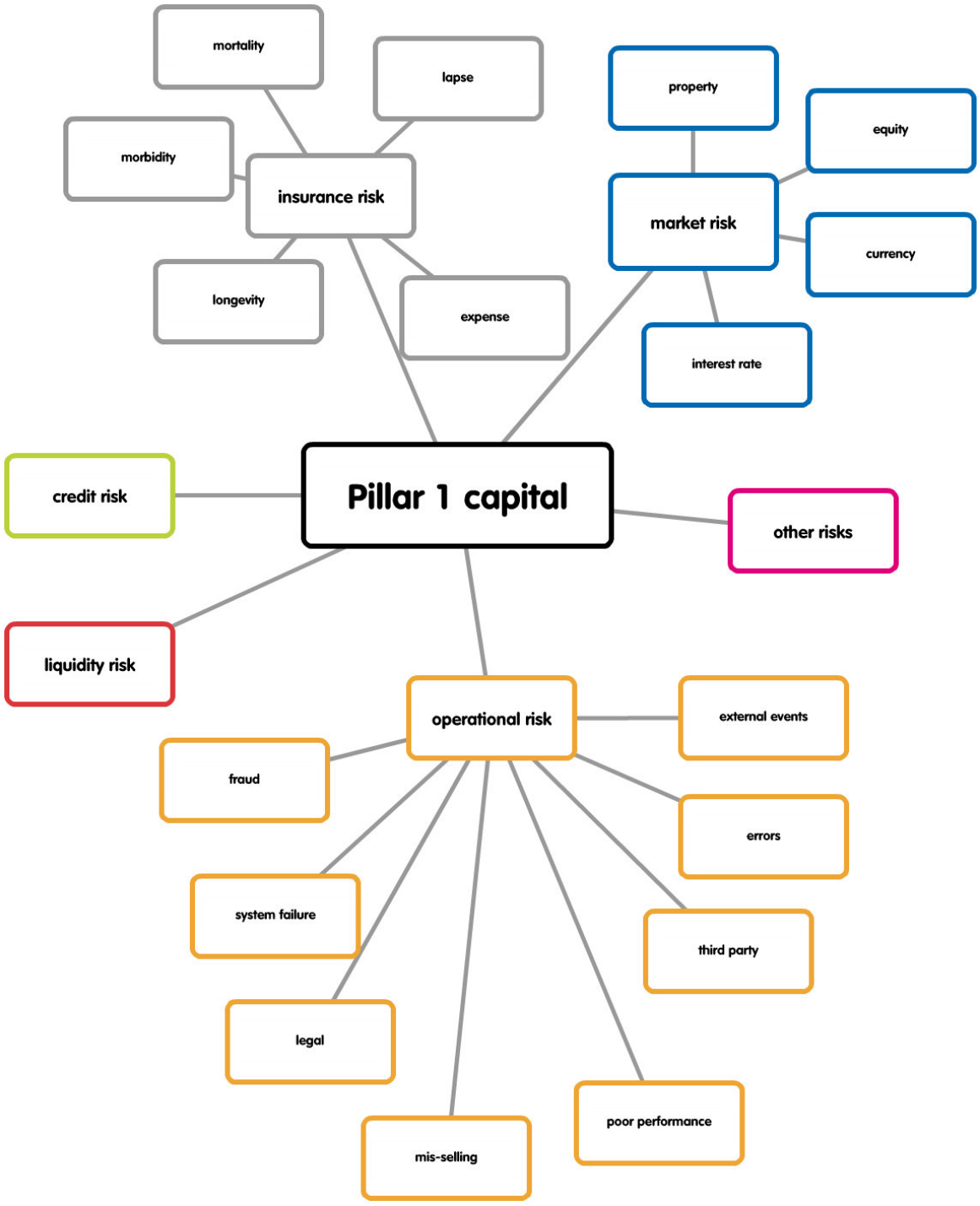
14.4.6. Defining stress

Under Pillar 1, the regulator will define stresses to be tested for use in a standardised model. Under an internal model, input into defining stresses will come from the company and/or the regulator as follows:

- the company defines the stresses for an internal model;
- the regulator may decide some stresses that are not company specific and will set the parameters for them. Such stresses which may be prescribed include:
  - equity falls, assuming a well-diversified portfolio is held (this can be checked in Pillar 2);
  - pandemics affecting mortality and morbidity which are external to companies;
  - expense stresses which are subjective—the regulator may want consistency across the industry;
- the regulator may require the company to set the parameters for some stresses, especially if they relate to aspects under the control of the company;
- where stresses are set by a company, the regulator may alter capital held during the Pillar 2 process if the stress is deemed insufficient.

Each of the stresses typically included in a Pillar 1 capital calculation are discussed below and summarised in Figure 14.9.

Figure 14.9: Pillar 1 mind map



14.4.7. Insurance risk

Insurance risk focuses on stresses that affect the frequency and amount of benefits, expenses and the receipt of future premiums. There are many potential causes of insurance risk, ranging from failure of process at underwriting, inappropriate contract design, changing social conditions that lead to higher claims and inadequate reserving. Some of these risks are clearly operational, a risk that is dealt with in Section 14.4.16.

At a high level, factors that create insurance risk may be classified into:

- mortality (increasing mortality rates that cause losses, such as in term insurance);
- longevity (decreasing mortality rates that cause losses, such as in annuity contracts);
- claim inception rates for morbidity contracts;
- claim termination rates for morbidity contracts with regular payments;
- lapse rates;
- expenses split by acquisition, maintenance and termination;
- take-up rates of guarantees or options, such as:
  - guaranteed annuity factors in deferred annuities with cash options (see Module 2 (Cashflows));
  - extension of a term insurance;
  - increasing sum insured on marriage or birth of dependants; and
- other material risks. For example, policy paid-up rates may be important in some jurisdictions.

Some of the factors above may need further refinement. For example, mortality is usually split into four types of stress (as described in Section 14.4.8).

Many of these stresses may be considered in isolation, with a stress test of the policy liabilities performed so that the policy liabilities in the stressed scenario can meet claims at the desired level of probability.

With some of the stresses, it may be better to consider a scenario analysis, combining the particular stress with other stresses. An example is lapses where policy owner behaviour in the lapse stress may change views on other stresses. This is not an easy topic and regulators have suggested various responses that are described in Section 14.4.19.

It was discussed in Module 8 (Assumptions) that it is generally accepted actuarial practice to start with best estimate assumptions which relate to the relevant population. A best estimate assumption is derived from a sample population. Standard practice for calculating policy liabilities, and indeed for pricing, is to ignore that the answer is a random variable. When looking at capital management, however, we need to consider whether the underlying statistical distribution:

- is known;
- can be estimated to the desired level of accuracy; and
- will change in future years.

14.4.8. Mortality and morbidity risk

Mortality and morbidity best estimate assumptions are derived from sample populations. Mortality and morbidity are modelled separately but are subject to the same types of stresses. Four risk components which apply to both mortality and morbidity are:

- random stresses (also called volatility);
- catastrophe;
- trend uncertainty; and
- level uncertainty.

As mentioned in Section 14.4.7, each of these mortality and morbidity stresses may be modelled in isolation, or it may be better to consider mortality and morbidity scenarios which combine each of these four sub-divisions of stresses, recognising dependencies which are likely to exist between them.

Random stresses are adverse fluctuations in experience from the best estimate, excluding the impact of single events that cause large numbers of claims, such as pandemics, terrorist attacks and natural catastrophes. The size of the random stress will depend on factors such as the number of expected claims, the distribution of sums insured and the impact of existing reinsurance arrangements.

The random stresses are applied for a period, typically the capital calculation time horizon, from the reporting date. The modelling assumes the random stress does not apply after the end of the time horizon. This situation is common to many of the stressed scenarios as we are attempting to find the capital required, at a specified confidence level, for a defined period.

For n policies, if sums insured and ages attained are all the same and the claim incidence rate (q) is a Bernoulli trial, then claims under the portfolio form a Binomial Distribution. The extra claims (compared to the expected value) at the 99.5% confidence level can be estimated using the Normal approximation to the Binomial Distribution[7]:

$$Bi(n,q) \approx N(nq, nq(1-q)).$$

A Normal random variable X, with mean μ and standard deviation σ, is expected to lie below μ + 2.576σ with 99.5% confidence. The extra claims are thus:

$$2.576 \times \sqrt{(n \times q \times (1-q))}$$

or

2.576 x √(1-q) / √(n x q) as a proportion of the best estimate number of claims (n x q).

Assuming (1-q) is very close to 1 (i.e. the claim incidence rate q is very small), the extra claims as a proportion of the best estimate number of claims can be approximated by

$$2.576 / \sqrt{(n \times q)}$$

For example, assume the best estimate mortality rate is 0.5% and there are 100,000 lives insured. The random mortality stress margin will be 12% (= 2.576 / √(100,000 x .5%)). The best estimate number of claims will be 500 and the number of extra claims at the 99.5% confidence level will be approximately 60 (i.e. 500 claims multiplied by the 12% stress margin).

[7] The normal distribution can be used as an approximation to the binomial distribution if n is large and/or q is close to ½.

If there were 10,000 lives insured the stress margin would be 36%. For 1,000,000 lives insured the random stress margin would only be 4%. This example highlights the importance of the number of lives insured in determining the amount of capital needed for random insurance stresses. A larger number of lives will result in smaller random claim fluctuations and therefore a lower amount of capital will be required. This is an example of the outcome of the 'law of large numbers', which students will be familiar with from their Foundation level studies.

In practice, a life company's policies are likely to have a skewed distribution of sums insured. A small proportion of policies will have very large sums insured. In addition, best estimate mortality rates will vary by age, sex, smoking status and other rating variables. The claims costs will not have a binomial distribution and stochastic modelling may be necessary to determine the random stress margins. The random stress will decrease as the number of policies, of similar riskiness, increases. The random stress will increase as the skewness of the distribution of sums insured increases.

Surplus reinsurance, discussed in the LI&R Product Development subject, can be used as a means of reducing the random stresses, as this type of reinsurance reduces the skewness of the distribution of sums insured (i.e. the sum insured retained by the life company will be limited to the retention limit specified in the reinsurance treaty).

Catastrophe stress

This stress extends the random stress event to allow for the impact of a single event causing multiple claims in some timeframe, usually the capital calculation time horizon, following the reporting date. The probability of the event occurring should be consistent with that underlying the capital calculation (e.g. a one-in-two-hundred-year event for a 99.5% capital adequacy calculation).

A single event that is expected to cause the most mortality or morbidity stress is a pandemic scenario, such as an influenza epidemic. However, the actuary needs to consider whether events worse than the pandemic scenario could happen. For example, the actuary may need to consider risks, such as terrorist attacks, natural catastrophes or industrial accidents if the life company has a high proportion of lives insured who work at a single site (this might occur if the life company specialises in issuing large group risk policies).

It is difficult to model this type of risk due to the lack of available data (by definition, these events are rare!). As an example, the Australian regulator has set the pandemic scenario with reference to the 1918 influenza pandemic (Spanish flu) that occurred over roughly a 12-month period during 1918 and 1919. Influenza normally affects mortality at young and old ages as well as weakened patients, but the Spanish flu killed mainly young, previously healthy adults. This pandemic spread around the world during a fairly short period. If a similar pandemic occurred now, its impact is expected to be much smaller, mainly due to advances in health care and the advent of antiviral drugs. However, others claim that the assumption that we are better equipped at dealing with such a pandemic is not justifiable as it is not obvious if we can treat an unknown pathogen. The impact of pandemics on claim amounts for insured lives is expected to be lower than in the general population due to selection effects. These effects include the impact of underwriting and the fact that people insured for larger amounts tend to have better access to medical care than the general population. Flu pandemics are expected to recur roughly once every 30 or 40 years. Smaller flu pandemics occurred in 1957, 1969 and 2009. Another pandemic could occur at any time.

The pandemic scenario may be spread over a period that exceeds the time horizon. This may look inconsistent with other components of the capital calculation but approximates the effect of a pandemic that commences at some point during the time horizon and continues for a period.

One feature to note is that increases in mortality and morbidity in the pandemic scenario are often the same at all ages. This means that the proportionate impact of the pandemic scenario, relative to normal mortality and morbidity rates, is much greater for younger lives. Another notable feature of the pandemic scenario is that it is the same regardless of the number of lives insured. If, for example, a pandemic occurred that exactly matched the assumed stress, the claims experience of different life companies would vary only due to random chance. However, life companies would not be required to hold capital against the risk that they may by chance experience even higher rates of claims than the industry average during a pandemic event.

The pandemic scenario may apply to contracts that are impacted favourably by higher mortality rates, such as lifetime annuities. If the policy liabilities include lifetime annuities as well as policies providing death cover, the overall impact of the pandemic scenario will be reduced.

Level uncertainty and trend uncertainty stresses

There is a need to consider other possible causes of variations in experience and assumptions for mortality and morbidity. These include the possibility that the best estimate assumptions are incorrect (level uncertainty risk) or that changes to allowances for future trends in mortality and morbidity experience will have to be made (trend uncertainty risk).

These stress margins are often applied from the reporting date for the remaining term of the liabilities. They usually allow for the possibility that the best estimate assumptions may need to change at the end of the time horizon, either because they were mis-estimated at the reporting date or because adverse trends have been identified during the period.

The size of these stress margins will depend on the adequacy of the investigations used to determine the best estimate assumptions and the range of adverse factors that could affect trends in claims experience. For example, the stress margin is likely to be lower if an extensive mortality investigation was carried out, using a large amount of past company data, supported by reliable population statistics. On the other hand, if the company has little past experience and relied purely on fairly limited population statistics, a much higher stress margin will be required.

The best estimate mortality or morbidity assumptions will usually be in the format of a factor multiplied by a standard table (such as 1.2 x Australian life tables). The factor is usually set by comparing actual experience for the company to that expected by applying the standard table.

Statistical techniques can be used to estimate the uncertainty arising from the numbers, sizes and attained ages of the policies included in a company's experience investigations and the industry experience underlying the standard table. There is a risk that the company's adjustment factor, or the standard table, will underestimate future claims experience because, due to pure random chance, there were fewer than expected claims during the periods of investigation. The margin required for this type of error can be estimated in a similar way to the random stress margin.

There is additional uncertainty about the best estimate assumptions because mortality and morbidity experience may have changed since the experience investigations were carried out. An unavoidable problem with experience analyses is that they are out of date to some extent. Standard tables based on industry-wide experience may no longer be relevant and/or may not be representative of the life company's data. The experience of the life company will generally be more up to date but will be based on a smaller number of lives than the standard tables. To get meaningful volumes of experience data and reduce the impact of random fluctuations, several years of experience data is normally required. This reduces the impact of random fluctuations on the mean but increases the risk that recent trends in experience are missed. For example, the company may have changed its underwriting standards, claims management practices, benefit definitions or target markets since the period of the most recent experience investigation.

Other examples of trends which might cause a deterioration in experience include diet and lifestyle factors, medical advances leading to improvements in diagnostic techniques that affect trauma claim rates, economic and social factors that affect income protection claims incidence and termination assumptions. Some allowance for adverse trends should be incorporated in the future stress margin. The size of this allowance will be fairly subjective.

14.4.9. Longevity risk

Longevity refers to having a long life. Longevity stress is a label for mortality improvements. A longevity stress is applied to contracts that offer some form of lifetime annuity, which can be negatively impacted by mortality improvements. The stresses relating to longevity are random stresses, level uncertainty and trend uncertainty. The catastrophe stress described in Section 14.4.8 is not applicable for longevity stress as mortality rates worsen rather than improve in a catastrophe.

14.4.10. Expense risk

Operating costs are typically split into three cost components: those related to acquiring business, those related to maintaining business and those related to terminating business. Expenses in each of these three categories may be further classified broadly as either fixed or variable. Fixed expenses do not vary by business volumes, whereas variable costs will change as volumes change.

There is an element of subjectivity when allocating fixed costs to acquisition, maintenance or termination costs. The consequences of allocating too many fixed costs in the acquisition category is that the liabilities in respect of maintenance and termination costs may be understated. On the other hand, allocating too few overheads to the acquisition category overstates the liability. It is often a matter of judgement to determine the best estimate allocation of fixed expenses.

The mechanisms to perform expense allocation calculations and analyse the outputs is considered in depth in the LI&R Product Development module.

Valuation of existing business does not include setting liabilities for future new business. However, as actual office expenses are notionally hypothecated to the three different categories, then this involves allocation of fixed expenses to the three categories. The allocation of fixed costs to the acquisition category therefore involves estimating future new business. This introduces a new business risk as actual sales may be different than those assumed. For example, if fixed costs allocated to acquisition expenses were $10m and actual sales were 50% lower than expected, then $5m of fixed costs may need to be recovered elsewhere.

A simple method to allow for this new business risk is to hold as capital one year's worth of fixed costs allocated to acquisition expenses.

Exercise 14.6

Write down three other methods that approximate the fixed-cost acquisition risk.

Maintenance expense and **termination expense** risks will normally not be separated when considering capital requirements and will be labelled 'renewal expenses'. As for acquisition expenses, renewal expense risks may arise if the business develops differently than expected. An additional risk is that the expense components (rental costs, wage growth, utilities, etc.) may grow at rates different than expected. Liability bases may include a simplifying assumption, on materiality grounds, that expense components grow at a uniform rate. It is therefore quite likely that actual expense growth will be different to that expected.

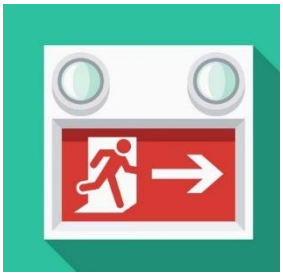
Modelling the stress for business developing differently than expected may involve creating a distribution comparing the historical ratios of actual to expected maintenance expenses. Or, more likely, a simple factor-based approach may be used (for example, by assuming maintenance expenses are 25% higher than expected).

Modelling the stressed inflationary component may involve shocking the assumed inflation rate and comparing the resulting shocked liability with the best estimate liability.

Exercise 14.7

Write down two different ways that the inflation shock to renewal expenses may be modelled.

14.4.11. Lapse risk



A lapse is a policy owner voluntary termination of a contract.

Lapse stress is complicated as:

- in some jurisdictions, the policy liability valuation may use a modified net premium method that has no explicit allowance for lapses;
- other stressed events may affect policy owner behaviour and hence affect lapse rates (for example, higher claims rates may drive the decision to increase prices, which would likely lead to higher lapse rates);
- the financial effect of lapse may vary across the duration of a contract; and
- views differ across jurisdictions on how to set capital to cover lapse risk.

The approach to setting capital is to consider both assets and policy liabilities—the total balance sheet approach described in Section 14.4.1. As discussed earlier, a modified net premium valuation methodology creates hidden capital. It is difficult to understand how this hidden capital will vary under stresses.

Up until this section, we have considered each stress to be a single independent stress. However, it is less clear that the lapse risk can be separated from other risks. Management responses to other risks, discussed in Section 14.4.17, may change policy owner behaviour and hence change lapses. These interactions require considerable judgement as the decision maker needs to think about what might happen to lapse experience if premium rates or fees are increased substantially in response to the mortality, morbidity and expense stresses.

There are three types of lapse events that need considering when setting the lapse stress scenarios:

Lapse risk 1 — release of liability and payment of surrender value

Just before a surrender of a policy, assume there is an associated policy liability of $V. Assume the surrender value for this contract is $S. On surrender, the asset side of the balance sheet falls by the cash payment of $S. The liability side falls by the release of the liability, $V. The effect on the company, in terms of the change in available capital (assets less liabilities) is:

- positive if V > S and thus a stressed lapse will be a decrease in lapse rates;
- negative if V < S and thus a stressed lapse event is an increase in lapses, although in some jurisdictions a policy liability must never be lower than the surrender value.

If lapses are not explicitly modelled when calculating policy liabilities, then a simple factor approach may be applied. The policy liabilities are divided into those where S > V and those where S < V. The capital requirements for this type of lapse risk could be modelled as n x (S - V) for the first type and m x (V – S) for the second type, where n and m are appropriately chosen factors.

Exercise 14.8

How might m and n (see above) be determined when selecting appropriate simple factors to model lapse stress scenarios?

Lapse risk 2 — acquisition expense recovery shortfall

In Module 6 (Profit), we discussed how to set up a Deferred Acquisition Cost (DAC) asset in order to recoup acquisition expenses from future premiums. We also discussed how a modified net premium reserve implicitly recognises the acquisition expenses. In both cases, lapses higher than anticipated are a risk to the recovery of the acquisition expense, as the assumption about being able to recoup acquisition expenses from future premiums may no longer hold true.

A simple factor model for this lapse risk may be a suitably chosen factor multiplied by the present value of expected acquisition expenses recoverable from future premiums (i.e. the current value of the DAC asset).

If a gross premium projection valuation method has been used to calculate policy liabilities, then lapse assumptions may be adjusted upwards (where S > V)[8] or downwards (where V > S). The increase in policy liability less the original policy liability represents the capital required for this risk. The adjustments to lapse assumptions can be simple factors (i.e. 10% increase or decrease) or more complicated (i.e. x% higher in years 1–5 and y% lower in years 6 onwards). A more complicated approach may be warranted for polices where lapse risk changes over the duration of the contract.

Lapse risk 3 — interdependence with other assumptions

If management actions are allowable, then the effect of these actions on lapse experience needs consideration. For example, suppose a response to an expense risk is to increase premium rates. Then healthy lives may seek cover elsewhere, leading to worsening mortality for the remaining policies. Different jurisdictions may take a different view on how to model this risk, either as part of a wider operational risk model or as an additional scenario to apply when considering the totality of insurance risks. For example, the Australian regulator has adopted the latter approach.

[8] As before, $V is the policy liability just before surrender of the policy and $S is the surrender value.

Exercise 14.9

Two companies both have policy liabilities consisting entirely of risk business. One company has a significant insurance risk charge, whilst the other company has an insurance risk charge of zero. Discuss possible reasons for the difference in charges.

14.4.12. Market risk

Long-term insurance companies need to invest in assets to pay for liabilities as they fall due in future years. There is uncertainty and volatility on both sides of the balance sheet in relation to movements in the level of financial variables. This variability is labelled 'market risk'.

A key word above is 'invest'. Assets are purchased to meet long-term commitments and not for short-term trading. While banks are traders in financial assets and have a much shorter timescale in measuring their risks, life insurers and retirement funds are long-term investors. They are much less active traders than banks and measuring market risks should therefore be on a longer timescale.

The market value is straightforward to assess if the asset is listed. It is more subjective for property due to the unique nature of each property. Unlisted assets are likely to form only a small part of a life insurer's portfolio. As discussed in Module 11 (Assets), the market value of insurance liabilities is more difficult to determine but may be approximated through fair value calculations or replicating portfolios. Matching of assets and liabilities was also discussed in Module 11 (Assets).

Market risk stress may apply to all assets. However, if surplus assets are included when examining the consequences of a stress, that would have the perverse result of capital distributions lowering the PCA (unless the distribution is funded by selling or transferring assets that do not have a market risk charge). The rest of this section only considers assets backing policy liabilities.

The main types of financial variables discussed in this subject relate to each of the main asset classes: equity, property, bonds and exchange rates. Variations in the value of these assets leads to the principle sources of market risks as follows:

- interest rate risk—losses due to decreases in asset values or increases in liability values resulting from fluctuations in interest rates:
  - changes in the absolute level of interest rates;
  - the spread between two rates (e.g. 10-year AA rated bond and 10-year BBB rated bond);
  - changes in the shape of the yield curve; and
  - any other changes in interest rate relationships (e.g. between indexed linked and non-indexed linked bonds);
- equity and property risk—losses resulting from fluctuations in the market value of equities and property;
- currency risk—loss in the value of foreign assets or increase in liabilities denominated in foreign currencies;
- reinvestment risk—future investments provide a lower yield than anticipated;
- concentration risk—too much exposure to one sector or geographical region; and
- asset/liability mismatch risk—cash flows from liabilities and the assets supporting them differ and this difference may increase in changed investment conditions.

The primary objective of life insurers is to meet liabilities as they fall due. Assets are chosen, where possible, to meet the nature, term and currency of the liabilities. Departures from a matched position depend on the availability of free assets. Since market stress is restricted to assets backing policy liabilities, one approach to consider is separating market stress into the following two types[9]:

- **Type A stress:** market stress relating to a matching portfolio. Consideration is given to the volatility in each of the matching portfolio and actual assets held.
- **Type B stress:** market stress relating to the balance of the liabilities which are not supportable by a matching portfolio because they require reinvestment on unknown future terms.

Type B stress is extremely difficult to measure. It involves measuring stresses for the duration of the portfolio and this significantly exceeds the chosen time horizon. As the stresses are applied for a longer time period than the chosen time horizon, the confidence level required should be lower. Internal models will be required that consider:

- both asset and liability cash flows;
- how assets and liabilities interact;
- the proposed reinvestment strategy; and
- how policy owners' behaviours may change in different economic scenarios.

A standardised approach, such as assuming conservative reinvestment rates, may be much simpler. Since these reinvestments are likely to lie outside the time horizon, it may be preferable for a regulator, and the company, to investigate such stresses within Pillar 2. The rest of the discussion in this section relates to type A stresses.

[9] "A Global Framework for Insurer Solvency Assessment: Research Report of the Insurer Solvency Assessment Working Party", 2004, International Actuarial Association.

Type A stresses, focusing on volatility in each of the matching portfolio and actual assets held, may be determined using a variety of approximations. A regulator proposing a standardised approach needs to balance ease of use and comparability against accuracy and complexity. The types of products sold will influence the development of a standardised approach. For example, complicated investment products may be sold in small quantities and a standardised approach may specifically exclude these products.

Potential approximate methods range from a simple factor method applied to components on the balance sheet to a full stochastic model. The approach below continues the theme of investigating univariate stresses, where each stress is calibrated to the required confidence level in the specified time horizon. Aggregating risks is discussed in Section 14.4.19.

Interest rate risk may be measured by considering the theoretical components of a bond yield. Yields may be expressed as the sum of the components shown in Figure 14.10.

Figure 14.10: Components of bond yields

Thus, interest rate risk involves a mixture of market risk (real yield and inflation risk premium), credit risk and liquidity risk.

Credit risk is covered in Section 14.4.13 and liquidity risk is covered in Section 14.4.14.

Changes to risk-free real yields and inflation risk premiums can be modelled as four separate shocks, as it is necessary to consider both rises and falls in each of these components. It is difficult to specify stresses to change the shape of a yield curve, apart from parallel shifts, due to the large number of variables that need to be considered in projecting the future shapes of yield curves.

Real interest rates (i.e. the risk-free real yields) are the portion of nominal risk-free interest rates that remain after deducting expected inflation. Nominal risk-free rates for assets and liabilities denominated in the local currency are the yields from government securities.

The real interest rates stress affects assets and liabilities whose value depends on a discount rate. On the assets side, it affects bonds but not property or equity assets. Liabilities with a value dependent on a discount rate will be affected. Liabilities for participating business and other discretionary investment business will also be affected if there is a change in the underlying value of bond assets backing the portfolio.

Inflation stress does not affect assets or liabilities where the cash flows are contractually indexed to inflation. A non-indexed bond or liability will be affected by both real interest rates and expected inflation stresses. A CPI-indexed bond or liability, by definition, will only be affected by the real interest rate stress.

Exercise 14.10

Look at the prices of a conventional bond and indexed linked bond. Figure out what happens to these prices (how they change) when inflation changes.

A **currency** stress measures the impact of an appreciation or depreciation of the local currency against all other currencies. Thus, there are two currency stresses (relating to the local and overseas currency markets). For example, where all liabilities are local and some assets are invested overseas, the appreciation of the local currency will create a capital charge because the overseas assets will fall in value.

An **equity** stress should measure the impact of falls in equity and an increase in volatility, which will affect derivative prices. The size of the stress will depend on the depth of the local market. For simplicity, the stress testing is unlikely to be more refined than one stress for listed securities and a larger stress for unlisted securities. The larger stress reflects the higher volatility observed for unlisted shares and a liquidity premium implicit in their share prices.

The fall in equity stress could be expressed directly as a percentage reduction or it could be expressed indirectly as a specified increase in dividend yield (a dividend expressed as a percentage of a current share price), which rises as asset values fall. The effect is not the same, as shown in the following example relating to assets in the ASX 200:

Suppose equity stress is measured by increasing dividend yields by 2.5%:

- If the current dividend yield for the market in ASX 200 securities is 4%, the stressed yield for listed equities would be 6.5%, which is equivalent to a fall of 38.5% in equity values (= 1 – 4%/6.5%).
- If the current dividend yield is 7% (a level reached in early 2009 during the global financial crisis following severe falls in equity markets), the stressed yield would be 9.5%. This is equivalent to a fall of 26.3% in equity values.

Similar considerations apply for **property** but the size of the stress should be larger because of the lack of diversity within a property portfolio.

14.4.13. Credit risk

This risk relates to the change in value of an asset due to default or expected default. It mainly affects fixed income assets and reinsurance recoveries.

As per the market risk section, credit risks are initially separated into two types:

- **Type A:** relating to actual assets held and the company's ability to manage its credit loss position; and
- **Type B:** relating to assets held in the future.

Type B is very difficult to model. This section looks at Type A credit risks only.

The yield on interest-bearing assets includes an allowance for credit risk (see Figure 14.10). Part of the credit risk relates to a credit spread. A credit spread is the difference in yield between an asset that is subject to credit risk (such as a corporate bond) and a similar risk-free asset (such as a government bond). Credit spreads can vary significantly over time, both for individual securities and for securities markets as a whole. A credit spread stress should increase the credit spread between these assets (i.e. increase the credit risk premium).

Another stress scenario should also allow for the risk of migration of individual assets to lower credit ratings, which will result in the assets having a higher credit spread (and lower value).

Further, explicit allowance may be required for losses through default over the following 12 months. This allows for both the probability of default and the loss given default (i.e. the proportion of the value of the defaulted asset that will not be recovered).

The credit spreads stresses should vary depending on the counterparty grade of the asset. Higher stresses should apply to securitised and re-securitised assets. An example of a securitised asset is a residential mortgage backed security. The higher stresses applying to these assets reflect their complexity and the difficulties associated with assessing their inherent risk.

Part of the credit spread stress may reflect an increase in the liquidity premium[10]. In some jurisdictions, some liabilities are discounted with an allowance for a liquidity premium. For example, policy owners cannot surrender lifetime annuities and it seems reasonable to allow for liquidity premiums in assets when discounting future annuity payments. A consequence is that annuities and other illiquid liabilities will reduce in value when the credit spread stress is applied, as they are now discounted at a higher yield, reflecting this increased liquidity premium.

[10] Liquidity refers to the ease with which an asset can be traded. If an asset is more difficult to trade, then its price will reflect this difficulty and be lower than that of a similar asset that is more easily traded. When considering the return on an asset, a less liquid asset will have a higher yield than a comparable more liquid asset, because of the inverse relationship between prices and yields. The additional yield covering the liquidity risk is known as the liquidity premium. The liquidity premium compensates investors for investing in assets with low liquidity. That is, they get a higher return.

There are other assets not considered in the above stresses. A default stress is required to apply to reinsurance assets, over-the-counter (OTC) derivatives, unpaid premiums and any other credit exposures that are not considered in the credit spreads stress. A simple factor could be developed to apply to the balance sheet value of these assets, however, as part of the supervisory review in Pillar 2, the regulator may consider further refinement to this approach to be necessary.

Exercise 14.11

Should the credit stress apply to all assets in the company, or only those that back policy owner liabilities?

14.4.14. Liquidity risk

Life insurance companies are exposed to loss in the event that insufficient liquid assets are available to meet payments to policy owners.

It is often assumed that this risk is not significant for life companies that have well-diversified portfolios. Therefore, life insurers may choose to make no explicit allowance for liquidity risk as part of their Pillar 1 capital calculation. Regulators may pick up liquidity risks in Pillar 2 by examining if there are specific circumstances that amplify liquidity risk. Examples that may cause regulators to have concerns are:

- relatively few policy owners represent a significant portion of a fund;
- the company is small and has limited access to capital markets;
- the company has insufficient ability to access short-term borrowing; and
- lack of diversity in assets or liabilities, although this may be picked up in the asset concentration risk.

14.4.15. Asset concentration risk

Additional capital may be necessary for companies that are not well-diversified, have excessive concentrations of investments in individual assets or have excessive concentration in exposure to single counterparties. This additional capital is known as the asset concentration risk charge.

The concentration limits, which define 'excessive' concentration, vary depending on the type of asset.

One of the considerations of life companies when setting their investment policy and reinsurance arrangements is to minimise capital requirements that could result from excessive asset concentrations. The asset concentration risk charge is therefore normally zero in practice.

The approaches for other stresses use a VaR method for setting minimum capital requirements. This may not be appropriate for an asset concentration risk charge. For example, historical records show that the probability of default over 12 months for a AAA-rated (counterparty grade 1) corporate bond is extremely low—much less than 0.5%. A life company could theoretically hold all its assets in a single corporate bond maturing in 12 months' time and have a probability of insolvency of less than 0.5%. The problem with this strategy is that if the bond did default, there might be a total loss of all assets. A catastrophic loss of this type is therefore better measured using a TailVaR approach.

14.4.16. Operational risk

An operational risk charge relates to the risk of loss resulting from inadequate or failed internal processes, people and systems or external events. Examples of operational risk include losses due to:

- fraud, either by staff or from external sources;
- failures in computer systems and administrative processes, whether from in-house or outsourced delivery;
- legal risk (excluding strategic risk and reputation risk);
- mis-selling of products;
- lack of effective management of distributors and other third parties, where they are integral to operations;
- manipulation or concealment of financial information;
- poor performance by the management team;
- unit pricing and other administrative errors;
- failure to provide customers with sufficient product information; and

- external events causing damage to the life company's premises, equipment or people (e.g. terrorism, vandalism, earthquakes, fires, floods and pandemics). These types of events can cause major disruption to an insurer's operations.

Recent experience has shown the potential for operational risk exposures to result in severe and unexpected losses. There is also evidence that operational risk is continuing to increase in its size and complexity due to factors such as the increasing reliance on advanced technology, legacy and IT system issues, outsourcing and agency distribution channels and mergers and acquisitions activity. Cyber risk is of increasing concern to the financial services industry.

There are data issues in terms of estimating the frequency and severity of operational risk losses for insurance companies. The heterogeneity in the underlying causes makes it an extremely challenging problem to measure operational risk. There are no clear, agreed models to capture operational risk. In theory, the amount of capital required for operational risks will depend on the complexity of an insurer's operations and the strength of its management and control processes. These things are inherently difficult to measure in an objective way.

The result of these difficulties is that the quantification of operational risk requirements under Pillar 1 is usually simplistic. A proxy for the risk is to set the capital as a percentage of premiums or percentage of policy liabilities. This has a desired effect of increasing the charge as a company grows but provides no allowance for a company improving its management of a process that may lead to lower operational risk losses.

The operational risk charge percentages are calibrated to be broadly appropriate for a well-managed insurer. Regulators can impose Pillar 2 supervisory adjustments (see Section 14.5.5) to companies that appear to have a higher operational risk profile or an inadequate approach to operational risk management.

14.4.17. Management actions

In each of the stresses discussed above, management may take actions that reduce the effect of the stress.

The insurance risk stresses analysed are intended to be extreme, but realistic. In practice, a life company will take mitigating actions in response to extreme stresses. These actions can include, but are not limited to:

- reducing bonus or crediting rates for participating business; or
- increasing premium rates for non-participating business.

Regulators may allow life companies to take credit for the actions it would expect to take in order to reduce their capital requirements. Any allowances for management actions which reduce capital requirements must be appropriate, justifiable and equitable. They must also be consistent with policy owners' reasonable expectations based on product disclosure documents. The regulator may challenge any credits applied in the capital calculation during the Pillar 2 review.

Premium rate increases cannot be assumed as a response to the random or event stresses. This is because these stresses only affect claims that are expected to be incurred in the time horizon. It would not be appropriate to assume that losses from these stresses could be recovered via subsequent long-term increases in premiums. Random and event stresses are effectively one-off occurrences, so an increase in premium rates in response to these stresses would be difficult to maintain in a competitive market. In some jurisdictions, premium rates may be changed by reference to a better understanding of the underlying rates (the future stresses), but in other jurisdictions insurers may have to wait five or more years before being able to adjust premium rates to reflect this better understanding of future stresses.

Management actions, such as reductions in bonus rates or increases in fees or premium rates, can be assumed in response to the expense stress. However, increases in fees or premium rates will not happen immediately following a shock. In practice, it takes time for the impacts of the shock to be measured and monitored to decide whether the impacts are one-off or ongoing and what actions are required, and to notify policy owners, in advance, of any resulting fee or premium increases. Allowance for such management actions therefore needs to factor in a minimum delay after the shock occurs, say at least one year.

Management actions can be allowed for in each of the market risk stress tests. The range of potential management actions is different from those in the insurance risk charge due to the different nature of the stresses. Potential management actions include reductions to future bonus or interest credits and immediate reductions to termination values (e.g. by reducing the surrender value of terminal bonuses or unvested interest credits). The ability of a company to vary its bonus rates and termination values in response to asset stresses is very important in reducing the capital requirements for participating and discretionary investment business.

An increase in premium rates for risk business may not be a feasible or appropriate response to asset stresses. Premium rates might become uncompetitive if other life companies matched their assets to their liabilities and were immunised from asset stresses. The reasonable expectations of policy owners is also a constraint if promotional material indicates that premium rates will only be increased in response to a worsening of claims experience.

Another type of management action that can be allowed for is altering the asset exposures of the fund after the stresses have occurred. This may reduce the value of any embedded options, such as investment guarantees that are included in the post-stress liabilities.

14.4.18. Dependency

The previous sections outlined various stresses and approaches to calculate the effect on a balance sheet if each stress occurred at the required level of probability. We noted that estimating statistical distributions for these stresses is not easy. A more complicated question, touched on in the lapse section (14.4.11), is to consider how these risks depend on each other. Measuring and modelling dependency structures is one of the most difficult aspects of economic capital modelling.

Dependency between risk factors means they are somehow linked. Having information about one risk factor that is linked to another provides information, albeit potentially unquantified, about the other risk factor.

Dependency does not suggest that there is a linear relationship between the two risk factors. Unfortunately, the term 'dependence' is often mixed with a particular definition of correlation. Introductory statistical courses introduce the **Pearson correlation coefficient**:

$$Cov(X,Y)/\sqrt{[Var(X) \times Var(Y)]}$$

which is a measure of the strength of linearity between two random variables. The Pearson correlation coefficient has desirable properties in that it is easy to calculate, is familiar to many stakeholders and is trivial to extend to calculating sums and differences of random variables. The measurement is an indication of the linearity but it is not always capable of evaluating the strength of the relationship[11].

The Pearson correlation coefficient, which lies between -1 and 1, has the following limitations in evaluating the strength of relationship between two or more variables:

- it does not capture nonlinear effects;
- if the knowledge of one random variable provides exact information about another random variable, then the correlation coefficient may still take any value between -1 and 1;
- the correlation coefficient may be quite different under monotonic transformations of the variables (e.g. the correlation coefficient of X and Y may be different to the correlation coefficient of log(X) and log(Y)); and
- some insurance risks are heavy-tailed, with potentially infinite variances, making the Pearson correlation coefficient indeterminable.

[11] Lookup 'Anscombe's quartet' for a good explanation of this concept, the detail of which is outside the scope of this syllabus.

These limitations of the Pearson correlation coefficient may be overcome with 'rank' correlation methods, such as the Spearman rank correlation coefficient (Spearman Rho) and the Kendal rank correlation coefficient (Kendall's Tau). These are non-parametric methods that do not depend on the marginal distributions of the underlying risk variables. The rank coefficient methods are less affected by outliers compared to the Pearson method. These tests are now included in the actuarial Foundation course and a summary sufficient for this subject is described below.

The **Spearman Rho** is calculated using the same formula as the Pearson correlation coefficient, except that the sample values of the random variables are reordered from lowest to highest (or highest to lowest). If X and Y are perfectly monotonically related[12], the absolute value of the Spearman Rho coefficient equals 1. In that instance, it will equal 1 if X and Y increase together and -1 if as one increases the other decreases.

Kendall's Tau coefficient is defined as:

$$\tau = \frac{number\ of\ concordant\ pairs - number\ of\ discordant\ pairs}{\frac{n(n-1)}{2}}$$

$$= \frac{2}{n(n-1)} \sum_{i<j} sgn(x_i - x_j)\, sgn(y_i - y_j).$$

where sgn(x) = 1 if $x \geq 0$ and sgn(x) = -1 if $x < 0$.

Suppose there are n pairs of observations, (x_1,y_1) (x_2,y_2), …., (x_n,y_n) of the random variables X and Y, where all values of $(x_i)$and (y_i) are unique (alterations to the method can overcome this condition). For any pair of observations, (x_i, y_i) and (x_j, y_j), with $i < j$, they are said to be concordant if both $x_i > x_j$ and $y_i > y_j$, or $x_i < x_j$ and $y_i < y_j$. They are said to be discordant if $x_i > x_j$ and $y_i < y_j$, or $x_i < x_j$ and $y_j > y_j$.

There are two main issues with the three correlation methods discussed above:

[12] Monotonic relationships are where one variable increases and the other increases, or one variable increases and the other decreases.

- they are a numerical measure of dependency and tell part of a story but do not fully characterise the dependency structure; and
- independent random variables have zero correlation, but if zero correlation is measured under any of the three methods it does not necessarily imply independence of the random variables.

When using these correlation methods, actuaries need to be mindful of these issues in interpreting the outcomes of dependency calculations.

These correlation calculations can be used when aggregating the impact of multiple risks, as discussed in Section 14.4.19.

14.4.19. Risk aggregation

The objective of capital calculation is to estimate an amount of capital such that there is only a small probability that assets will be insufficient at the end of the time horizon to cover the liabilities. A set of stresses is considered where each stress leads to an amount of capital sufficient to meet the small probability requirement. A method must then be used to aggregate the capital requirements under each of these individual stress scenarios.

This section outlines the following aggregation techniques:

- simple summation;
- fixed percentage;
- correlation matrix; and
- copulas.

Simple summation assumes perfect dependency between risks (effectively assuming that if one risk occurs, they will all occur) and simply adds up the stand-alone marginal risk capital amounts.

It is a simple to calculate, conservative method that is easy to explain. By definition, no data is required to estimate correlations. However, the assumption of perfect dependency is unrealistic and the method places too high an amount on the required capital as it is extremely unlikely that all risks considered will occur over the modelled time horizon.

The difference between the simple summation of capital charges under each risk and the actual capital amount calculated, allowing for relationships between risks, is referred to as the **risk aggregation benefit**. For a simple summation method, the risk aggregation benefit is, by definition, zero.

Fixed percentage is a straightforward extension of the simple summation method. It applies a factor (< 1) to the result under the simple summation method (i.e. the sum of the individual risk capital amounts).

Unlike the simple summation method, there is some allowance for diversification, albeit crude, as the factor is not sensitive to changes in underlying risk exposures.

Correlation matrix, or the variance-covariance matrix method, assumes there exists stable pairwise correlations among the risks.

It is relatively simple to calculate via the formula: $\sqrt{\{\sum_{i=1}^{n}\sum_{j=1}^{n}\rho_{ij}\ C_i\ C_j\}}$, where

- C_i is the capital for the i^{th} risk; and
- ρ_{ij} is the correlation coefficient between risks i and j.

This method is still simple and relatively easy to communicate to management. Whilst the individual risks are dependent on individual companies, a regulator could specify the entries in the correlation matrix to obtain consistency across its regulated companies.

This method is used by regulators for life insurance companies and can be extended to defined benefit funds. In Europe and Australia, a nested approach is used. Under this nested approach, univariate shocks to insurance risks (mortality, expenses, etc.) are combined via a regulatory specified correlation matrix. Univariate shocks to market risks are combined with another regulatory specified correlation matrix and so on. Finally, another matrix is used to aggregate the capital amounts from the high-level categories: insurance, market, credit, liquidity, operational and other risks.

A nested approach has the following advantages:

- it is easier to check that each smaller matrix satisfies the required properties, in particular that each matrix is positive semi-definite (described at the end of this section);

- it avoids building very large correlation matrices that need lots of uncertain minor cross-terms; and
- it is easier to identify the drivers of risk-based capital (grouping by risk category allows a comparison of risk contribution between risk categories and over time).

In normal circumstances, market and insurance risks are largely independent. However, the correlation factor is not zero because extreme insurance risks, such as natural catastrophes and pandemics, can have adverse impacts on both claims experience and asset values. There is also some evidence to suggest that disability claims experience tends to worsen during times of economic stress.

The operational risk capital charge is usually excluded in the calculation of the aggregation benefit because operational risk is linked to both asset risk and insurance risk, and these correlations become stronger in times of extreme stress. Operational risks can manifest in the form of poor management of investment policy, underwriting and claims administration, and can be a significant factor in company failures because of these linkages.

The asset concentration risk charge is designed to address excessive concentrations of assets and it is usual to exclude this charge when calculating the aggregation benefit.

There is a complication with respect to shocks that are difficult to consider in isolation (e.g. lapse). One method that has been adopted by regulators is, for example, to use the correlation matrix approach for the univariate insurance stresses, to calculate capital at the required probability level for those stresses. A separate calculation then considers lapse stresses and the effects on other parameters, and then determines the capital, with respect to insurance risks, at the desired level of probability.

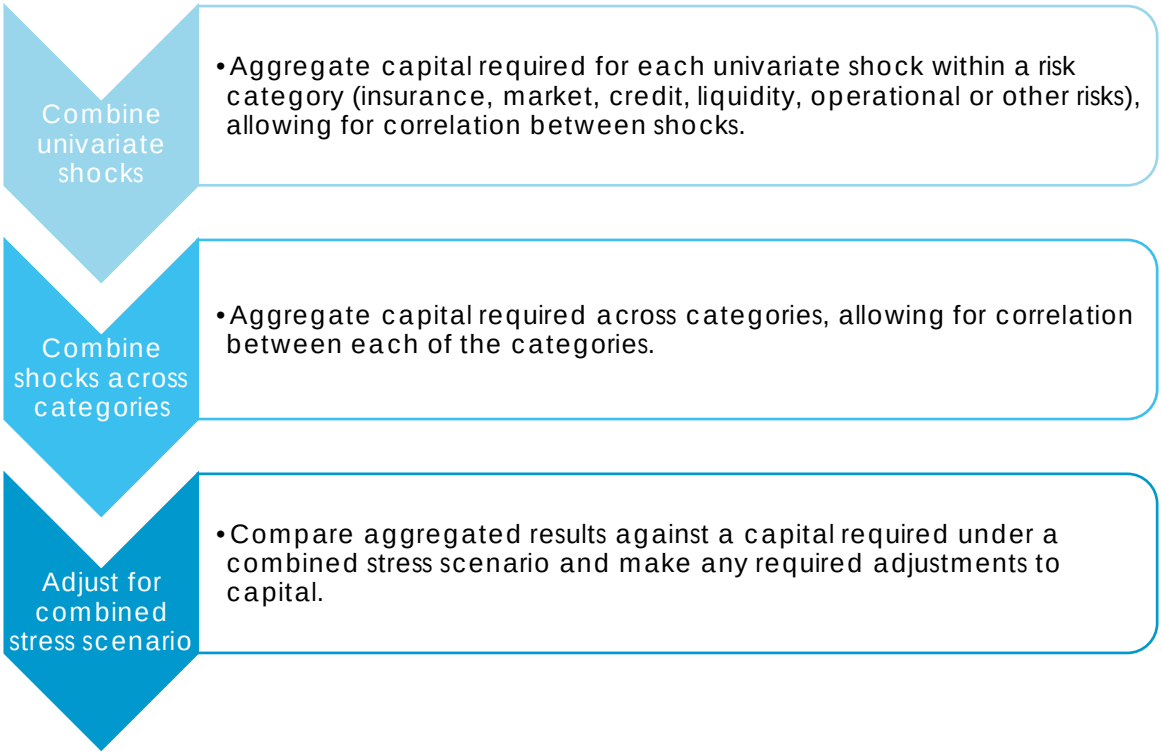
A final test may occur after all the risks have been aggregated, using a combined stress scenario. A combined stress scenario is a single scenario where all of the insurance, market and credit risk stresses are applied simultaneously, after modifying the stresses by multiplying them by diversification factors (reflecting diversification benefits between risk categories). A combined stress scenario is a top-down approach used to cross check the capital requirement calculated using a bottom-up approach (i.e. aggregating the capital requirements under each univariate shock). The combined stress scenario may indicate that an additional amount of capital is required on top of that calculated by aggregating individual risks. This additional amount of capital is referred to as a **combined stress scenario adjustment**.

For example, the stressed scenarios used for the univariate stresses will give rise to tax benefits (i.e. a reduction in future tax liabilities). These tax benefits may be recognised in full in each stress scenario and will reduce capital charges. The combined stress scenario tests the extent to which these tax benefits are recoverable. The limit to the recoverability of tax benefits is the point at which future tax liabilities reduce to zero.

The combined stress scenario also tests the extent to which management actions can reduce capital charges. For example, reductions to bonus rates can be assumed in determining the insurance risk charge and in each of the stress tests for the market risk charge. However, it is possible that the combination of all of these bonus rate reductions would produce negative bonus rates. The bonus rates assumed in the combined stress scenario must be consistent with policy documents, promotional material and policy owners' reasonable expectations.

The steps used under this risk aggregation method are summarised in Figure 14.11.

Figure 14.11: (Nested) correlation matrix method for aggregating risk



The disadvantages of the correlation matrix method are:

- there is insufficient evidence to support the non-diagonal entries in the correlation matrix, especially when considering how correlations behave under extreme circumstances;
- the need to assume risks follows a class of statistical distributions known as elliptical distributions (of which the Guassian distribution is a special case);
- it underestimates the effects of skewed distributions and potentially does not provide enough weight to heavy-tailed distributions;
- the correlation coefficients are sensitive to the chosen underlying marginal risk distributions; and
- the method does not capture non-linear features, nor can it fully describe all cause-and-effect structures.

When attempting to determine correlations, a lack of credible data either at company or country level is 'solved' by using expert judgement.

It is possible to choose correlations that have unintended effects, such as diversified capital exceeding undiversified capital. Technically, the symmetric n by n correlation matrix M must satisfy: $\underline{\mathbf{x}}^T M \underline{\mathbf{x}} > 0$ for all non-zero vectors $\underline{\mathbf{x}} = (x_1, \ldots, x_n)$. There are various techniques that may be used to check if the correlation matrix satisfies this necessary condition.

The need to determine appropriate correlations highlights the reality that capital modelling at a specified probability of loss is subjective and does not, in a statistical sense, represent, for example, a 99.5% confidence level. It is important to understand that a regulator will be seeking consistency across companies in their approach to capital modelling. It is also important to realise that the quantification of capital is the start, and not the end, of a process of understanding what to do next in maintaining a company's capital adequacy.

Copula methods provide a link between the univariate distributions and the combined multivariate distribution of the total risks faced by a company. This method provides a way of separately identifying and describing the dependence structure between risks. This fits well with actuarial modelling, as actuaries tend to think about the individual risks and then consider the interactions amongst the risks.

There is a wide variety of choices of copulas (link functions) and this assists in modelling possible dependency structures and understanding the sensitivities of the risks to the dependency structures. Numerical solutions are often deduced under a copula structure through repeated random sampling (Monte Carlo simulation).

Below is an annotated mathematical theorem[13]. It states that there is a copula that links the marginal distributions with the full, complicated, multi-variate distribution. This subject does not develop the topic in any more depth[14].

[13] Some of the detail of the theorem has been excluded to make it simpler to follow.

[14] A detailed discussion of copulas in risk management is contained in: McNeil, A.J., Frey, R. and Embrechts, P. 2015, "Quantitative Risk Management: Concepts, Techniques and Tools", *Princeton Series in Finance.*

Sklar's Theorem: Let F denote a multivariate distribution function with marginal distributions, $F_1, \ldots, F_d$. Then, there exists a function known as a copula, $C(u_1, \ldots, u_d)$ such that, for all vectors $(x_1, \ldots, x_d)$:

$$F(x_1, \ldots, x_d) = C(F_1(x_1), \ldots, F_d(x_d))$$

The power of the theorem is that it shows:

- all multivariate distribution functions essentially contain copulas; and
- a copula may be combined with univariate distributions to construct multivariate distributions.

Limitations of the copula method include:

- the theorem says that a theoretical copula exists, but doesn't provide information on how to construct it;
- the models may only be understood by a limited number of staff. It is not easy to explain the concepts to non-technical senior managers, but regulators may want those stakeholders to demonstrate their understanding;
- fitting parameters to data is fraught with difficulty as data is sparse in the tail of distributions;
- multiple models usually need to be constructed to test the quality of the model (e.g. using Akaike information criterion); and
- whilst copulas may be theoretically better suited to building capital models, there are many non-trivial considerations when choosing a copula. These choices are outside the syllabus scope.

Despite these limitations, copula methods are occasionally used but care is always needed to understand these limitations.

14.5. Pillar 2 — qualitative requirements and supervision

The previous sections of this module focused on the capital base and the calculation of a Prescribed Capital Amount (PCA) under Pillar 1.

As previously outlined, Pillar 2 is the entity's review of its internal processes, followed by the supervisory review process. This includes supervision of the risk management and capital management practices of life companies.

The self-assessment and supervisory review processes are linked to the topics covered in previous sections of this module and those covered in Module 13 (Risk management).

14.5.1. Self-assessment

The self-assessment of capital adequacy in Pillar 2 is assisted by the regulator specifying the need to develop, document and follow an assessment process. The name of this process varies by jurisdiction (e.g. Internal Capital Adequacy Assessment Process or ICAAP in Australia and the US, Own Risk and Solvency Assessment or ORSA in the UK). There are differences in content between jurisdictions, however, the key principles remain the same. In this subject, we will refer to the process using the Australian terminology, ICAAP. An ICAAP involves an integrated approach to capital and risk management, aimed at ensuring the capital held is adequate in the context of the risk profile and risk appetite of the life company.

Under an ICAAP, a company develops its own processes with appropriate and adequate techniques, tailored to fit into its organisational structure and risk management system, and taking into consideration the nature, scale and complexity of the risks inherent to the business.

The Risk Management Function plays an active part in the self-assessment, including steering how the assessment is to be performed and challenging the results. It documents the company's policy and completes a record of each assessment, including a detailed internal report and a report to be provided to the regulator.

Risk appetite, discussed in Module 13 (Risk management), is a key component in the ICAAP process. Companies define their risk appetite in the form of a risk appetite statement. This statement is usually approved by the board of the company. It provides a foundation for risk management throughout the company. It also sets boundaries for risks that the company is willing to accept.

A strategy is required to ensure adequate capital is maintained over time, including specifying capital targets set in the context of the company's risk profile, the board's risk appetite and regulatory capital requirements. The ICAAP process includes:

- plans for how target levels of capital are to be met and the means available for sourcing additional capital where required;
- adequate policies, procedures, systems, controls and personnel to identify, measure, monitor and manage the risks arising from the life company's activities on a continuous basis and the capital held against such risks;
- actions and procedures for monitoring the life company's compliance with its regulatory capital requirements and capital targets. This includes the setting of triggers to alert management to, and specified actions to avert and rectify potential breaches of the regulatory capital requirements;
- stress testing and scenario analysis relating to potential risk exposures and available capital resources;
- maintaining data quality standards;
- processes for reporting on the ICAAP and its outcomes to the board and senior management of the life company and the regulator;
- processes for ensuring the ICAAP is taken into account in making business decisions; and
- policies to address the capital impact of material risks not covered by explicit regulatory capital requirements.

Regulators often require companies to prepare projections of their capital levels over time (e.g. over a three-year period). This can be a very complex task and sophisticated models may be required. In addition to the best estimate assumptions used for calculating policy liabilities, assumptions will also be required for future levels of new business and future capital distributions and raisings. It may be necessary to make allowance for changes to best estimate assumptions during the projection. For example, best estimate maintenance expenses must be sufficient to cover forecast costs for the following year. Best estimate maintenance costs are therefore likely to change each year throughout the three-year projection, necessitating a recalculation of profit margins each year. Any planned changes to product pricing, reinsurance arrangements or investment policy add more complexity to the task of making the projection. The projection model also needs to be capable of performing stress testing and scenario analysis, where actual experience in any or all of the three years differs from the best estimates.

An analysis of actual to planned capital outcomes over the previous year is also usually required by the regulator. This can also be a complex task. This analysis will need to explain the reasons for movements in the capital base and the prescribed capital amount.

14.5.2. Target capital

Target capital is the amount of capital that a life insurance company aims to hold over the medium to long term. The actual amount of capital will vary from the target, depending on whether recent experience of the company has been better or worse than expected. Actual capital will also be affected by capital raisings and distributions.

Due to the serious nature of breaching the PCR, life companies must have target capital that exceeds the PCR by a significant margin. The excess of target capital over the PCR is referred to as ‘target surplus’.

Target capital is determined by a life company having regard to its risk profile, the board's risk appetite and the regulatory capital requirements. In setting its target capital policy, a life company may also consider:

- the amount of risk-based (or economic) capital that is required to meet the company's objectives;
- the amount of capital required to support a specific financial strength rating by external rating agencies;
- the likelihood of breaching the PCR and the consequences of such a breach; and
- the cost of capital.

A life company may take the view that the amount of risk-based (or economic) capital that it requires is greater than its PCR. For example, it may consider that a higher probability of sufficiency than required by the regulator or a longer time horizon than specified is appropriate. It may also take a different view from the regulator on the amount of capital required for particular risks. For example, a company may think that post-retirement products such as annuity business are extremely risky and require significant capital. As discussed in Section 14.2.2, it is difficult for a company to be competitive in a market if it sets its economic capital higher than regulatory capital. In these scenarios, a company may instead choose not to pursue certain lines of (what it considers to be) riskier business.

A life company might target a specific financial strength rating from ratings agencies, such as Standard and Poor's or Moody's and Fitch. The financial strength rating is important to a company as it may be one of the factors used by financial advisors in making recommendations to potential policy owners. It is also important if the company intends to borrow funds. The ratings agencies each have their own method for assessing the amount of capital a company needs to hold in order to achieve specific ratings.

Target capital is often set by companies at a level that provides a desired level of sufficiency with regard to a breach of PCR over the time horizon. The probability of breaching PCR that a company is willing to tolerate within its risk appetite might range from as low as 0.5% to as high as 10%. The lower the probability of breaching PCR, the higher the target capital needs to be. A company might be satisfied with a lower level of target capital if its cost of capital is high if it is confident that it can rapidly rectify any breach of PCR and the consequences of a temporary breach are not too severe.

A model is typically used to determine the amount of capital required to meet these targets. A target capital model would normally consider:

- all the material risks currently faced by the entity, including, for example, strategic and political risks, some of which may not be covered under the regulator's capital standards;
- how to quantify the probability and impact of these risks, taking into account the underlying probability distributions, correlations between different risk types and how these could interact or break down in extreme scenarios;
- management actions available in the case of a deterioration in capital position; and
- how risks could emerge (e.g. a sudden shock or a gradual deterioration), which can affect the timing of the impact of these risks on the capital position and consequent management actions.

An alternative to assessing target capital through a modelling approach is to set target capital as a multiple of the PCR, for example 150% of PCR. However, a target of this nature is less useful as it does not indicate the likelihood of a breach of PCR. Target capital may also be defined as a range rather than a single number. A target range is a useful concept for managing capital as it recognises that actual capital is volatile, but management action only needs to be taken if capital levels move outside the target range.

The cost of capital is the return shareholders seek to earn on their invested capital less the investment return (net of tax) on the assets that the capital is invested in. The return shareholders seek to earn depends on the risks the capital is exposed to. The cost of capital limits the amount of capital shareholders are willing to commit to a life company. On the other hand, if surplus capital is too low and a breach of PCR occurs, the adverse publicity is likely to be damaging to the value of the company (and will probably drive the cost of capital up for the company!). There is also the possibility that the regulator will take actions which damage the value of the shareholders' interests in the business. For example, the regulator may enforce closing the company to new business. A balance must be struck between having too much or too little surplus capital.

Life companies may consider the position of other companies when setting their own target capital policy. A life company will probably not want to be the weakest in the industry. Weak companies may have difficulties attracting new business and retaining existing business and will be the first to breach PCR in a crisis that affects the entire industry. On the other hand, a life company may not see any need to be the strongest company in the industry. A life company that is excessively well capitalised may struggle to remain price competitive in the market.

14.5.3. Stress testing

Stress and scenario testing are an integral part of decision making in a life company and in setting a life company's risk appetite and target capital levels, and also play a key role in determining a life company's reinsurance strategy and investment policy. Stress and scenario testing should form part of the life company's ICAAP. In addition, regulators often conduct stress tests on an industry-wide basis as part of their supervisory responsibilities.

Scenario testing is used to assess the vulnerability and resilience of a life company under severe but plausible scenarios. A scenario typically describes an event, which translates into several different types of risk outcomes, such as an increase in claims, a fall in equity and property markets, adverse movements in interest rates and foreign currency exchange rates or a reduction in new business volumes. Actual scenarios that have happened in the past can be a useful guide. The impact of each scenario on financial metrics such as cash flows, profits and capital are then modelled.

It can also be a useful exercise to conduct 'reverse stress testing'. Reverse stress testing involves devising scenarios that lead to a breach of PCR or the insolvency of a life company. These scenarios can help management and boards to gain an understanding of the severity of events that would lead to these outcomes and either find ways to reduce their exposure to these events and/or plan their response should such scenarios actually occur.

14.5.4. Capital response

A life company's ICAAP typically adopts a graduated approach of response actions to protect the company's capital position should it fall below target capital. These actions might include:

- adjusting dividend policy;
- repricing existing business;
- managing the rate at which new business is acquired;
- changing the company's reinsurance arrangements;
- adjusting the investment asset mix to achieve a change in the company's risk profile;
- transferring assets between statutory funds and into (and potentially back from) shareholders' funds, if available; or
- capital injections from the company's parent.

Not all of these alternatives can be arranged quickly, or necessarily as required, and may become impaired or even unavailable in an environment where capital is scarce.

An ICAAP usually includes a dividend policy, which specifies how much dividend it expects to pay to shareholders each year. An example of a dividend policy is an aim of paying a dividend of between 70% and 80% of profits over the medium to long term. A rapidly-growing company might aim to pay a lower dividend and retain a higher proportion of its profits to fund its future capital requirements. However, if dividends are too low relative to earnings, there may be tax disadvantages to domestic shareholders.

A dividend policy normally has regard for the position of the life company's capital base relative to its PCR and target capital. If the capital base is less than target capital, but still well above PCR, dividends might be reduced. If the shortfall relative to target capital becomes serious, dividends may be suspended.

If a life company is growing rapidly, it may need to raise additional capital. As part of its ICAAP, a life company will estimate its future capital needs and plan for future capital raisings if there is a possibility they will be necessary.

A life company will also need to regularly review the capital positions of each of its funds. Transfers would be made from funds with excess capital to funds that have less than their target capital.

Exercise 14.12

You are the head actuary for a medium-sized listed life company. The regulator has just announced a significant strengthening of its capital standards following a period of severe turmoil in financial markets. The impact of this will be that your company still meets its PCR but falls short of target capital by a significant margin. What actions could the company take in response to this situation and what factors would you consider in making a recommendation to senior management?

Exercise 14.13

In Exercise 14.12, why might the cost of additional reinsurance be lower than the cost of holding additional capital for insurance risks?

14.5.5. Supervisory review

The regulator will want to monitor the amount of capital of a company and have confidence in the ICAAP process, including processes used to derive the capital amount. Insurers report to the regulator and provide evidence that their processes are adequate.

Regulators may adjust the capital requirement calculated by the insurer. Part of Pillar 2 is the provision of power to the regulator to include a supervisory adjustment to the submitted capital amount. These supervisory adjustments to the PCA occur in a range of circumstances, including when:

- the PCA calculation does not adequately address the risks specific to the life company (e.g. strategic risk, reputation risk);
- the life company is newly licensed or has recently materially changed, or plans to materially change, its business mix;
- the regulator has identified material issues with the competence or probity of responsible persons associated with the life company;
- the regulator has identified material weaknesses in the life company's governance, risk management strategy or realised risk management outcomes;
- the life company has failed to comply with, or is consistently minimally compliant with, applicable prudential standards;
- the life company is using a business model, has an organisational structure or is following a business strategy that the regulator regards as highly risky or overly difficult to assess, in a way that is not captured under the calculation of the PCA;
- the life company's internal processes are not well-defined or documented, or its target capital policy is assessed as being inadequate, such as due to a lack of sufficiently rigorous stress and scenario testing; or
- the life company has been unable to restore its capital position to target capital levels in accordance with its own policies in a timely manner.

When a supervisory adjustment is added to a company's PCA, the resulting capital requirement can be referred to as the Prudential Capital Requirement (PCR). As mentioned in the Pillar 3 overview (Section 14.3.3), the supervisory amount is unlikely to be disclosed. It is a private matter between the regulator and the regulated entity.

Exercise 14.14

Explain why a merger of two companies could reduce the PCR for the combined entity.

14.5.6. Intervention powers

Regulators expect to be informed by a life company if a breach of PCR is imminent and will keep a close watch on life companies that are close to a breach of PCR.

The options available to a life company that breaches its PCR include raising additional capital from outside the company, closure to new business and reducing the riskiness (i.e. 'de-risking') of the business.

Closure to new business might help to restore capital over time because any capital strains from new business are eliminated, whilst any profits from existing business are added to the existing capital. However, closure to new business creates some additional one-off costs that reduce the capital base. For example, staff involved in marketing, sales and processing of new business may be made redundant.

De-risking strategies can involve changing the investment policy to a less risky mix of assets, purchasing derivatives to limit the size of potential future asset losses or purchasing additional reinsurance to limit potential losses due to increases in claim costs.

If a breach of a PCR occurs, or the company is coming close to a breach and it can't remedy the situation within a short time, regulators have a range of intervention powers, including:

- directing the company to take actions in a broad range of areas, such as:
  - removing directors or senior managers or limiting their roles in the company;
  - changing the auditor;
  - removing the appointed actuary;
  - directing the company to stop selling business, renewing policies or collecting premiums;
  - directing the company to stop borrowing and stop paying dividends;
  - undertaking an actuarial investigation by independent actuaries; and
  - changing the business structure;

- appointing a judicial manager, either directly or via a court, who effectively takes over the day-to-day management of the company from the board and senior managers and may suggest:
  - recapitalisation;
  - the transfer of liabilities to another insurer; or
  - the wind-up of the life company.

A recapitalisation or transfer of liabilities to another life company are the preferred courses of action as the contractual entitlements of policy owners are preserved under these options. Wind-up is normally the least desirable outcome and is only recommended if none of the other courses of action are feasible.

The following example from Australian history (the 1980s) helps to illustrate the intervention powers available to life insurance regulators:

Example

On 28 September 1990, a transaction was completed whereby $65 million was fraudulently removed from the statutory funds of the Occidental and Regal life companies. The fraudulent transaction was in relation to an attempted sale of both life companies by their parent. Both life companies were already in a weak position. The parent company was also in some financial difficulty and could not continue to support the life companies with sufficient capital.

Both life companies had grown rapidly during the late 1980s and were subject to financial pressures on a number of fronts. These included:

- large exposures to unlisted assets, such as properties and loans;
- expense overruns, low profitability and high growth of new business; and
- excessive distributions to participating policy owners in order to grow market share.

These problems were inter-related. Adequate profits could only be achieved if unit costs were kept down. Low unit costs could only be achieved through high new business growth. High new business growth could only be achieved if crediting and bonus rates were kept competitive. High crediting rates could only be afforded if high investment returns were achieved by investing in risky assets.

The reasons for the expense overruns included:

- too many products for efficient management. New products had been developed at frequent intervals and in multiple versions. While there were substantial volumes of business written for some products, there were many other products with non-viable volumes. The products were generally not designed in a manner which permitted later merger and upgrades of old products;
- continuing difficulties in maintaining and upgrading computer systems;
- products were sold via independent agents who received generous remuneration, including attendance at high cost conventions and other non-commission benefits;
- the head office accommodation of both companies was particularly lavish.

The acquisition of both companies by the same parent in the late 1980s had achieved little in the way of expense savings because the two companies had very different computer systems, products, commission bases and market segments.

On 25 October 1990, the Deputy Commissioner of Life Insurance in the Insurance and Superannuation Commission (ISC, the predecessor of APRA) was appointed as an inspector to both companies. Immediately following this appointment, the ISC issued the following directives to the companies using its powers under the Life Insurance Act 1945:

- cease issue of new business;
- no board meetings without ISC presence;
- bank account signatories to be ISC authorised;
- persons investing funds to be ISC authorised;
- all new business premiums received to be refunded; and
- payment of surrender values to be suspended.

On 31 October, the ISC applied for the appointment of a Judicial Manager under the Life Act and on 7 November, a Judicial Manager was appointed by the Federal Court.

The Judicial Manager arranged the sale and transfer of the risk business of both companies to another life company in February 1991. The payment of surrender values for investment policies continued to be suspended until after these policies were eventually sold and transferred to another life company in October 1992. A major effort was required during the period of the judicial management to correct the basic policy data records to the point where they could be transferred to another company.

Ultimately, most policy owners received the full value of their policies and many reforms were included in the Life Insurance Act 1995 in response to the Occidental and Regal failures.

The Australian government enacted legislation in early 1992 which gave it the power to raise a levy from the life insurance industry to compensate Occidental and Regal policy owners for their losses. A levy was not ultimately needed and the act allowing it was repealed in 1994.

14.6. Key learning points

- Capital underpins financial strength by providing a buffer to absorb unexpected losses.
- Risk-based capital incorporates quantitative analysis of different types of risks—insurance, credit, market, operational, etc. Allowance is made for dependencies amongst risks.
- The three pillar approach to supervision involves detailed quantitative requirements (Pillar 1), qualitative requirements (Pillar 2) and market disclosure (Pillar 3).
- Regulators may impose conditions on the quality of capital held.
- The PCA is calculated using risk-based methods, predominately Var and Tail Var. The PCA is set so that insurers are extremely confident they can withstand shocks and have sufficient assets to cover liabilities at the end of the measurement period, typically one year.
- Insurance risk focuses on stresses that affect the frequency, amount of payments and income. Insurance risk arises from a range of factors, for example, poor underwriting, poor contract design, catastrophic events or random fluctuations in claims costs.
- There is volatility on both sides of the balance sheet in relation to movements in the level of financial market prices and rates.
- A life company may anticipate mitigating actions in response to extreme stresses. Any allowances for future management actions which reduce capital must be appropriate and justifiable.
- A well-developed and effective ICAAP helps to embed a risk culture in an organisation.
- Regulators often have powers to add supervisory adjustments to the PCA. The PCR comprises the PCA plus any supervisory adjustments.
- Regulators have a range of intervention powers if a breach of the PCR has, or is likely to, occur.
- To improve return on capital employed, companies limit the amount of capital they hold. Nonetheless, to avoid a regulatory breach, life companies set capital targets that exceed the PCR.

14.7. Answers to exercises

Exercise 14.1:

The purpose of life insurance is to transfer risks contingent on the health status of an individual to a life insurance company. Explain why it is challenging to assess insurance risk. (Hint: Set out an answer that considers assumptions, timescales and actual experience.)

Answer:

Life insurance claims are probabilistic. Assessing insurance risk requires the company to quantify underlying probabilities from observed data. The data analysed must be relevant to and indicative of the risks insured.

Not only are claims outcomes probabilistic, but the estimation of underlying probability distributions is also subject to statistical error. Often life insurance policies provide cover over long time periods, 20, 30 years and more. Underlying claims distributions are not static in time. Any relevant and predictable trends need to be assessed and incorporated.

This process is complicated by the number of characteristics of the insured and the wide range of policy terms and conditions, underwriting and claims acceptance processes all of which will affect claims costs. Underwriting is the process by which a life company decides the terms on which an individual may be accepted for insurance.

When pricing and calculating reserves for insurance policies, other factors such as future investment returns, lapses and expenses also need to be assessed. There may be interdependencies that need to be considered, for instance, lapse rates may impact claims costs if poorer risk are less likely to lapse their policies.

Exercise 14.2:

In what ways could the failure of a life company cause problems throughout a financial system? Consider the impact of such a failure on a range of the life insurer's stakeholders, including its employees, shareholders, policy owners, reinsurers, creditors etc.

Answer:

Loss of confidence in remaining life insurance companies, large scale lapses causing problems for other insurers and their reinsurers, potential contagion to other financial intermediaries including banks. Investors unwilling to provide capital / invest in life insurance, Social implications/ hardship for those who can't obtain insurance cover at similar prices or even at all. Loss of jobs for employees and need to retrain in other job.

Exercise 14.3:

Why is a net premium valuation method compatible with reversionary bonus participating contracts? (Hint: Consider the build-up of reserves for an endowment policy. Consider the effect on profit distribution if the valuation basis is conservative.)

Notes:

The question does not state that the NPM is the only method but asks you to explain how it may be compatible.

Answer:

If the NP is calculated using an interest rate approximately equal to the expected return on assets less the assumed reversionary bonus rate, then it may be shown that there is a surplus arising equal to the cost of that year's bonus. Further, unlike the gross premium method, the NPM does not place a value on future bonus and this helps with PRE.

Exercise 14.4:

What other factors affect investors' decisions? Research Australia's prudential insurance supervisor (APRA) and its investigations into the Disability Income Insurance (DII) market and consider these investigations as you work through this module.

Answer:

The return on investment is one concern for investors. Investors are also concerned with the investment risks, often the potential downside, such as the risk of loss of capital. Investment sentiment will be a factor, for example, a lower ROCE (return on capital employed) may be acceptable in a recessionary economic environment. Some foreign investors may accept lower returns which also impacts the market for investment capital.

Diversification is a factor. Investors may accept lower expected returns if the investment improves the diversification of their whole investment portfolio, as a more diversified portfolio will have lower risk. Anticipated changes to the regulatory or political environment will also impact investors decision. Are their significant or new political risks?

Exercise 14.5:

Suppose you are acting as the capital management actuary for a life insurer. You believe an extreme event at the regulator's required confidence level (e.g. a well-regulated, deep equity market has a 0.5% probability of falling below 40% over one year) is more extreme than the regulator's published view (e.g. the regulator suggests a scenario involving only a 20% fall in the equity market). How would you respond to this discrepancy when calculating the company's PCA?

Answer:

If liability values move in line with asset values in a shocked scenario, such as is typical with unit linked policies, the impact on the company's PCA may be marginal. In this situation, while the result may not be an issue for capital management, the stressed scenario would impact policy owners and if your results are surprising or unintended, the company may wish to investigate further.

There may be a tendency to follow the view of the regulator, given the potential negative impact on capital and the range of defendable views. The process of determining shocked scenarios at a 0.5% probability can be complex with many subjective judgements required. The calculation will involve application of models, built using a theoretical model for how the market should behave and calibrated by actual data. You will want to investigate possible reasons for the differences.

Your decision will be guided by the regulations and professional standards. One approach might be to calculate the PCA according to the views of the regulator and to add an internal margin (target capital). The margin may reflect a percentage of the additional impacts that you have determined and will be guided by the results of your further investigations.

Try to understand whether there are factors specific to your company impacting your results, such as the selection of more risky equities than average.

Exercise 14.6:

Write down three other methods that approximate the fixed-cost acquisition risk.

Answer:

Setting a capital "charge" equal to one year's worth of fixed costs allocated to new business, effectively seeks to ensure that these costs are covered in a stressed scenarios , where the company ceases to write new business.

Variations could be:

- Hold say 75% of first year's costs and that may be equivalent to writing some business in a stressed scenario.
- Hold 5% of all premiums as proxy for the fixed cost but check that this is sensible.
- Fixed costs can cover a range of items from computer systems to office rent. Costs are rarely all fixed or all variable and most costs can be adjusted, given sufficient time. It could be argued that one year is insufficient to adjust for closure to new business and a charge of 150% or 200% could be used to reflect longer periods for adjustment. Another factor is that closure to new business may also affect retention of existing business, so a proportion of fixed costs recoverable from existing business may also be added.

Exercise 14.7:

Write down two different ways that the inflation shock to renewal expenses may be modelled.

Answer:

- Add a fixed amount, say 1%, to the best estimate rate over the term of the contract
- Add a higher amount for a shorter period e.g. 2% for 2 years and then revert to best estimate rate.

It is important to recognise that policies may have provisions to increase charges. If higher expenses were being experienced, and were expected across the industry, it may be reasonable to assume that eventually, charges would increase. The net impact would be used to model a renewal expense shock.

Exercise 14.8:

How might m and n (see above) be determined when selecting appropriate simple factors to model lapse stress scenarios?

Answer:

Options include:

- look at historical experience of actual v expected lapse rates to determine a stressed % of "extra" lapses. It may be worthwhile to consider the nature of the stressed scenario, say economic downturn. Economic downturn has been historically been associated with higher lapse rates. What does the data suggest may be relevant for different types of products for your company or the industry?
- the regulator may require specific standardised shocks
- compare factors used by different companies in the local jurisdiction (where the information is available)

Exercise 14.9:

Two companies both have policy liabilities consisting entirely of risk business. One company has a significant insurance risk charge, whilst the other company has an insurance risk charge of zero. Discuss possible reasons for the difference in charges.

Answer:

The size of the insurance risk charge will depend on a number of factors. The random stress will depend on the number of lives insured and the distribution of sums insured (net of reinsurance). The future stress will depend on the adequacy of experience investigations therefore the implied statistical errors in the assumptions set from those investigations, and the potential for changes in trends. The relative impact of the event stress will depend on the age distribution of the lives insured and may be reduced by, for example, catastrophe reinsurance.

A fund with exposure to both mortality and morbidity risks will gain diversification benefits that are not available to a fund with exposure to a single type of risk.

If products can be repriced at short notice, the insurance risk charge may be reduced. Some products might only allow for premium rates to be changed on a policy anniversary, and a notice period may have to be given to policy owners. This is likely to reduce the future stress charge but not the random or event stress charges. Some products may have a guarantee that premiums will never be increased.

If there is a substantial margin between premium rates and best estimate claims and servicing expenses, it is possible that premiums will exceed the stressed claims and expenses for the first 12 months as well as in following periods. A net cash inflow to the company from active lives during the first 12 months may be allowed as an offset against the stresses to termination values for IBNR, RBNA and disability claims in course of payment. This may lead to the insurance risk charge being zero. This outcome is more likely for individual risk business than for group risk business.

Individual business typically has greater margins built into the premium rates due to the need to recover the higher acquisition costs. A zero insurance risk charge is also more likely for mortality risks than for morbidity risks as termination values tend to be less significant for policies with mortality risks – there are no claims in course of payment, and death claims are reported and settled much faster than disability claims.

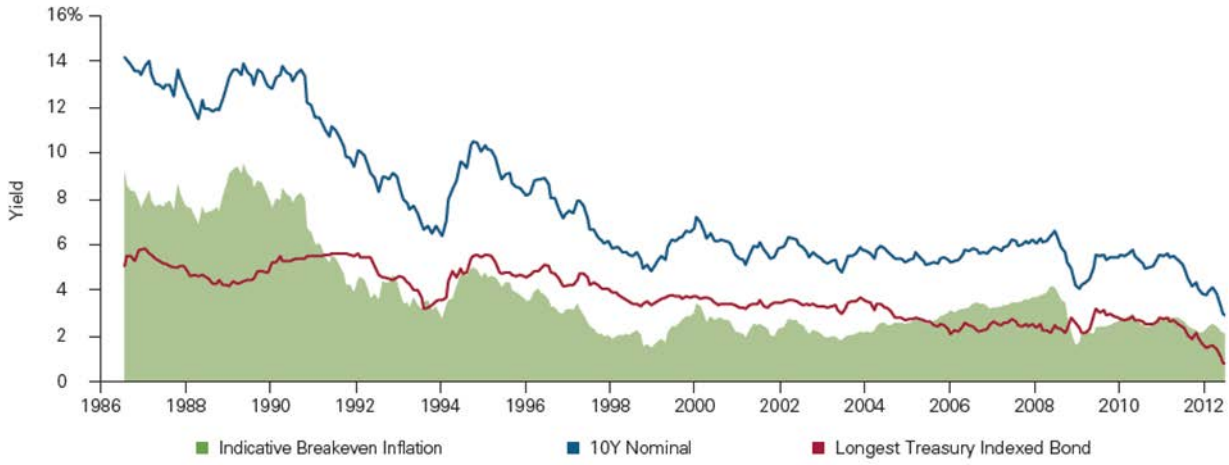
Exercise 14.10:

Look at the prices of a conventional bond and indexed linked bond. Figure out what happens to these prices (how they change) when inflation changes.

Answer:

The following table shows a historical comparison of nominal (conventional) bond yields with those of indexed bonds. The difference in yields represents the expected inflation rate over the term of the bond, termed the indicative breakeven inflation.

Figure 6 Nominal and Treasury Indexed Bond yields (along with Breakeven Inflation)



Source: Vanguard calculations based on data sourced from RBA, as at September 2012. Note that the real yields are for the longest inflation linked bond on issue.

Exercise 14.11:

Should the credit stress apply to all assets in the company, or only those that back policy owner liabilities?

Answer:

All assets that have credit risk are at risk of falling in value when credit spreads or margins increase. The value of liabilities that these assets are backing will generally not change following increases in the credit spreads. If assets are supporting other, non-policy liabilities, then credit stress should apply also to these.

It could be argued that a credit stress charge is not necessary for assets supporting surplus capital (capital in excess of any prudential or internal target capital requirements) as these are not required to support liabilities. Therefore, credit stresses should be calculated with reference only to those assets supporting policy and other liabilities.

Regulators may vary in their views regarding the way that asset stresses should be applied. One view is that, if all assets are in the same legal fund, then the insurer should stress all assets, not just those backing policy liabilities. An alternate view is that, even if all assets are in the same legal fund, they could notionally be regarded as being divided into two separate pools, one backing policy liabilities and the other surplus assets. Treating them as notionally separate is sometimes termed hypothecating asset pools.

The example below shows that the results can be different depending on the approach taken. If all assets are invested in the same investment pools and mix, using a shock based on total assets is not the same as using a shock based on assets supporting policy liabilities only. If surplus assets are invested in more risky pools, an even higher charge would apply when based on total assets rather than just assets that back policy liabilities.

In the example below, method one uses a charge based on total assets and method 2, a charge based on assets that back policy liabilities only.

In the table, policy liabilities are assumed to be unaffected by the credit stress. The left hand side shows the balance sheet before applying the stress and the right hand side shows the position after the stress has been applied.

The stress does not change the total assets in a balance sheet but does have an effect on the surplus. Post stress, some of the surplus is now regarded as risk-based capital.

Same asset mix for all assets								
Balance sheet before stress						Balance sheet post stress		
	Assets		**Liabilities**	**Stressed Assets**			**Method 1**	**Method 2**
	100	PL	100	99		PL	100	100
						PCA	1.5	1
	50	Surplus	50	49.5		Surplus	48.5	49
Total	**150**		**150**	**148.5**			**150**	**150**

Riskier asset mix for surplus assets								
Balance sheet before stress						Balance sheet post stress		
	Assets		**Liabilities**	**Stressed Assets**			**Method 1**	**Method 2**
	100	PL	100	99		PL	100	100
						PCA	3.5	1
	50	Surplus	50	47.5		Surplus	46.5	49
Total	**150**		**150**	**146.5**			**150**	**150**

These tables are in spreadsheet **LI&R Val S1 2020 M14 Exercise 14.11.xlsx**

Credit stresses assumed:

- -1% fall when the same asset mix is used for all
- -1% fall for assets backing policy liabilities and 5% fall for other assets when a riskier mix applies to assets backing surplus capital.

Exercise 14.12:

You are the head actuary for a medium-sized listed life company. The regulator has just announced a significant strengthening of its capital standards following a period of severe turmoil in financial markets. The impact of this will be that your company still meets its PCR but falls short of target capital by a significant margin. What actions could the company take in response to this situation and what factors would you consider in making a recommendation to senior management?

Answer:

You will use models to project the future capital position of the company under different scenarios. You will also need to investigate the impact on profits and appraisal value of different courses of action.

Possible actions include:

- do nothing but recognise that there will be an increased risk of breaching PCR in the short to medium term. There may also be consequences for sales of new business and persistency of existing business if the company is recognised as being weakly capitalised by market participants. The risk and consequences of a downgrade by ratings agencies would need to be considered.
- raise additional capital. Further investigation would be required as to the best way of raising capital – there are different types of Tier 1 and Tier 2 capital instruments that could be issued and they have differing costs.
- dividends could be reduced over the short to medium term. However, this may disappoint investors and lead to weakness in the company's share price.
- new business targets could be scaled back, or the company could reduce its capital utilisation by selling less capital intensive products.
- profitability could be enhanced by increasing premium rates and fees. The feasibility of this option will depend on the company's competitive position. It is more likely to be feasible if other companies also raise their premium rates and fees in response to APRA's changes.
- increase the company's use of reinsurance. The company will need to balance the cost of holding additional capital with the cost of reinsurance. It might be possible to design a reinsurance program so that the cost of reinsurance is lower than the cost of holding additional capital.
- change investment policy with the aim of reducing the asset risk charge. This is likely to reduce expected profits but is also likely to reduce the volatility of profits. Policy owners' reasonable expectations would need to be considered if any changes to investment policy affected participating or discretionary investment business.

if the company would have an asset concentration risk charge, changes to asset exposures should be made so that this charge is eliminated.

Exercise 14.13:

In Exercise 14.12, why might the cost of additional reinsurance be lower than the cost of holding additional capital for insurance risks?

Answer:

A reinsurer might have lower stress margins than a direct insurer in respect of the random and future stresses because these stress margins are partly dependent on the number of lives insured. Australian reinsurers retrocede a significant portion of their business to their overseas parents. These global reinsurance groups could have proportionately lower capital requirements than Australian direct insurers simply because of their greater size.

It is also possible that foreign regulatory capital requirements could be lower than those applying in Australia. If reinsurers have a lower cost of capital than Australian direct insurers, they might choose to pass these savings on through lower reinsurance premiums. This is more likely to occur at times when the reinsurance market is competitive and price sensitive.

Exercise 14.14:

Explain why a merger of two companies could reduce the PCR for the combined entity.

Answer:

A larger pool of insured lives would reduce the random and future stresses for the insurance risk charge, and also possibly the lapse stress. If the insurance risk charge was negative for one fund (before applying the minimum of zero), it could be offset against a positive insurance risk charge for the other fund.

Combining statutory funds might produce a greater diversification of asset risks. In particular, if the two funds are at risk from movements in opposing directions for real interest rates, expected inflation or currency, combining the two funds will allow risks to be offset.

Combining statutory funds might increase the overall aggregation benefit.

The asset concentration risk charge is likely to be smaller (if it is not already zero) as the limits will be based on the assets of the combined statutory funds.

The "change component" of the operational risk charge will increase for the first 12 months following the merger due to the increase in premiums and/or policy liabilities in the merged fund (although APRA might give relief to the life company from this requirement if there was no real increase in operational risks as a result of the merger). Subsequently, the volatility of the "change component" of the operational risk charge should be reduced by combining statutory funds. If one of the original funds was growing rapidly, whilst the other was declining, the combined fund would be more stable and the "change component" would be more likely to be zero.

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