A survey into the practical implementation of economic capital models

Report of the Working group on Economic Capital Models [*]

The Working Group has been set up by *de Raad van Financiële Toezichthouders, de Nederlandse Vereniging van Banken* and *het Verbond van Verzekeraars*

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SUMMARY & CONCLUSIONS

This paper presents an overview of the current state of risk modelling in Dutch financial conglomerates. The paper builds on the description of economic capital methodology in the previously published papers of the Working Group on Economic Capital, giving a comprehensive view of concepts and best practice in economic capital modelling. [1] Now, we survey the present state-of-play in implementation at the participating institutions; ABN AMRO, Fortis, ING Group, and Rabobank.

In the description of the current state-of-play it will become clear that, in many areas, (model) implementation is not in steady state but is undergoing rapid change. An important, external influence in this process is the approaching implementation of new supervisory frameworks Basel II and Solvency II for banking and insurance sector, respectively. Given the schedules of both projects and scarce resources, institutions have understandably chosen to focus on first improving models on the banking side. A similar acceleration of activities can be expected on the insurance side as the Solvency II framework becomes more solid.

The survey has uncovered a wealth of information about the current state of implementation of economic capital models at large Dutch financial conglomerates and revealed a number of commonalities. All participating institutions have a model in place producing an economic capital amount estimated to be sufficient to cover unexpected losses at some pre-defined confidence level. These models are for instance used for capital allocation, performance measurement and external reporting although the importance of each of these purposes differs by institution.

Another commonality is that institutions have conceptually consistent models for each risk type across sectors although practical considerations might lead to slightly different implementation in parts of the conglomerate. An example of the common conceptual framework is the implementation of market risk VaR models. These models have a relatively long history on the banking side but have a short time-horizon, due to their risk management origins and the relatively short holding period of trading positions. Thus, on the banking side, to come to an estimate of the annual VaR, the short-term VaR-numbers are scaled up. On the insurance side, legacy models are less of an issue and thus the models for market risk tend to be capable of computing annual VaR-numbers directly.

In ranking the relative reliability of models, there seems to be a consensus on the banking side; market risk is placed first, followed by credit, operational and business risk. On the insurance side more divergent views prevail; for instance, for market, credit, and insurance risk all three risk types are chosen as the most reliable model at least once.

[1] These papers are available from www.dnb.nl.

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1. INTRODUCTION

1. This paper gives an overview of the current state of risk modelling in Dutch financial conglomerates. The overview in this paper builds on the description of economic capital methodology in the previous three papers of the Working Group on Economic Capital.[2] In the first paper, we presented a classification of risks and risk drivers which we employ in our subsequent discussion of the appropriate approach in economic capital modelling. Then, in the second paper we turned our attention to risk measures, the time horizon and the valuation principles to be used in economic capital models. Finally, in the third paper, we discussed the handling of diversification and aggregation of risk measures. Together these three papers give a comprehensive view of concepts and best practice in economic capital modelling. Now, we will survey the present state-of-play in implementation at the participating institutions; ABN AMRO, Fortis, ING Group, and Rabobank.

2. The main focus of the present paper is describing the current state-of-play. In many areas we will cover, however, (model) implementation is not in steady state but is undergoing rapid change. An important, external influence in this process is the approaching implementation of new supervisory frameworks Basel II and Solvency II for banking and insurance sector, respectively. Given the timelines of both projects and scarce resources, institutions have understandably chosen to focus on improving models on the banking side first. As Solvency II becomes more solid and implementation nears, a similar speeding up of activities can be expected on the insurance side.

3. Another issue we will also pay attention to is validation. Although limited data availability might make rigorous statistical backtesting unfeasible, the model's users naturally would like to attain a certain level of comfort in the sense that the model gives a good account of an institution's present and future capital needs. In discussing these issues we will cover to both the methods applied and the organisational structures in place.

4. The structure of this paper is as follows. First, we will discuss the stated objectives of economic capital models and then we will briefly review the overall coverage. This is followed by a number of overall, introductory remarks concerning amongst others time horizon, organisational setting, and reliability. Then we will discuss each of the risk types in turn followed by some remarks on future developments. Finally, we conclude.

[2] Available from www.dnb.nl.

2. OBJECTIVES FOR ECONOMIC CAPITAL MODELS

5. Economic capital models can serve a number of purposes, which we will discuss in turn. At present, economic capital is mainly determined for internal use. Outcomes are for instance used to allocate capital across business units or to evaluate the performance of staff. Especially for more senior staff this information might feed more or less directly in to the determination of performance related pay. In addition, economic capital models are in some cases used as input for (risk-based) pricing or limit setting. An external use of economic capital models is in communicating with stakeholders: all participating institutions mention economic capital outcomes in external reporting (i.e. Annual Reports) in varying detail. In the future, the model outcomes might be used to determine the amount of economic capital for regulatory solvency.

6. All of the abovementioned objectives are important for all of the institutions participating in our survey, although to a different degree. All institutions use their economic capital model to determine capital for risk management purposes; in this process model outcomes are compared with available capital. In addition, the model outcomes are used in the allocation of capital (i.e. risk limits for individual obligors and/or sectors) and (as an input for) pricing.

7. With regard to the use of the model for evaluating the performance, and consequently, determination of performance related pay, the picture is more diverse. All institutions use the model in some way to evaluate performance on a more or less aggregated level (business units). In addition, the performance related pay of the higher echelons of management is in some cases partly determined using economic capital outcomes. The economic capital outcomes are thus at present not used directly for performance related pay at lower levels in the organisation. However, if economic capital models are used at higher levels, then personnel at lower level will be influenced, at least indirectly. Moreover, participating institutions see a continued trend towards further, more granular use of economic capital in this respect.

3. IMPLEMENTATION OF ECONOMIC CAPITAL MODELS: AN OVERVIEW

8. Institutions generally discern the various risk types as given in the Working Group's first paper, i.e. Market/ALM, Credit (including transfer or country risk), Life, P&C or non-life, Operational, and Business or Strategic risk. Furthermore, institutions use the inputs and models as given in our earlier taxonomy. We will now first give a general overview of implementation for all risk types. This will be followed in the next section by remarks relevant to all risk types and then by some more detailed remarks for each of the discerned risk types.

9. For market or ALM risk, all institutions use Value at Risk (VaR) models for banking and, if applicable, in insurance. These models are generally at book level. In addition, stress tests or Monte

Carlo scenarios are used as supplementary analysis. The models are not necessarily identical across sectors although harmonisation within ALM is intended to take place in the future.

10. Currently, relatively sophisticated credit risk models are in place or are to be implemented shortly on the banking side. Most new models are consistent with the Basel II guideline and involve separate estimates of the probability of default (PD), the loss given default (LGD), exposure at default (EAD) and maturity. Some institutions use, for some portfolios, approximations; unexpected losses are for instance assumed to be some multiple of expected loss (EL). To calculate economic capital, correlation within portfolios or correlations with risk drivers are used. Together, this information leads to economic capital amounts. The availability of the inputs to internal credit models make it relatively easy to implement the Internal Ratings Based (IRB) approaches under Basel II since they rely on the same parameters.

11. For the insurance side, credit risk has historically been less of an issue and the models have thus evolved less. However, in most cases model development and implementation is underway. An advantage in this area is that models developed on the banking side can be adapted for insurance with relatively little effort. This implies that, also with respect to the integrated model, (full) harmonisation is approaching. Cross-border credit risk, i.e. transfer or country risk, is sometimes modelled separately involving parameters such as PD, LGD and EAD but this is not the case for all institutions.

12. In the measurement of life insurance risks there seems to be a reasonable level of consensus. Moreover, for both mortality and for morbidity or disability, the same approach is taken. All institutions use assessments of the surplus and some form of stress testing or other measures of resilience for both determining economic capital and validation. Such a stress test could for instance be the application of a shock to the mortality table used on the current portfolio. For P&C or non-life, all institutions use similar approaches as well, although implementation will differ. For extreme events (catastrophe risk), exceedence probability curves are employed while in the case of non-catastrophe P&C, frequency based severity modelling, loss triangle analysis and historical claim ratios are also used, again for economic capital determination and validation.

13. It is clear that the measurement of operational risk is an area in rapid development. Most institutions, however, already have a model in place or are in the middle of development on the banking side. If operational risk is also modelled on the insurance side, then the same model is used for both sectors. These models all employ historical loss data over quite a number of years (up to 25 years). In some cases, a scorecard approach is used to measure the quality of control(s) in a business line. The information gained through scorecards is used by some institutions to fine-tune economic capital allocation.

14. In business or strategic risk, all institutions analyse historical earnings volatility. Generally, this volatility is cleansed for the influence of other risks (i.e. market, credit and operational risk). For lapse risk and expense risk, which are also included under this header, more extensive analyses are performed. In some cases aspects of these insurance side approaches will be extended to the banking side.

4. GENERAL REMARKS ABOUT ALL RISK TYPES

4.1. Introduction

15. In the first paper of the Working Group, a taxonomy of the various risks was proposed. This classification will be used as a framework to discuss the present state of implementation of economic capital models in Dutch financial conglomerates. First we will discuss a number of general issues that are relevant for all risk types. The issues that we will discuss in turn are: (1) time horizon and confidence level, (2) aggregation, (3) validation methods, (4) commercial interests, development and the organisation of internal validation, (5) data availability, and finally, (6) model reliability. Then we will cover a number of issues for each risk type: management action, assumptions, information on performance and risk drivers, use of external data, inclusion of risk self-assessment, consistency and, finally, validation. In some of these aspects repetition is unavoidable because similar approaches are followed for two or more risks or issues are applicable to all risk types.

4.2. Time horizon and confidence level

16. All institutions use a time horizon of one year. Confidence levels are chosen to reflect target ratings and range from 99.95% to 99.99%. The correspondence between the target rating and the confidence level depends on –amongst others– the internal definition of capital and the calibration method.

17. The time horizon and the confidence levels are the same across sectors within each institution. For market risk on the banking side the shorter time horizon VaRs are extrapolated to an annual figure at the desired confidence level. These short term measures might be computed at a different (lower) confidence level. On the insurance side, such scaling up is less prevalent because, in contrast with the banking side, models had to be implemented from scratch. This allowed institutions to build in such functionality relatively easily since development was not hindered by legacy systems. For business risk, the confidence level is in some cases implicit; the stress tests used are deemed to coincide with some chosen confidence level.

4.3. Aggregation

18. As discussed in our earlier paper on diversification and aggregation there are generally two approaches to calculate economic capital. In the first approach, economic capital is first calculated per risk type for the particular institution as a whole, and subsequently the economic capital results per risk type are aggregated to an overall economic capital estimate. In the second, economic capital is first calculated for individual business units (comprising all relevant risk types), and then the economic capital results per business unit are aggregated to an overall economic capital estimate. Most institutions use the first approach (per risk type first, then combine) in banking while the second approach (per business unit first for all risks, then combine) is implemented on the insurance side. The overall approach is thus a mixture of the two approaches.

19. An issue that is related to the previous practical choice(s) is the question whether models are consistent for each risk type across the institution or whether they are, alternatively, only consistent within business units. Generally, approaches are consistent *within* banking and insurance. Furthermore, the approach towards Market, Credit and Operational Risk is generally conceptually consistent *across* both sectors. Differences might occur with regard to measurement approaches and/or reporting requirements.

20. Another important aspect in (sub)aggregation is the mix between more and less advanced approaches. Generally, for credit- and market-risk a fine grained approach is in use. Any diversification effect on the aggregate is in some cases passed on to lower business units. For operational risk and business risk, some institutions use individual data as well. Other institutions, however, use a more broad brush approach. For such an approach, the required capital for the particular risk type is first determined at the top level and then allocated to the organisational units below.

21. In aggregating, generally some variant of the variance-covariance method is in use. In this method a matrix with all the correlation values between all the risks in the institution should –at least theoretically– be available. In practice, all institutions use assumptions and in making these assumptions, institutions tend to build in some prudence. Some institutions recognize diversification but limit its effects by allowing correlation within business units for a single risk but not across business units. An assumption with somewhat more impact, used by some institutions, is to assume that risk types are perfectly correlated (i.e. no diversification) or, on the contrary, that some risk types have low correlation with other risk types (e.g. operational risk and the other risk types). Note that, regardless of the exact assumptions made, netting (i.e. offsetting exposures) can still take place.

4.4. Validation methods

22. Various methods are employed to validate models. The most important of these are backtesting, scenario analysis and benchmarking. Backtesting is the comparison of model results with historical realisations. Scenario analysis entails definition of a set of movements of risk drivers, possibly including developments over time. The cohesion in the parameter movements is provided by historical or hypothetical developments (e.g. a recession or severe slump in property prices). Given this state of the world, the effects on the institutions current position are computed. In coming up with plausible scenarios, some institutions employ methodology platforms, bringing together experts. The resulting scenarios are generally a mix of both historical and hypothetical experiences. Stress testing is a simpler variation in the sense that only the extreme movement is defined (arbitrarily) and that this shock does not have to form part of a coherent whole. The dividing line between stress testing and scenario analysis is, however, not clear cut. Benchmarking in Dutch conglomerates generally takes on two forms. First, it can entail a comparison with peers. Second, it can be a comparison with industry standards (i.e. vendor models). The outcomes of the validation exercises are, in some institutions, used explicitly as a part of the economic capital calculations. Other institutions use these exercises primarily to test the robustness of the economic model.

4.5. Commercial interests, development and validation

23. An important issue in both development and validation of economic capital models is the proper balance between the influence of the commercial functions on the one hand, and those responsible for building and assessing the validity of the models, on the other. Institutions have chosen different approaches to resolving this issue. One possibility to curtail interference from commercial interests in developing economic capital models is to place the responsibility for development completely outside the commercial business units. However, to assure that the model remains realistic, commercial business units should be able to challenge economic capital methodologies. Thus some institutions have significant involvement of commercial functions in the development of their model. In addition, once agreement is reached, the methodology is approved in senior risk committees and/or by senior risk management. Ex post validation can either be allocated to the risk management function or to independent corporate audit departments, although these audit departments tend to focus on evaluating the process rather than the model.

4.6. Data availability

24. Institutions have a wealth of data at their disposal but their practical use is more apparent than real. One reason is that much of the information is only available in dispersed, physical dossiers. Converting this data into usable information costs can then be prohibitive. A second reason is that

although credit histories might go back quite some time, they generally do not include a number of relevant parameters; for example, periodic estimates of the PD for a specific credit, using a definition (broadly) consistent with the presently used definition, are not likely to be included.

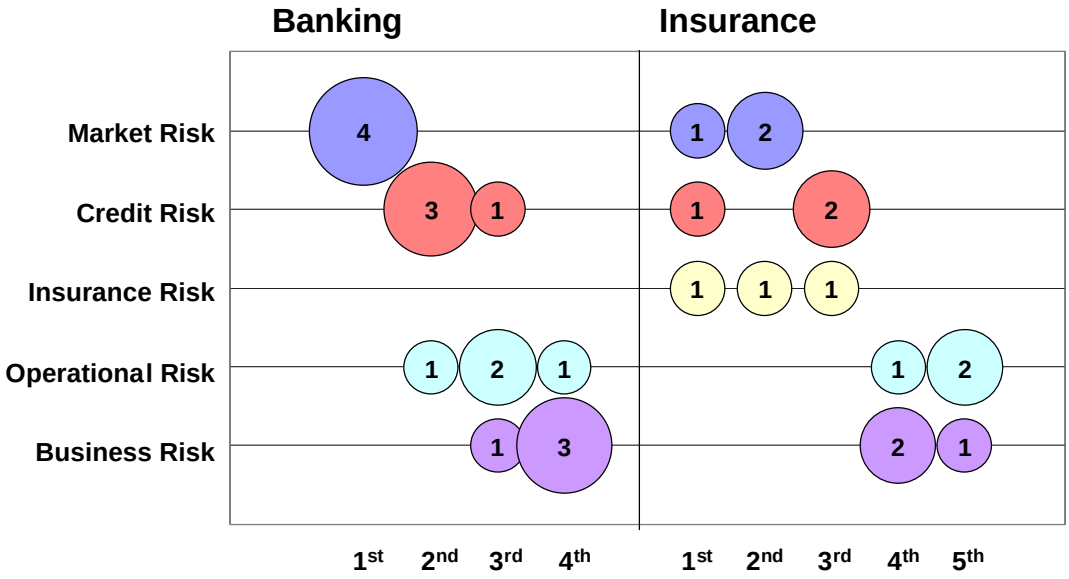
4.7. Reliability

25. Given the available data, approaches differ in whether it is primarily a bottom up or a top down approach. A bottom up approach is defined as an approach where there is a relative wealth of information at a disaggregated level while a top down approach uses aggregates data to determine the level of economic capital. For most risk types, the approach chosen is a mixture of the two. However, the emphasis for market- and credit-risk is on the bottom up side while for operational risk and business risk aggregated data play a much more important role.

26. The models for the various risk types have different levels of sophistication because of materiality or of data availability. The lack of materiality of some risks can lead institutions to decide to model some risks in less detail or not at all. Another important reason is the availability and reliability of data. Finally, the feasibility of improvements in risk measurement methods differs across risk types. To get a deeper understanding of the reliability of the parameters, institutions use sensitivity analyses and determine confidence intervals.

27. To give a general, and thus at points crude, impression of the overall reliability of models for the various risk types, participating institutions have ranked their models on both the banking and the insurance side on a relative scale. The scores are shown in Figure 1 below where the relative size of the spheres and the number within the sphere reflect how frequent scores were given. Thus for instance for credit risk on the banking side, three institutions ranked credit risk models second (to market risk) and one institution ranked it third.

Figure 1 The relative ranking of model reliability



Note: The figure shows the response for 4 banks and 3 insurance companies. Furthermore, since the insurance side has an additional risk type, the ranking runs from 1 to 5 instead of from 1 to 4. The relative size of the spheres and the number within the sphere reflect how often a specific score was given.

28. The figure shows that, especially on the banking side, market risk models are thought to be the most reliable. For credit risk, institutions´ views diverge, especially on the insurance side. It is important to note however that the importance of credit risk for insurers is limited. For insurance risk, results differ considerably. Some institutions that view the model for this risk type as most reliable while others rank it lower, even down to third place. Operational risk models are on average considered reasonably dependable on the banking side but are generally thought to be the least reliable on the insurance side. Finally, business risk is the risk type with the least reliable models on the banking side while on the insurance side these models are deemed to be just as reliable as the models used in operational risk. Interestingly, consensus seems to be closer on the baking side than on the insurance side. On the banking side, the hierarchy revealed runs from market risk to credit risk, operational and finally business risk. Opinions are much more diverse on the insurance side.

5. APPROACHES PER RISK TYPE

5.1. Market or ALM risk

29. *Management action*: For market risk and ALM risk, management action is explicitly modelled by all institutions. This means that for instance liquidity (time-to-close) and binding limit structures are incorporated. Moreover, reductions of limits are sometimes included in the analysis.

30. *Assumptions*: For market risk all institutions make the assumptions necessary to apply a one day VaR-calculation in their bank activities. In insurance VaRs are generally calculated for a one year horizon directly. In scaling up to the one year number, the VaR realisations are assumed to be independent over time. In addition, some Monte Carlo simulations are employed, taking into account management intervention. As noted in Section 4.2, models for this risk type in insurance are generally calculated for a one year horizon directly.

31. *Information on performance and risk drivers*: For market risk, many years of history of the underlying risk drivers (interest rates, exchange rates etc.) are available (15 years and up) but shorter periods are used to calculate the VaR. For backtesting, longer periods are used than for the VaR calculation but generally less then the full sample.

32. *Use of external data*: Market prices are taken from commercial providers like Bloomberg, DataStream and Reuters.

33. *Inclusion of risk self-assessment*: None of the institutions use risk self-assessment in a systematic way in measuring market or ALM risk.

34. *Consistency*: The models are consistent across the banking and the insurance side.

35. *Validation*: There are several possible methods to test the validity of the models used, e.g. backtesting, scenario analysis or benchmarking. Most institutions use all three methods in assessing the solidity of market risk and ALM models. Especially for market risk models, backtesting is widely used. Some institutions build a scenario-based module to stress the event risk exposure that an institution has in the trading books on the banking side. In such an approach, aggregation methods are used to come to a consolidated Event VaR exposure, different from the consolidated VaR exposure. The approach is based on a number of basic scenarios and several methods of accumulating these, such that they cover a wide range of trading positions the institution takes or could take. The outcomes of these different computations are then compared. Scenarios and parameters are set and reviewed regularly. To gauge the reliability of the parameters, sensitivity analyses are performed. In addition confidence intervals are determined. On the insurance side, extreme interest rate scenarios are used on the ALM-positions.

5.2. Credit risk

36. *Management action*: Management action is not explicitly modelled. Some institutions note that ideally rating triggers should be modelled as well.

37. *Assumptions*: In modelling unexpected loss in credit risk, institutions make assumptions about the parameters. PD is in most cases not calculated directly, but associated with a credit rating that has been assigned to a counterparty; in some cases PDs are estimated directly through models like

Moody's KMV. In modelling PDs some institutions model valuation and credit migration. A common practice is that once an obligor is in default, obligors will, upon completion of a possible restructuring, only return as new obligors. Finally, EAD is assumed to be non-stochastic and hence does not exhibit any dynamics around a default. In addition to the assumptions about the parameters, institutions make assumptions about the shape of the of the distribution –especially the tail– reflecting for instance correlations. Only some institutions' models include covenants and only on a limited scale. In the case data are missing either benchmark external data are used or, for instance, PD, LGD and EAD are determined by expert judgement.

38. *Information on performance and risk drivers*: Institutions have between two to seven years of credit history available on the banking side. On the insurance side the range is in most cases somewhat lower.

39. *Use of external data*: Moody's KMV is the most frequently mentioned external data provider. In addition, independent rating agencies like Moody and S&P supply information as well.

40. *Inclusion of risk self-assessment*: Some institutions use expert judgements to determine the value of particular parameter values if data are missing.

41. *Consistency*: In principle all institutions have a consistent approach within the banking and the insurance side. However, in some cases historical reasons, implementation difficulties, materiality or the availability of the required data prevent a consistent implementation across both sectors. Generally it is the case that the credit risk models that are developed on the banking side are then implemented on the insurance side.

42. *Validation:* For credit risk all institutions use backtesting and benchmarking to validate the models used. Half of the institutions employ scenario analyses as well. The advantage of scenario analysis over stress testing is that one-off surprises in terms of a realised state-of-the-world (e.g. two consecutive quarters of negative growth etc.) are easier to explain than rather arbitrary shocks to risk drivers. The focus of the backtesting exercise is, for some institutions, on establishing the accuracy of the EL component. Furthermore, the accuracy of PD, LGD, and EAD are also assessed in some cases.

5.3. Insurance risk

43. The approaches implemented for life insurance, on the one hand, and P&C or non-life insurance risk on the other, have very similar characteristics and will thus be discussed in a single section.

44. *Management action*: Management action is not explicitly modelled.

45. *Assumptions*: Some institutions straightforwardly apply the assumptions made by regulators in their risk based solvency supervision. Other institutions make particular assumptions about how, for instance, to distinguish between trend and level uncertainty.

46. *Information on performance and risk drivers*: Institutions have at least ten years of loss data but some institutions have, for individual business units, up to 50 years of data. For P&C or non-life insurance risk the available data series are somewhat shorter on the whole. The impact of the shorter series for P&C and non-life is relatively limited, given that trend uncertainty is generally less of an issue (compared to life risk).

47. *Use of external data*: Presently, relatively little external data is used in insurance risk. An exception is the use of external mortality tables and trends in these tables. These are generally applied to the institution's own cohort structure. Other external sources may be for instance be demographic data from the Central Bureau of Statistics

48. *Inclusion of risk self-assessment*: None of the institutions use self-assessment in insurance risks.

49. *Consistency*: Generally, the approaches are consistent although some institutions do not set all relevant parameters centrally. Local (risk) management is thus capable to set parameters to capture the nature and specific features of the business within each unit.

50. *Validation:* Only some institutions use backtesting and benchmarking in assessing the accuracy the risk models in life insurance. Most institutions do not use any of the discussed validation tools. For those institutions that do, it is a regular activity of the insurance risk management function. Thus business units are required to test the adequacy of their reserves under moderately adverse scenarios at least annually. For business units where adequacy is viewed as a potential issue, reserve adequacy testing is computed on a higher frequency. Some institutions use specific models for non-life fire line of business to assess catastrophe risk as a result of storms, fires or earthquakes. The outcomes are used to update external catastrophe re-insurance programs.

5.4. Operational risk

51. *Management action*: Management action is not explicitly modelled.

52. *Assumptions*: An important assumption in using historical data is that they provide a sufficiently accurate picture of future risks. Besides this point, no particular issues were raised.

53. *Information on performance and risk drivers*: Most institutions have operational loss data for about 4 years. Some institutions, however, have up to 25 years of data available. The frequency of measurement and the definitions of events are, however, not entirely stable over time. On the insurance side, some institutions use benchmarks instead of internally generated data.

54. *Use of external data*: External data are widely used in operational risk measurement to add to internal data. Market leaders in providing external data are ORX and OpVantage. The latter provides a database (composed of the preceding Netrisk and PriceWaterhouse loss database) that contains publicised operational incidents world-wide of at least USD 1 million.

55. *Inclusion of risk self-assessment*: Particularly in the area of operational risk, all institutions use self-assessment in some form or other. Sometimes these self-assessments are more formalised and involve a group of experts.

56. *Consistency*: The models are consistent across the banking and the insurance side.

57. *Validation*: Again, the approaches taken differ across institutions because this is an area that is in development. Backtesting is used by half of the institutions, although in some cases only for average losses, not economic capital. One other institution is planning to use this tool in the future. Scenario analysis is used by one institution while another just started. Finally, benchmarking is used by the majority of the institutions.

5.5. Business or strategic risk

58. *Management action*: Management action is not taken into account. This is not surprising given that the time horizon of economic capital modelling is relatively short compared to the time that management action would need to have any effect on the business or strategic risk of an institution.

59. *Assumptions*: Institutions use widely differing assumptions, reflecting the various approaches chosen.

60. *Information on performance and risk drivers*: Institutions have between 4 and 11 years of data although the latter number is applicable for an aggregated series.

61. *Use of external data*: Some institutions use external benchmarks (i.e. industry figures).

62. *Inclusion of risk self-assessment*: Not all, but most institutions use self-assessments in some way. Some institutions, ask business units to for instance choose the revenue drivers and sensitivities.

63. *Consistency*: Similar to the other risk types, institution aim to achieve complete consistency across both sectors. Some institutions, however, note that although the approaches are consistent within the sector, it is currently not feasible to implement a single methodology. This implies that, at the group level, there is in some cases a data need that cannot be made available for the whole group.

64. *Validation*: Similar to operational risk, approaches differ widely: one institution uses backtesting, scenario analyses and benchmarking while another uses none of these. Other institutions use just backtesting or (have just started using) benchmarking.

6. FUTURE EXTENSIONS

65. As technology and insights develop in the future, institutions see further, incremental development of the present modelling techniques. These developments will lead institutions to refine risk management's information requirements. Bringing this information together in a centralised data warehouses will, for instance for credit exposures, enable methodologies to consistently incorporate additional risk drivers (sector and county), thus producing better measures of concentration risk and systematic risk.

66. Some institutions are developing models to capture funding liquidity risk. There is however no consensus on what the role of such a model would be in an economic capital environment. Although well capitalised banks will have easier access to additional funds in case of liquidity shortage, capital is not seen as the primary defence against such a shortage.

7. CONCLUDING REMARKS

67. The survey has uncovered a wealth of information about the state-of-play of the implementation of economic capital models at large Dutch financial conglomerates. Discussion of this material has uncovered a number of important commonalities. All participating institutions have a model in place that produces an economic capital amount, estimated to be sufficient to cover unexpected losses at some pre-defined confidence level. The economic capital models are used for, for instance, capital allocation, performance measurement and external reporting. The relative importance of each of these purposes differs by institution, however.

68. Another commonality is that institutions have conceptually consistent models for each risk type across sectors. Practical considerations might lead to slightly different implementation in parts of the conglomerate, however. An example is the implementation of market risk VaR models. On the banking side these models have a relatively long history but have a short time-horizon, due to their risk management roots and the relatively short holding period of trading positions. To come to an estimate of the annual VaR, the short-term VaR-numbers are scaled up, using some formula. On the insurance side, legacy models are less of an issue and thus the models for market risk tend to be capable of computing annual VaR-numbers directly.

69. To gauge the reliability of models, participating institutions have ranked the models used for each of the 5 risk types discerned. This ranking revealed that there is more or less a consensus among participating institutions about the relative reliability of the models for each risk type on the banking side; market risk is placed first, followed by credit, operational and business risk. In contrast, the institutions have more divergent views on the insurance side. Overall, market, credit, and insurance risk are deemed to be more reliable than operational and business risk. Within the former three risk

types, however, the views of the three participating institutions that are active in the insurance sector are slightly at odds; all three risk types are chosen as the most reliable model at least once.

70. Modelling for many of the risk types is developing at a steady pace. In implementing the models, institutions have chosen to first concentrate on models on the banking side. This is mainly driven by the priorities following from the timelines associated with the implementation of the Basel Capital Adequacy Framework (Basel II). To qualify for the more advanced approaches under Basel, banks have to realise a timely implementation of credit and operational risk models. On the insurance side, Solvency II will also introduce a more risk-based framework and although the Solvency II project is still in a formative phase, the general framework is already clear.