A Capital Buffer

Report of Working Party 'Integrated Risk Management of Financial Services'

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1 Introduction

This report is a summary in English of a report written in Dutch by a working party of Dutch actuaries in July 2003. The working party consisted of:

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This summary aims to make the content of the report available to a wider audience than only the Dutch speaking community. It should be noted however that the report was written from a purely Dutch perspective, based on the current situation in the Dutch financial markets, and the Dutch regulatory system.

The dynamics of the financial markets and the regulatory system in The Netherlands differ in many respects from that in other countries, including those within the European Union. Nevertheless the main conclusions of the report are not country specific, and may therefore be well worthwhile for a wider audience. Also, as the report contains a wide range of observations about the market for financial services in The Netherlands, it is of interest to those who would like to know more about it.

1.1 Background

Borders between different lines of insurance as well as those between insurance and other financial services have become less and less apparent in the last few years. This has been caused by several developments including mergers and acquisitions of financial companies, legislative changes and changes in customer demand. An example of the last category is 'personal financial planning', meaning advice on all aspects of a household's financial decisions on an individual basis.

This report discusses 'Integrated Financial Services' by which the working party means:

Financial services that carry features of insurance as well as banking.

Such services pose new challenges for the actuarial and risk management professions as well as financial regulators[1]. Integrated financial services create a need for uniform risk assessment methodologies which can be used for any type of financial service, regardless of which (type of) financial institution offers the service.

1.2 Purpose

The purpose of this report is:

To sketch a framework for a generic risk assessment model that can be applied towards life insurance, general insurance and banking and can be used by regulators, financial services providers as well as their final clients.

The following steps towards completion of a model for risks to a financial institution are identified:

- Project liability cashflows;
- Match the cashflows as well as possible with assets;
- Define and quantify residual risk.

The working party will focus on the last step as numerous models of various types are already in existence for the first two steps.

Besides risks for financial institutions, risks for their final clients are discussed as well. The working party has tried to be as complete as possible in identifying sources of risk however it is impossible to say that all possible sources of risk have been considered.

1.3 Report structure

The structure of the report is as follows:

Section 2: Integrated Financial Services
Section 3: Risk for suppliers of financial services;
Section 4: Risk diversification and its effects;
Section 5: Time horizon;
Section 6: Inventory of commonly used risk models;
Section 7: Recommended methodology for risk management of integrated financial services;
Section 8: Conclusion and recommendations.

[1] There are currently three financial regulators in the Netherlands: PVK: pension and insurance chamber, DNB: Dutch Central Bank and AFM: Authority Financial Markets. Closer cooperation between these regulators is currently under discussion. More information (also in English) can be found on any of the regulators websites www.pvk.nl, www.dnb.nl and www.afm.nl.

2 Integrated Financial Services

The first subsection of this section discusses risks that are carried by the clients of financial institutions, and are not transferred to a financial institution or another party through the use of any financial service. The second subsection discusses possibilities of integrated financial services, and the third section discusses advantages and disadvantages of integrated financial services for clients, financial institutions and regulators.

2.1 Consumer specific risks

Not all financial risks that a client (household or company) of a financial institution is exposed to are normally transferred to a financial institution, or another professional risk carrier. Even after insurance coverage and/or other financial protection are put in place, several risks usually remain, in whole or in part, with the client:

- Risk of wrong decision when purchasing a financial service as a result of wrong or incomplete information or misselling.
- Premium increases.
- Cancellation of insurance policies by the insurer.
- Legislative, economic and other environmental changes.
- Retention/deductible;
- Costs of legal procedures;
- Loss of reputation;
- Loss of profits;
- Investment risk.

As one of the most prevalent functions of financial services is to limit financial risks to its purchasers, the extent to which financial services leave clients exposed to any type of financial risk affects the quality of those services. It is therefore also in the interest of financial institutions to limit the overall financial risk for its clients.

2.2 Possibilities for integrated financial services

For the majority of risks that households and companies seek protection against through insurance, protection is offered only on a single coverage basis. For example home insurance is offered separately from auto, liability, life insurance etc. The working party is of the opinion that in The Netherlands, there are opportunities for improvement when it comes to combining various coverages into a single product.

An example is given below:

Instead of insuring each of the listed perils separately, a single policy can be designed to offer coverage for all the perils combined. For the client company ABC there are several advantages to this solution:

1. A single excess amount can be used for the ‘combined-perils’ policy. Hence in case of a calamity causing more than one of the above perils to occur, there is more clarity about the loss that will be retained by the insured..

2. Company ABC will benefit from diversification between the different perils. For example, suppose that in a particular year sick leave is higher than normal but also investment income is above expectation. Then the additional investment income can be used to fully or partially fund the extra cost of sick leave. Hence company ABC may not have to file an insurance claim, which will eventually result in a lower premium. The effect discussed here is generally referred to as diversification.

2.3 Advantages and disadvantages of integrated financial services

Advantages of integration of financial services for clients are:

- Lower premiums through diversification (as discussed in previous subsection);
- Single point of sale for various product types.
- Possibly better suited to fit clients' needs, less overlap of coverages.

Disadvantages for clients are:

- Client position more vulnerable and more dependent on a single provider.
- Less transparency in pricing.

Advantages of integration of financial services for financial institutions are:

- Diversification of risks => lower internal solvency requirements.
- Expense reduction through economies of scale and improved efficiency;
- More information about clients available => increased effectiveness of marketing.
- Increased opportunities for distribution.

Disadvantages for financial institutions are:

- Increased impact of cancellation;
- Possible conflict of interest if several distribution channels are used.

Advantages of integration of financial services for a regulator are:

- Increased insight into true exposure of financial institutions to risk.
- Better overview of overall activities of financial institutions especially conglomerates.

Disadvantages for a regulator are:

- More intensive research will be required to understand risk exposure of financial institutions.

3 Risks for suppliers of financial services

This section contains a taxonomy of risks for financial services providers. A first division is made into risks affecting:

3.1 All types of companies (financial and non-financial);
3.2 Banking and Asset Management companies;
3.3 Insurance companies;
3.4 Companies providing credit facilities

3.1 Generic risks affecting all types of companies

Strategic risk: the risk of making wrong strategic decisions or suffering loss of reputation.

Financial risk: default on outstanding debt by business partners and loss of value of invested assets such as bonds or equities.

Political risk: risk of legislative changes and government intervention

Operational risk: risk resulting from operational errors or from external events. For example fraud, systems failure, money laundering, misselling.

This categorisation concentrates on the consequences of risks and not on their causes. A further division of the risk types listed above can be made by focusing on causes of risk[2]:

- Volatility (process) risk: risk caused by pure random fluctuations. For example person A passes away, company X goes bankrupt.
- Uncertainty (parameter) risk: risk of changing factors in the risk environment leading to changed model parameters, and the risk of model misspecification.
- Extreme event risk: highly infrequent events with dramatic impact such as September 11.

3.2 Banking and Asset management

A distinction is made between investment products of which the investment risk is borne by the financial services provider (e.g. savings account or annuity with fixed interest rate) or by the client (e.g. unit linked policy).

Typical investment risks arising in traditional forms of insurance are the so-called mismatch risks. These are caused by commitments made to policyholders regarding the nature and amount of investment returns. Three forms of mismatch risks can be distinguished:

1. Risks associated with interest paid on directly callable savings accounts. The interest paid is higher than the interest earned on short term money market loans. Hence banks are forced to invest the balances of those savings accounts into longer term investments. This is justifiable as there is generally not a lot of fluctuation in the total balances on savings accounts. The risk for the bank is a wrong choice of the term of

[2] The Working Party on Solvency uses this categorisation.

the chosen investments. If the chosen term is too short, the bank will not be able to offer the same interest rate as its competitors. If the chosen term is too long, the bank will be locked in when interest rates rise, while its competitors will be able to adapt faster.

2. Risks associated with guaranteed fund values at future expiry dates. Such risks are manifest if the guarantees are not matched by assets generating the same pay-out pattern over time.

3. Risks associated with interest rate guarantees. These risks are present mainly in life insurance policies with profit sharing and a guaranteed minimum return, and can usually be hedged with derivative instruments.

Unit linked insurance and investment accounts

1. Several implicit options in the client conditions can create risks for a financial institution offering these products/services. For example a cooling-off period for new policies without possibility of refund reduction due to decreased fund value during the cooling-off period.

2. No possibility of adjustment of expense loadings in unit-linked products, while in traditional products such possibilities often do exist.

3.3 Insurance

3.3.1 General

Risks associated with underwriting insurance are:

1 Risk selection

Not all the rating factors that can be determined statistically can also be used in the actual rate making. Ethical, political, or commercial reasons may prohibit the use of several rating factors known to the insurer (e.g. race, gender), which may lead to inadequate pricing of risks.

2 Premium collection

Propensity and ability to pay the agreed premium. Economic factors and price competition can have an adverse impact on market levels of insurance premiums.

3 Claims and expenses

Uncertainty with regard to the actual coverage provided, and the amount and timing of claims, and associated expenses.

4 Administrative and other operational expenses

Expense levels are subject to general economic uncertainty such as inflation and wage developments.

5 Reinsurance

In case of a calamity, an insurer can be dependent on its reinsurers for the full and timely reimbursement of reinsured losses.

3.3.2 Life Insurance

Mortality risk

Deviations from expected mortality can lead to losses and/or gains by an insurer depending on the direction of the deviation and the type of policies underwritten. Higher than expected mortality leads to losses on mortality risk policies, and to gains in annuities and pure endowment policies.

3.3.3 Loss of Income and Health Insurance

Availability risks

- Limited availability of health care can lead to increased costs and diminished quality of the care provided.
- Legislative changes and political considerations often impact coverages and conditions under which these products are underwritten.

3.3.4 General Insurance

Market risk

Pricing levels are impacted by competition in the general insurance market, which can fluctuate independent of actuarially determined rates.

3.4. Credit facilities

Risks specific to financial institutions providing credit facilities are:

1. Risk selection: too lenient underwriting can lead to losses.
2. Default risk: frequency and severity of default are subject to external conditions, for example value decrease of a collateral.
3. Accumulation of losses. Due to events effecting entire groups of debtors simultaneously, losses can accumulate (e.g. agricultural sector in case of contagious cattle disease).

4 Risk measures

Risk classification alone is not sufficient. In order to implement risk management, it is also necessary to quantify and measure risks. In this chapter, some commonly used risk measures and their characteristics are discussed. Also the concept of 'diversification' is explored.

4.1. Risk measures

In order to complete a risk transfer, a premium or contingency margin needs to be determined. This in turn requires a quantification of the risk transferred. Risks are quantified using characteristics of their probability distribution. Such characteristics include the standard deviation, variance, and measures derived from percentiles of the distribution, for example VaR and TailVaR.

Risk measures can be categorised as follows:

1. Risk measures reflecting the variability/volatility such as the standard deviation, variance, mean deviance and coefficient of variation.
2. Risk measures reflecting the probability of ruin, such as Value-at Risk (VaR). Given a probability of ruin p, VaR(p) is the minimum capital buffer required so that the probability of ruin is equal to or less than p.
3. Measures for the expected cost of ruin in case of default, such as the Expected Policyholder Deficit (EPD). EPD can be interpreted as follows: suppose a capital buffer is held equal to VaR(p). EPD(p) is then the average capital deficit over all possible future scenarios, which is equal to the probability of ruin times the average capital deficit if ruin occurs.

   A related risk measure is the TailVaR (TVaR). TVaR(p) is the average total loss given that the total loss exceeds VaR(p). Hence TVaR(p) is always greater than VaR(p), and takes into account all scenarios in which the total loss exceeds VaR(p).

At present, distributional characteristics are not frequently used in the insurance practice. For example, the EU solvency rules for insurers do not reflect any such characteristics. In the banking industry, the VaR-measure is commonly used to gauge the magnitude of unhedged trading positions.

Extensive discussion has been held in recent years about the properties that risk measures should possess. The biggest hurdle in reaching agreement about such properties is the effect that aggregation of risks should have. This topic is further discussed in the next subsection. Desirable properties of risk measures are further discussed in subsection 4.3.

4.2 Modelling of diversification effects

It can be stated in general that by aggregating risks, diversification benefits are created. This means that the total risk combined of several individual risk exposures is smaller than the sum of the individual risk exposures. In practice, the standard deviation is often used as a risk measure. It can be proven mathematically that the standard deviation of the sum of two risks is always smaller or equal to the sum of the standard deviation of those two risks. If X and Y are two individual risks, than the following property always holds:

$$Stdev(X + Y) \leq Stdev(X) + Stdev(Y).$$

Further, the equality only holds if the linear correlation between X and Y is perfect, i.e. 100%.

The phenomenon of diversification is closely related to the law of large numbers. A portfolio containing a large, independent number of risks will need less capital per policy than a smaller portfolio, to ensure an adequate amount of capital with a given degree of certainty.

4.2.2 Correlation

An important factor driving the degree of diversification in a portfolio containing a number of risks is the correlation between the risks. Linear correlations are most in use, and measure the linear dependence between two risks. A major disadvantage of linear correlations is however that they do not reflect dependencies in the tail of the probability distributions used. The tails of the distributions can be interpreted as the most extreme and unlikely events that are represented by the distributions. In particular, if the linear correlation between two risks equals 0, this does not imply that these risks are independent, and there may still be a significant dependency in the tail.

A relatively new aggregation technique called 'copulas' does enable the modelling of tail dependencies, by using so called 'rank' correlations instead of linear correlations. Although copulas are not in use by many practitioners as yet, they are certainly worth further investigation.

4.2.3 Stress and scenario testing

Another approach to determine adequate capital buffers is stress and scenario testing. An adverse scenario for each risk driver is chosen, and its financial effect on a portfolio determined. For example, what happens if interest rates rise by 1%?

The advantage of this type of capital assessment is that it is easy to explain. On the other hand, it is not easy to determine the 'right' scenario, i.e. the scenario that represents the desired degree of protection that the capital buffer should provide.

4.3 Coherence

Extensive discussion has been held in recent years about the properties that risk measures should possess. Several years ago, 'coherent risk measures' were defined as risk measures satisfying the following properties[3]:

[3] See Artzner, Delbaen, Eber and Heath, 1999: *Coherent measures of risk*, Mathematical Finance 9, p 203-228.

A coherent risk measure is a real valued function $\rho(.)$ on the space of real valued stochastic variables such that for all real stochastic variables X and Y we have that:

1. *Monotonocity* If $X \geq Y$ with probability 1, then $\rho(X) \geq \rho(Y)$.
2. *Subadditivity* $\rho(X+Y) \leq \rho(X) + \rho(Y)$.
3. *Positive homogeneity* For each $\lambda \geq 0$ we have $\rho(\lambda X) = \lambda \rho(X)$.
4. *Translation invariance* For each real valued α we have $\rho(X+a) = \rho(X) + a$.

It can be shown that frequently used risk measures such as the standard deviation, variance, VaR, probability of ruin and EPD are not coherent risk measures. TailVaR, on the other hand, is a coherent risk measure.

The properties of coherent risk measures are certainly not generally accepted as being the right properties for risk measures in all circumstances. One might question if these properties always have economic validity. For example, the property 'positive homogeneity' implies that by taking on more of the same risk, the risk measure should increase proportionally. However, a party taking on more of the same risk will end up with a concentration of that risk, hence may very well be inclined to demand a reward that is more than proportional.

Also the property of 'subadditivity' may be questioned, as is discussed in the next subsection. Finally, it is worth noting that some risk measures seem to work better in practice than others. For example, it has been observed[4] that TailVaR as well as standard deviation are less robust against the effect of outliers.

[4] CAS Valuation and Finance and Investments Committee 2001: *Interest rate risk: an evaluation of duration matching as a risk-minimizing strategy for property/casualty insurers.*

4.4 Observation

It is not necessarily true that aggregation of risks will always lead to lower or equal level of risk compared to the sum of the risks in isolation. In exceptional cases, the total risk can be greater than the sum of the parts, depending on the risk measure chosen and the underlying processes.

For example, if two companies merge, this may negatively affect the behaviour of the employees in both companies, leading to e.g. a higher percentage of absenteeism due to illness in the newly created company, or an increased frequency of internal fraud. The sub-additivity property in the 'coherent risk measures' framework is violated by this example.

Although occurrences of this type of 'negative diversification' are exceptional, they illustrate that the properties of risk measures discussed in the previous subsections do not always hold in reality. However when using the standard deviation as a risk measure, the aggregation of two separate risk exposures is never greater than the sum of the two individual risks.

5 Time horizon

Before a capital buffer for a risk can be determined, a time horizon needs to be set. The buffer provides coverage against the risk until the end of the time horizon.

In a Value at Risk-approach as applied within the banking sector, usually a very short time horizon, i.e. 10 to 30 days, is used. A short time horizon can be used because the position taken in the capital markets for which the buffer provides coverage expires within the given period, hence the risk is entirely eliminated.

Similarly, it can be stated that the minimum total capital of an insurance company should be a prudent (*i.e.* higher than actual) estimate of the possible decline in value over a certain period. The rationale behind this argument is that it should be possible to transfer the insurance company to a third party at the end of the period. In order to realise such a transfer, the value of the company should be positive.

The chosen time horizon thus corresponds to the period within which a transfer of the company to a third party is assumed to certainly *not* take place. Obviously various types of risks can manifest themselves within this period. Some of these risk types only have short-term, one-off effects (e.g. windstorms, heat wave). Measures can be taken to limit or even eliminate their financial effects for the company in future periods, for example through hedging or reinsurance. Other types of risks however have a long term financial impact on the company and therefore also impact the value of the company in a possible transfer at the end of the chosen time horizon. An example is longevity risk, the risk that insureds in a life insurance portfolio will live much longer than anticipated thus generating higher than expected future benefits over several decades.

The former category of risk types mentioned has no impact on the transfer value of the company, while the latter category does. Therefore when a time horizon is set at e.g. one year, for the former category of risks only the financial impact during that time horizon should be taken into account. For the latter category on the other hand, the financial impact of the risks should be included over a much longer time horizon.

The distinction between these two types of risk corresponds to the distinction between ‘systematic’ and ‘diversifiable’ risks made in investment theory. Generally speaking, systematic risks are represented in the value (= transfer price) of a company, but diversifiable risks are not.

A typical example of a systematic insurance risk is the longevity risk mentioned above. A typical example of diversifiable risk is volatility risk in life and general insurance (also see subsection 3.1).

The impact of a single claim from a policyholder is diversified, i.e. diminished, by holding a large portfolio of insureds. According to the law of large numbers, the randomness in the total claims liability decreases when the portfolio size is increased so that there is no material impact of individual claims on a portfolio level.

For diversifiable risks, there is a certain amount of freedom in the choice of the time horizon. This choice is also related to the choice of risk measure. When the time horizon is increased, the likelihood that a certain risk will manifest itself will increase or stay level, but will never

decrease. Hence a capital buffer that is chosen based on a given time horizon and degree of certainty (e.g. 99%) can also be interpreted as a capital buffer for a longer (shorter) time horizon and lower (higher) degree of certainty.

Supervisors generally require that buffers be held for systematic as well as diversifiable risks. For systematic risks, the time horizon should cover the full expiration period of the underlying risks. For diversifiable risks, buffers need to be held as well although they can be eliminated. However as long as they have not been eliminated it is fully justified that regulators require buffers for diversifiable risk. The choice of time horizon for this type of risk contains an element of subjectivity.

In conclusion, different time horizons can be used for different sources of risk when determining a capital buffer. In practice it is however not always evident which risks are diversifiable and which are systematic.

6 Comparison of existing modelling techniques

A large variety of methods for quantification of risks are in use within the financial services industry. This section contains a general classification of such methods.

A classification of methods in itself gives rise to ample discussion, and contains a substantial degree of arbitrariness. However, the working party found the classification below helpful for the discussion. Distinctions are made between models targeted on either reporting or economic value. The second distinction made is between objectives of the models such as valuation, capital adequacy and performance measurement.

Asset Liability Management and Dynamic Financial Analysis are types of models that can not be quantified under these headings, as their main purpose is to provide strategic management support.

As mentioned above, the suggested classification below can be questioned. For example, 'embedded value' is by origin a reporting based type of model. However the goal of an 'embedded value' calculation is to come to a more realistic assessment of assets and liabilities of a life insurance company, and thus leads to an alternative, more economic based quantification of the equity of a company. Hence the equity determined in an embedded value calculation is already a step towards a balance sheet based on 'Fair Value' principles.

Also, although the classification applies at present, it is likely in the opinion of the working party that boundaries between reporting and non-reporting based methods will fade away in the future. When more economic and risk-based measures will be used for accounting and solvency assessment, there will be no difference anymore between risk based/economic methods on the one hand, and reporting based methods on the other.

Categorisation of risk assessment methods

	Valuation	**Capital adequacy**	**Performance measurement**
Reporting based	Embedded Value Appraisal Value Profit Test	Statutory solvency and reserve requirements	Return on Investment
Non-reporting based	Market Value Margin Fair Value	Risk Based Capital Value at Risk	Risk Adjusted Return on Capital

7 The suggested approach

In order to come to a uniform assessment of the total of risks that a company is exposed to, the total risk needs to be quantified. The risk measure chosen here is *Total Capital*, which is the total capital required to be able to cover all the risks in aggregation. *Total Capital* includes equity as well as liability components. No distinction is made between these two categories.

This section contains conditions that a uniform quantification of heterogeneous risks should satisfy. Subsequently the process of quantification is described in a number of steps, making use of the conclusions reached in the previous sections. No specific preference is given for any methodology in particular, rather a number of commonly used alternatives are given for each step.

7.1 Conditions that a uniform risk measure should satisfy

- Consistency between lines of business: the amount of capital required for each risk should be independent of e.g. the supplier and the distribution channel. For example loans supplied by an insurance company should have the same capital requirement as loans supplied by a bank.
- Consistent choice of time horizon for all risks: the time horizon chosen should reflect the type of risk. N.B. this does not mean the time horizon needs to be the same for all risks, see section 5.
- Economic valuation should be used for risk assessment and capital buffers. These may deviate from accounting values.
- Risk classification should be as complete as possible -which risks have not been included in the model?
- The approach taken should be transparent and practical.
- The approach should take into account multiple adverse scenarios leading to the application of the capital buffer to coverage of risks.
- The approach should take into account dependencies between risks when aggregating separate capital charges for individual risks.

7.2 Steps to be taken towards uniform quantification of risks

Step 1: Determine the risks included in the model quantification, mention the excluded risk types and describe the quality of the models used.

Step 2: Determine the amount of prudence one wants to include in the *Total Capital* requirement.

Step 3: Based on the previous step, determine the adverse scenarios one wants to include to determine the *Total Capital* requirement. Stochastic or deterministic models can be used to determine the scenarios.

Step 4: quantify the correlations/dependency relations between the risk types and the scenarios.

Step 5: determine the required *Total Capital* for either the individual risk types or the individual scenarios.

Step 6: describe and apply methods of aggregation to determine *Total Capital*.

7.3 Description of steps

Step 1:

For some types of risk, various detailed and sophisticated models are available, while for others there are none or only very approximate ones. In addition there are risks of which nobody is (yet) aware. It is therefore recommendable to describe the quality of the models/approach used for each individual risk type, and to mention the risks which have been consciously excluded.

Step 2:

Here the risk measures discussed in section 4 are of interest. A uniform measure can be a percentile from a probability distribution, or a key figure about the tail of a distribution such as the TailVaR. In case a deterministic approach is taken, adverse economic scenarios can be used such as an *x*% drop in equity prices, or *y* million of hurricane claims.

Step 3:

In step 3 the actual impact of the adverse scenarios is quantified for the company at risk. For example the 99.5% VaR for credit risk equals 25 million or a 40% drop in equity values leads to a decrease in value of the equity portfolio of 25 million.

Step 4:

Dependency relations are shown in a qualitative manner in the table below:

	Increase interest	Decrease interest	Decrease equity prices	Increase average age	Storm	Description of risk type
Market risk	- (+)	+ (-)	-	0	-	Change in asset (liability) value due to changes in capital markets.
Credit risk	-	+	-	0	-	Change in asset value due to change in creditworthiness of debtors/default.
Life risk	0	0	0	-	0	Change in liability due to change in population mortality.
General insurance risk	0	0	0	0	-	Fluctuation in frequency/severity of new and outstanding claims.

‘+’ means: occurrence of the event favourable for risk type.
‘-’ means: occurrence of the event unfavourable for risk type.
‘0’ means: no effect for risk type.

On the horizontal axis a number of adverse scenarios is given while on the vertical axis a number of related risk types are shown. In order to assess a capital requirement, the indicated

relations need to be quantified. For example, increase of interest rate by 1% point leads to an expected increase in credit defaults by 50 million.

Step 5:

Generally two approaches can be taken in step 5. Either one can determine a capital requirement separately for each risk type, and then aggregate over the risk types. Alternatively one can determine a capital requirement for each of the scenarios and then aggregate over the scenarios.

In the first approach, the fact that the risk types are related/dependent on each other needs to be taken into account. For example credit and market risk are in part the result of the same root causes underlying the economy, hence can be expected to be positively correlated.

In the second approach the relation between the adverse scenarios needs to be taken into account, for example changes in equity prices can be expected to show some relation with changes in interest rates.

Step 6:

The method of aggregation needs to be in line with the method used for the assessment of the individual risks. If a probability measure is used for the individual risks (e.g. 99%VaR), the same measure should be used in the aggregation.

The most commonly used method of aggregation is a linear correlation matrix. Correlations between risks are estimated based on experience data, expert opinion or a combination of both. The total capital is then derived by a matrix multiplication of the capital requirements for the individual risks, and the correlation matrix. More advanced approaches for risk aggregation include simulation models within which dependencies can be further refined, for example by using copulas.

If a deterministic approach is used for the assessment of the individual risks, the aggregation method is of a more subjective nature. The individual capital requirements can simply be added together, or an additional assumption about diversification between the risks can be made. Although the deterministic approach forces subjective choices to be made, it is not necessarily worse than a probabilistic approach. Also in a probabilistic approach, subjective choices need to be made and parameter and model errors occur.

7.4 Relation to Fair Value

The distribution of the required *Total Capital* over separate components on the liability side of the balance sheet depends directly on the accounting principles used in the valuation.

8 Conclusion and recommendations

Currently, there are few truly integrated financial services offered by financial institutions in the Netherlands. However, various examples can be given of integrated products that would offer distinct advantages to clients. Also for providers and regulators there are not only disadvantages but also advantages to more integrated products.

To determine capital buffers required to underwrite integrated financial services, insight into the risk profile of such services needs to be obtained. Stochastic techniques are, as yet, not used to their full ability by the financial community. Also, discussions about the appropriate choice of risk measure(s) are ongoing.

In determining a capital buffer for financial risk, the time horizon is of interest. The choice of time horizon is not only linked to the choice of risk measure, but also depends on the type of risk. Capital buffers for diversifiable and systematic risks arguably require different time horizons.

Taking into account all modelable risks and their interdependencies, it is possible to construct an integral type of model that is universally applicable to all risks within the financial services industry.

Finally, recommendations of the working party are:

- To avoid confusion, it would be desirable if there were commonly used terminology to indicate 'economically required total capital'. In this report, the wording *Total Capital* is used, however other authors may have already done other suggestions.
- Further research into the properties of different risk measures and their suitability for the assessment of capital buffers is desirable.
- Further research into the classification of risks as either systematic or diversifiable is desirable. Also the impact of such a classification on the choice of time horizon is of interest.
- Further research into dependence relations between various types of risks borne by financial institutions is of interest.
- It would be interesting to investigate to what extent mergers and acquisition offer advantages through economies of scale, and at which point disadvantages start to outweigh advantages.
- It would be interesting to investigate risk management techniques outside the financial services industry, and to gauge the suitability of such techniques within the financial services industry.