Canadian Institute of Actuaries | Institut canadien des actuaires

Risk Diversification

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1. Introduction

This resource document addresses the topic of risk diversification as it relates to all areas of actuarial practice: life and health insurance, property and casualty insurance (P&C), mortgage insurance and pensions.

It is intended to be an overview resource for actuaries, risk practitioners, risk managers and executives who are entering a risk management role or seeking to broaden their knowledge of risk diversification.

"Do not put all of your eggs in one basket" is a phrase commonly associated with diversification. The idea being that multiple baskets mitigate risk, reducing the chance of losing all your eggs. Risk diversification, or the concept of spreading risks, forms the foundation of insurance and is the keystone on which important risk management processes ultimately rely.[1] Risk diversification applies equally to pension plan funding and management.

This document addresses risk diversification in the following sections:

2. Risk diversification concepts
3. Within-risk diversification
4. Between-risk diversification
5. Risk response
6. Applications of risk diversification
7. Regulatory perspective on risk diversification
8. How to measure risk diversification

Links to additional resources and source material are in the bibliography.

Throughout this document, "company" and "entity" are used interchangeably to capture both insurance organizations and pension plans.

In accordance with the Institute's *Policy on Due Process for the Approval of Practice Resource Documents*, this practice resource document has been prepared by the Enterprise Risk Management Practice Committee (ERMPC) and has received approval for distribution to all members from the Practice Development Council on May 12, 2023.

The ERMPC would like to acknowledge the contribution of the working group that assisted in the development of this practice resource document: Ana Nunes (chair of the working group), Cara Low, Devika Prashad, Kathy Thompson and Tonia Tse.

2. Risk diversification concepts

Risk is defined as the possibility of loss or adverse outcomes as a result of an action, inaction or an external event. There exists a multitude of risks within the context of insurance and pension plan management, and those risks can be quite varied in their causes and consequences.

2.1 Risk diversification

Risk diversification is the process of combining risk exposures in a way that can reduce the overall risk.

[1] The Chief Risk Officer Forum. 2005. *A Framework for Incorporating Diversification in the Solvency Assessment of Insurers*. p. 12.

For example, when investing, risk diversification means lowering an entity's total portfolio risk by spreading money across and within different asset classes, such as stocks, bonds and cash. It allows an investor to better weather market ups and downs (since, for example, asset classes tend to behave differently in response to economic conditions) while still maintaining the potential for growth.

2.2 Risk diversification benefits

Diversification benefits may come from combining risks within one risk category such as insurance risk (see Section 3, Within-risk diversification), or from combining risks across several categories such as insurance risk and asset risk (see Section 4, Between-risk diversification). Diversification benefits can also arise when considering multiple entities within a given geography as well as across geographies or regulatory jurisdictions.

2.3 Correlation

There exist varying degrees of risk diversification benefits because risks can have different drivers, or they may respond differently to a single driver. Mathematically speaking, the risks can be correlated differently. Correlation is a measurement of the extent to which one variable changes as another, second variable changes (i.e., a measure of how the risks are related).

At one end of the spectrum, there is perfect positive (or full) correlation. In this case, factors driving different risks, and the resulting outcomes, are identical and thus there are no diversification benefits between those risks. Consequently, the aggregate risk is simply the sum of the risks.

At the other end of the spectrum is perfect negative correlation, where factors driving two different risks have opposite effects on the outcome. In this case, the aggregate risk is zero and full diversification benefits are achieved.

Consider a simple example of $100 invested in asset class A, and $100 invested in asset class B. As a result of an increase in interest rates, asset class A gains $10, and asset class B loses $10. The two asset classes are perfectly negatively correlated. The gains and losses cancel each other out, resulting in full diversification benefits.

The amount of diversification benefit depends on whether the risk types are perfectly positively correlated, perfectly negatively correlated or somewhere in between along the spectrum. The diversification benefit would be largest for perfectly negatively correlated risks, and non-existent for perfectly positively correlated risks. For correlations between the two extremes, which is often the case, the lower the correlation, the more diversification benefit is achieved.

There is also the possibility of zero correlation, which implies no relationship (or independence) between two risks. For example, factors driving mortality risk and interest rate risk are independent of each other, resulting in some diversification benefits. With zero correlation, the degree of offset, or value of the diversification benefits, will vary depending on the characteristics of the underlying risks.

Generally, there is high correlation between financial risks (credit and market) and low correlation between insurance and credit risks, as there are different factors driving the risks.

Risk diversification choices can be used by management to change the degree of diversification benefit achieved in an entity's operations. For example, increasing or decreasing the number of eligible asset classes within an investment portfolio will impact the overall risk of the portfolio. Effective diversification can reduce the likelihood of a large or catastrophic loss but can also reduce the likelihood of significant gains.

3. Within-risk diversification

The following section discusses considerations related to risk diversification within each of the following risk categories. These risk categories are as defined in the CIA's practice resource document *Actuarial Aspects of Enterprise Risk Management*.[2]

- **Strategic/business risk**: The risk in relation to the achievement of an organization's strategic business plan and objectives.
- **Insurance/pension experience risk**: The risk of loss arising from movement in insurance variables, including claim incidence, claim termination and persistency; and for pension plans, the risk of loss arising from plan member incidence of termination, disability, retirement and death benefit claims.
- **Market risk**: The risk of loss arising from changes in market variables (including equity risk, interest rate risk, etc.).
- **Credit risk**: The risk that a counterparty will be unable or unwilling to make payments due under a specific agreement.
- **Liquidity risk**: The risk associated with the ability to trade a particular asset quickly without incurring a loss.
- **Operational risk**: The risk of loss from failed or inadequate internal processes, people or systems, or from external events (including regulatory and compliance risk).

The discussion and examples that follow in this section and in Section 4, Between-risk diversification, focus on a single entity or company but by extension may also apply at the group level when considering multiple entities (1) within a given geography or (2) across geographies or regulatory jurisdictions.

3.1 Strategic/business risk

One area of diversification relates to lines of business. Having multiple lines of business that are not perfectly correlated means that financial results are, in theory, more stable, as poor results in one line of business do not necessarily translate into similar results in another line. Strategic risk applies to the top line (risk of not achieving targeted revenues or growth) and bottom line (risk of not achieving the targeted profitability). Geographical location of the business can also add to the diversification benefits. Geography is also considered under "insurance risk" below.

3.2 Insurance/pension experience risk

Different product types may have different experience related to insurance risk drivers such as mortality, morbidity, longevity and lapse risk. Analysis of blocks of business could provide insights into cohorts. For example, purchasers of life insurance and annuities are not generally the same, so poor mortality experience (earlier deaths than expected resulting in higher claims) emerging from life insurance products may be somewhat hedged by annuity experience (earlier deaths than expected results in smaller claims as annuity payments cease). P&C insurers can reduce insurance risk through product mix (automobile, residential, small and large commercial business). A well diversified insurance portfolio can provide diversification benefits especially between short- and long-tail lines of business due to the reserving risk within the long-tail lines.

[2] An additional definition for pension experience risk has been included here.

Geography and demographics also influence insurance risk. Considering P&C insurance, if the business is focused in a single region that is highly susceptible to earthquakes, then the likelihood of loss is even greater. If instead the business is written across multiple regions, the spread of risk increases and the likelihood of multiple events occurring across regions at the same time is limited. For life insurance as well as annuity business, similar to P&C insurance, demographic factors such as age, residence location (postal code), etc. can have a meaningful impact on overall risk diversification benefit. Risk is potentially further diversified if risks are spread across multiple countries.

Pension plan membership is typically driven by the demographic makeup of the participating employer(s), but a more diverse membership in a defined benefit or target benefit plan can help to diversify pension benefit payouts. One factor in the amount of demographic diversification and pension payouts experience is whether the plan remains open to new entrants or has been closed.

3.3 Market risk

Market risk can impact both assets and liabilities. Structuring investment guidelines or strategies to consider asset type (equity, fixed income, real estate, etc.); credit exposure and sector (manufacturing, industrial, energy, etc.); financial condition; environmental, social and governance profile; and quality (ratings assigned by a rating agency, such as AA, A or BBB) as well as macro and micro economic developments and trends, including prospects for specific industry sectors, will lead to diversification benefits.

The geography or issuing location of the security can also provide diversification, as economic variables are not the same worldwide. Currency rates would then become another variable that can provide diversification or alternatively can be managed by hedging back to the home currency. The act of hedging can create credit risk and/or liquidity risk (see below).

Specific knowledge of asset types, their underlying components and the interaction with liabilities are crucial in properly measuring and managing market risk.

3.4 Credit risk

In addition to credit characteristics captured under market risk, credit risk also considers counterparty exposure. If derivatives are used within an investment portfolio, then consideration would be given to the underlying counterparty. It may be prudent to have collateral arrangements with more than one counterparty to avoid reliance on a single source, thus reducing the concentration and providing diversification. Many insurance carriers leverage reinsurance to assist in managing insurance and market risks; however, reinsurance arrangements can also lead to credit risk.

3.5 Liquidity risk

The various types of asset classes have varying degrees of liquidity risk. An expanded definition of liquidity risk is that an insurer or pension plan is unable to realize its investments in a timely manner to meet its financial obligations, including collateral needs, as they fall due.

Higher yields may be achieved when illiquidity is at its highest. An example would be mortgage assets or direct real estate holdings, neither of which can be easily sold.

Exposure to liquidity risk will be driven by the cash needs and liability profile of the insurer or pension plan. If liquidity is easily predicted (cash outflows are known with reasonable certainty), then one can manage their assets to achieve the desired liquidity needs while investing more dollars in illiquid classes, thereby achieving higher returns.

Consideration would also be given to unexpected experience that could drive higher outflows than expected. For example, liquidity risk can be elevated in volatile markets, particularly around the use of derivatives and associated collateral requirements, as illustrated by the UK liability-driven investment crisis in late September 2022.

In the absence of sufficient liquid assets to support cash outflows, alternative options such as lines of credit can be considered. The use of such tools supports diversification, as otherwise cash or highly liquid holdings would be required to support a wide range of scenarios.

3.6 Operational risk

Operational risk includes risks such as legal and regulatory compliance, human resources, technology, information security, business continuity and third-party risks. Operational risk is inherent in all products, activities, processes and systems and therefore may be an add-on to other risk categories.

There are some diversification benefits that can be achieved when considering operational risk. For example, it may be prudent to leverage more than one information technology infrastructure provider or location to reduce the risk of downtime or cyber intrusion. The use of a single third party to support a critical process, such as claims management, may result in greater risk if business volumes exceed the capacity for the service provider and the third party is not able to manage claims quickly enough, resulting in higher payments. Understanding critical business services is the first step in determining where diversification may benefit operational risk exposure.

Just as there are opportunities to gain diversification benefits within a single risk class, as illustrated using the six main risk categories, there are also opportunities to diversify between risk categories. This is discussed in the next section.

4. Between-risk diversification

Since many of the risk drivers are different across the different risk categories, there is consequently risk diversification between the risk types (credit risk, market risk, insurance/pension experience risk, liquidity risk and operational risk).

From a capital perspective, the total aggregated capital requirement for all risks would be less than the sum of the standalone capital requirements for each individual risk being aggregated. This is due to the diversification benefits achieved by aggregating the risks. It is unlikely that all risks will happen at the same time, so it is appropriate to allow some diversification benefits to reflect this.

For example, both the Minimum Capital Test (MCT) for federally regulated P&C insurers and the Life Insurance Capital Adequacy Test (LICAT) for federally regulated life & health insurers aggregate the net requirement for insurance risk with the requirements for asset risk (sum of credit risk and market risk). The correlation assumed between the two classes of risks is 50%.

Sometimes there is no diversification benefit between risk types. For example, it is questioned whether there is correlation between operational risks and other risk types. There is no explicit diversification benefit provided for in relation to operational risk under LICAT, MCT or the European Solvency II standard formula. The operational risk requirement is simply added without an allowance for diversification between operational and other risks. Even though there is no diversification benefit between operational risk and other risk categories in these regulatory frameworks, an actuary may want to investigate this correlation in an internal economic capital model or within their Own Risk and Solvency Assessment (ORSA) work.

5. Risk response

Not all risks can be diversified away; sometimes other risk responses are required.

For example, investors can only reduce non-systemic risks – those that are specific to a company, industry or market – through diversification. Systemic risk (i.e., undiversifiable or market risk) cannot be eliminated through diversification and is not specific to a company or an industry.[3] Examples of systemic risk include natural disasters, weather events, inflation and changes in interest rates.

The remaining risk left after diversification, management actions or other internal controls are considered is referred to as residual risk.

Companies can choose to accept the remaining (residual) risk, avoid the risk or respond to reduce the risk by engaging in further risk mitigation strategies, including sharing or transferring some or all of the risk to a third party. Risk mitigation strategies can also be employed to reduce (but not eliminate) systemic risk, such as hedging of interest rate risk.

Accept

An organization can choose to accept the residual risk, in which case no additional action needs to be taken, other than measuring and monitoring the risk.

Avoid

If the residual risk, after all acceptable mitigations, is outside of the organization's risk appetite, risk tolerance and risk limits, then the organization could consider how to avoid that particular risk. Note, however, that it can often be difficult to totally avoid risks, in which case other alternative mitigation strategies could be considered to further reduce the exposure.

Mitigate

Beyond diversification, other methods can be employed to reduce the residual risk to an acceptable level. Mitigations can be used to reduce the potential impact of the risk or reduce the likelihood of the risk occurring. The actions to be taken will depend on the type of risk. Several examples are found in the CIA practice resource document *Actuarial Aspects of Enterprise Risk Management*.

Transfer/share

Risk may be transferred to an unrelated third party in exchange for a fixed premium or series of payments. For example, excess risk, which is the amount of risk above which the company is not comfortable, can be transferred to a reinsurer such that claims above the retained insurance amount are handled by the reinsurer.

Another example is that a defined benefit pension plan may eliminate its liability risk for all or a portion of its plan by the purchase of annuities from an insurer. Or, a plan can address only a subset of its risks, such as mortality risk, by obtaining an annuity buy-in or longevity swap agreement.

Note that transferring or sharing risks creates reliance upon the third party, such as a reinsurer, which can create new risks that companies need to consider before deciding to proceed with the risk transfer.

[3] The Chief Risk Officer Forum. 2005. *A Framework for Incorporating Diversification in the Solvency Assessment of Insurers*. p. 7.

6. Applications of risk diversification

Diversifying strategies are a key component of sound risk management and can be used to counter concentrations of risk, particularly in times of stress. As such, diversification would be a consideration when building risk appetite statements and supporting metrics.

Diversification is also used in practice to manage risks. Diversification is most applicable to financial and insurance/pension liability risks, although in certain cases it can also be applied to operational risks.

6.1 Risk appetite statement

As noted in Annex B of OSFI's Corporate Governance Guideline, the risk appetite statement reflects the aggregate level and type of risk that an entity is willing to accept to achieve its business objectives.

The approach to reflecting diversification benefits should be articulated so it is clear how these benefits are impacting the risk appetite statement and associated risk limits.

For example, consider the case where an entity has three distinct business units. The risk appetite is based on the entity's aggregate level of risk, reflecting that the total risk is less than the sum of the risk assumed within each of the business units. Depending on the level of diversification across the business units, a change in the level of risk for any of the business units, including a reduction of risk, may result in a higher aggregate risk for the entity than desired.

6.2 Risk limits

Risk limits consist of qualitative and quantitative measures that allocate an entity's risk appetite to business lines, subsidiaries, risk categories, concentrations or other levels as appropriate.

In determining risk limits, consideration should be given to whether diversification benefits are included or excluded. If they are included, it is desirable to clearly define the approach used for capturing the diversification benefits. Changes in risk limits may require a review of diversification benefits, which in turn could impact the entity's risk appetite.

6.3 Business strategy

Diversification can be an important component of a company's business strategy. For example, the spreading of risk may allow companies to expand or even exploit spare capacity.

- **Mergers and acquisitions**: The decision to acquire a block of business may be influenced by diversification benefits with the existing business that a company may already have.
- **Enhanced risk profile through new business growth**: Companies may choose to offer a new product line that acts as a hedge to their existing products. Those with a well-diversified portfolio can write more business as it enhances the company's risk profile.
- **Capital allocation**: Business units providing significant diversification benefits to the company may be more capital efficient, and therefore the unit can write more business with a lower marginal cost of capital.

6.4 Pricing and underwriting

From a pricing perspective, insurance companies may try to optimize the diversification benefits within their portfolios to provide more competitive pricing on their products.

Underwriting can also be used to achieve a diversified portfolio to manage concentration of risks. For example:

- Life and health insurance companies could consider the concentration of large risks (e.g., extended families, business associates, or group policies sold within a certain geographic area) and may choose to set limits or to reinsure the business to spread the risk.
- For P&C companies, a high concentration of risk in a geographic area could lead to significant large loss events, such as floods, hurricanes, hailstorms and earthquakes. Companies use various catastrophe models to assess the impact and manage (e.g., reinsure) risk concentrations. Diversification benefit can also be gained by having a balance of property products and casualty products (e.g., umbrella, auto liability, cyber insurance).
- For mortgage insurance companies, a high concentration of exposures in a province or region that is in a weaker economy could lead to less profitable business for an extended period of time. Companies may choose to set stricter underwriting rules to limit the concentration of business and market share in a single region. Extending beyond region, companies would also consider exposure to first and second mortgages as the associated credit risk differs.

6.5 Asset management

The diversification of assets is also important to manage the risk of overconcentration of asset classes.

Insurance companies often have specific limits for asset classes. Asset managers of insurance companies need to consider the diversification between asset classes to optimize the risk and return ratio of the investment portfolio.

For pension plans, the primary use of risk diversification is in the allocation of pension fund assets to a strategic asset mix, in order to diversify investment risks such as market risk, credit risk, interest rate risk, etc. The primary investment risk in a pension plan is asset-liability mismatch risk. However, a fully liability-matched asset mix can still retain certain risk concentrations if the assets are not diversified across maturities, issuers, etc.

In setting the going-concern discount rate for defined benefit and target-benefit pension plans, actuaries may include a positive adjustment to the expected return on assets to account for the benefits of diversifying and regularly rebalancing across asset classes.[4]

In the context of a defined contribution pension plan, offering enough asset class options will allow defined contribution plan members to diversify their retirement savings accounts across asset classes, although it has been shown that offering too many options is typically counterproductive.[5]

7. Regulatory perspective on risk diversification

7.1 Regulatory and economic capital

Diversification is used in the regulatory and economic capital frameworks for life and health insurers P&C insurers and mortgage insurers. Generally, capital frameworks provide some recognition for companies with a well-diversified portfolio. The level of diversification will depend on the framework. As these frameworks are focused on solvency, they are more prudent and typically offer lower diversification credits. Some examples of solvency-based capital frameworks are:

[4] CIA Committee on Pension Plan Financial Reporting. 2023. *Educational Note: Determination of Best Estimate Discount Rates for Going Concern Funding Valuations*.

[5] Keim DB, Olivia SM. 2015. "Simplifying Choices in Defined Contribution Retirement Plan Design." Pension Research Council Working Paper Series. Philadelphia, PA: Wharton School, University of Pennsylvania.

- The LICAT framework for life and health insurance companies recognizes diversification within risk (e.g., mortality and morbidity) and between risk (e.g., insurance, market and credit risk). More details can be found in the LICAT Guideline in the chapter "Aggregation and Diversification of Risks."
- The MCT framework for P&C insurance companies has an implicit diversification credit for insurance risk as there is an implicit assumption that insurers have a well-diversified portfolio of risks. The MCT also has an explicit diversification credit because losses arising across some risk categories are not perfectly correlated, so it is unlikely a company would incur the maximum possible loss at a given level of confidence from each type of risk simultaneously. There is an explicit credit allowed for diversification between the sum of the credit and market risk requirements and the insurance risk requirements. More details can be found in the MCT Guideline in the chapter "Diversification Credit."
- The Mortgage Insurer Capital Adequacy Test framework for mortgage insurance companies does not recognize any explicit risk diversification between risks.
- An insurance company may also have an internal capital model, which measures the economic capital that a company needs to remain solvent under a highly adverse scenario (e.g., a one-in-200-year event). The model accounts for the risk profile of the company and considers diversification within and across the risk categories, including different geographies and business sectors, if applicable. Internal models may be used during the ORSA process to compare capital against the amount of regulatory capital required in adverse scenarios.

7.2 Valuation of insurance contract assets and liabilities

Under IFRS 17, the valuation of insurance contract assets and liabilities includes a risk adjustment component that reflects the compensation an entity requires for bearing the uncertainty associated with non-financial risks.[6] There are numerous methods to determine the appropriate risk adjustment, and diversification is a key consideration.

For further details, the CIA has published two educational notes: *IFRS 17 Risk Adjustment for Non-Financial Risk for Life and Health Insurance Contracts* and *Educational Note: IFRS 17 Risk Adjustment for Non-Financial Risk for Property and Casualty Insurance Contracts*.

8. How to measure risk diversification

This section discusses at a high level several commonly used aggregation techniques that are applied, for example to capital calculations or to a company's asset portfolio:

- **Variance-covariance approach**: This method uses the historical correlations between risk drivers to form a correlation matrix. This approach is commonly used since the formula is simple to understand. However, for most multi-variable distributions, the correlation matrix is not sufficient to determine all the ways that two variables can interact, such as tail risks. To overcome these limitations, one can apply a pseudo-correlation matrix (e.g., a "stressed" or "tail correlation" measure), which may be derived independently or as an adjustment on historical correlations. One can also make ad hoc adjustments to the original risk measure.
- **Distribution-based (copula) approach**: In contrast to the variance-covariance approach, copula-based methods model the entire loss distribution by enabling a wide variety of dependent

[6] IFRS 17 Insurance Contracts – Appendix A Defined Terms.

structures on the aggregated distributions. Most of the methods in this category are analytically complex and do not lend themselves to implementation with closed-form formulas. As a result, these methods frequently involve simulations (e.g., Monte Carlo) when used in applications.

- **Scenario-based approach**: The previous approaches aggregate by combining statistically derived distributions. In contrast, the scenario-based approach aggregates risks from activities that form certain scenarios. Developing the relevant scenarios requires a deep understanding of the company's business and risks, and in this case, the correlation and diversification is implicitly defined instead of being an explicit input. For example, stress testing can be considered a type of scenario analysis that assesses a company's capital adequacy under plausible extreme events.

For more technical details on risk aggregation techniques, refer to the Basel Committee on Banking Supervision document from October 2010 (which is also a Society of Actuaries study note), *Developments in Modelling Risk Aggregation*. For additional technical information see the CIA research paper from April 2016 *Risk Aggregation and Diversification*.

When quantifying the benefit associated with diversification, consideration would be given to the underlying purpose of the calculation. Diversification benefits may not emerge in all scenarios in the same manner or to the same degree. Consideration would be given to how risks react in stressed environments and whether the diversification benefits will emerge as expected to provide the desired risk reduction.

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Canadian Institute of Actuaries
360 Albert Street, Suite 1740
Ottawa, ON K1R 7X7
613-236-8196
head.office@cia-ica.ca
cia-ica.ca
seeingbeyondrisk.ca

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