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Modeling ORSA scenarios at APG Group level

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“Risk is a function of how poorly a strategy will perform if the wrong scenario occurs.”

Michael Porter, professor at Harvard Business School

University of Twente

Abstract

Recently, national supervisor DNB imposed APG at group level to an insurance regulation called Solvency II. As a consequence, APG has to submit an overarching group "Own Risk and Solvency Assessment" (ORSA) to the DNB. The ORSA is a risk management tool that insurance companies use to obtain a picture of their own risks and solvency requirements. At the heart of ORSA lies the scenario analysis.

In this research, a model was developed that supports APG with its scenario analysis. The model acts as a layer on top of the model within the insurance business unit Loyalis. By using the model, APG is able to estimate the financial consequences of the ORSA scenarios. The assessment is in terms of both strategic and solvency KPIs that were defined in this research. The model is based on *risk drivers*. These drivers, formulated as a function of the KPIs, are the variables that are shocked for each scenario, *ceteris paribus* for the assumptions made in the model. The risk drivers can be altered by the model user, but preferably the altering is done by a group of experts knowledgeable of APG and the environment in which it operates in or by use of human swarming.

The modeling of ORSA scenarios at APG Group level enhances both strategic and risk management. Scenario analysis can assess the robustness of the current strategy by testing whether or not the firms strategy can be maintained under adverse circumstances. From a risk perspective, modeling ORSA scenarios is useful because it enhances the firms ability to react to future risks, which makes the firms strategy more resilient. Thus, even though the solvency capital requirement of APG Group is somewhat irrelevant to compute due to APG's Group small contribution to the overall solvency capital requirement level, the ORSA modeling is meaningful for the above reasons.

Keywords: Solvency II, ORSA, scenario analysis, scenario assessment, capital requirements, expert elicitation, human swarming

Preface

This report is the result of my graduation project for completing my master *Industrial Engineering and Management* with the specialization *Financial Engineering and Management* at the University of Twente. I was given the opportunity to carry out my graduation assignment at APG Group in Amsterdam Zuid.

I would like to thank APG in general and the department Group Risk and Compliance in specific for the opportunity they have given me to carry out my research here. I have found my time at APG to be very enjoyable and instructive.

During my research, I received help from various people. I would therefore like to thank a number of people. First of all, my thanks go in particular to my company supervisors Karin and Hidde who, with their meaningful feedback and guidance, sent me in the right direction time and time again. I would also like to thank all my colleagues from Group Risk and Compliance for their kindness and making the research more enjoyable for me. Finally, I would like to thank my supervisors from the University of Twente, Toon de Bakker and Berend Roorda, for their guidance and constructive feedback. This investigation would not have been possible without their assistance and cooperation.

Enschede, October 2017

Wai Tun Chung

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Chapter 1

Introduction

This research project is conducted for APG Group N.V. (from hereon APG). This chapter provides the background of the organization and elaborates on the research project.

1.1 Background

APG is a financial service company that carries out the executive consultancy, asset management, pension administration and communication for Dutch Pension Funds. The company manages approximately €443 billion (as of December 2016) pension capital on behalf of these funds. The largest fund is ABP (Algemeen Burgelijk Pensioenfonds), and this pension fund is also the major shareholder.

APG is structured in five legal entities. Each entity represents a different business function. APG Rechtenbeheer N.V. is responsible for executive consultancy, pension administration and communication for pension funds. APG Diensten B.V. acts as internal service provider. The main responsibility of APG Asset Management N.V. is to manage and invest assets, while APG Deelnemingen N.V. focuses on innovative and extra services for individuals and employers. Loyalis, an insurance company, carries out insurance activities such as offering supplementary pension and disability insurance products. An overview of the organizational structure is depicted in Figure 1.1 (APG, 2015).

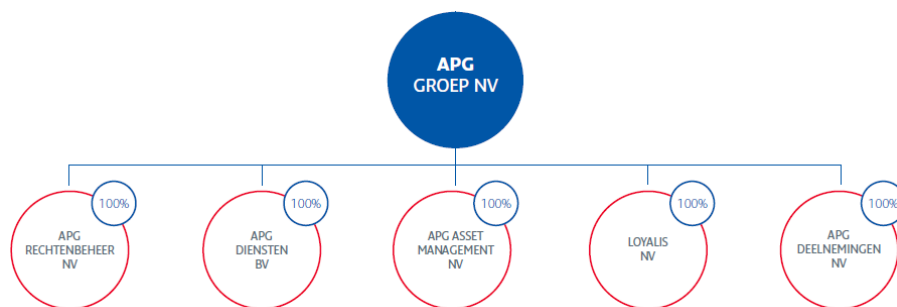


FIGURE 1.1: Organizational structure of APG Group (APG, 2015)

1.2 Problem identification

As an insurance company, Loyalis is subject to the supervisory framework Solvency II. This framework is a risk-based regulation for the insurance sector in the European Union. Since the introduction of Solvency II in the Netherlands only the business entity Loyalis within APG was obliged to comply with this regulation. However, recently the Dutch central bank DNB (de Nederlandsche Bank) has identified APG as a FICO (Financial Conglomerate). This classification imposes APG to additional supervisory regulations. As a result, not only solo entity Loyalis but the whole group of APG is subject to the supervisory rules of Solvency II.

At the moment there is much attention for this new regulation at APG. In particular the attention lies at ORSA (Own Risk and Solvency Assessment), a key requirement of Solvency II. The EIOPA, which is the European Insurance and Occupational Pensions Authority, defines ORSA as the entirety of the processes and procedures employed to identify, assess, monitor, manage and report risks which a company faces or may face and determines the own funds necessary to cover the overall solvency needs at all times (CEIOPS, 2008). Besides the solo ORSA submission by Loyalis which covers the insurance activities, APG is required to submit an overarching group ORSA to the DNB in 2017 that covers all the legal entities within the group. Group Risk and Compliance (GRC from hereon), the department where this research is conducted, is partially responsible for the submission of this report.

One of the key aspects of ORSA is the scenario development. Scenarios are a mean to explore the future. By identifying what might possibly happen, the company could anticipate upon future developments. This flexibility provides APG with a strategic advantage since it can respond to future developments and opportunities in a quick manner. Currently, APG has finalized the development of the scenarios. However, the assessment of the impact of these scenarios is not possible yet. GRC does not have a tool to assess the impact of the scenarios on APG's financial stability. The financial stability is measured by the following key performance indicators (KPI), which were defined in accordance with the DNB. These KPIs were predetermined before the research project.

Strategic KPIs

- **Profit and loss:**

The P&L statement shows an overview of the income earned during a time period as well as the operational and non-operational costs spent. The income is the firm's first line of defense against (unforeseen) losses. Therefore it is a key output element in this research. Since the income differs for each business entity, the P&L should make a clear distinction between various revenues. It should be noted however that APG does not aim for profit maximization. Its main objective is to provide pensions for people in the Netherlands.

- **Pension funds under management:**

These are the customers of APG and the main source of income for APG.

- **Assets under management:**

The assets under management development for each pension fund under management is important not only because it is the driver of pension capital available for participants in Dutch pension funds in the Netherlands, but also because it is the major driver of revenue for APG.

- **Participants:**

People who participate in the pension scheme of the pension funds. Participants affect the financial stability of APG as the in- and out flow of participants influences the sustainability of the pension funds. Since the pension funds are the customers of APG, it will affect APG as well.

- **Full time equivalent:**

Number of FTE at APG. This measures how many full time employees would be required to perform the work done in the organization. FTE is a major driver of operational costs for APG.

Solvency KPIs

- **Solvency capital requirement (SCR):**

This is a risk based buffer that enables insurance companies to absorb losses from (1) market, (2) counter-party default, (3) life underwriting, (4) non-life underwriting, (5) health underwriting and (6) operational risks. Due to the new Solvency II regulation, APG has to submit an overarching group SCR to the DNB that includes all business units.

- **Own funds:**

The level of own funds that consist of the excess of assets over liabilities plus subordinated debts. The own funds reflect the actual capital buffer available within the company.

- **Solvency ratio:**

This denotes the ratio of the amount of own funds to cover the SCR. This measure shows the capital adequacy of the company, meaning whether or not the company has a sufficient actual buffer to protect itself against adverse events.

GRC requires a model that can determine both the strategic and solvency KPIs of APG with respect to different scenarios. Accordingly, GRC deems the projection of these measurements essential. The projection should cover the duration of the scenario horizon. With the help of this model, APG can formulate management actions to protect itself against adverse scenarios. It is important to stress that the model required by GRC will in particular be used for the overarching group ORSA, which means that the financial stability should be assessed at group level.

1.3 Research objective

The aim of this research is to develop a model that can assess the impact of scenarios on the financial stability of APG Group. During the development it is important to take flexibility into account, meaning the user of the model should be able to assess a broad range of possible scenarios. This is important from an ORSA perspective, since the scenario assessment is required every year. If the model can take into account only the current developed scenarios, the model will not be applicable next year. Thus, it is paramount to structure the scenarios in a standardized way such that the impact computation of the scenarios are automatized. Furthermore, it is also necessary that the model can assess the impact of management actions.

1.4 Research questions

The problem identification and research objective give rise to the following main research question:

What model can be developed for the assessment of the financial stability KPIs of APG Group with respect to different ORSA scenarios?

From the main research question, several subquestions were derived:

1. What is an ORSA?
 - 1.1. What does scenario analysis entail in the context of ORSA?
 - 1.2. What are relevant measurements in the ORSA and how can these be evaluated?
2. What are the most important characteristics of the business units within APG Group?
3. What risks are APG Group susceptible to in the context of ORSA?
4. What are the risk drivers for the financial stability KPIs?
5. How can the scenarios be structured as input for the model?
6. Is the modeling of ORSA scenarios at APG Group level, meaningful or not?

1.5 Methodology

The approach that will be employed in order to develop a model for scenario assessment is graphically depicted in Figure 1.2. The structure follows logically from the research questions.

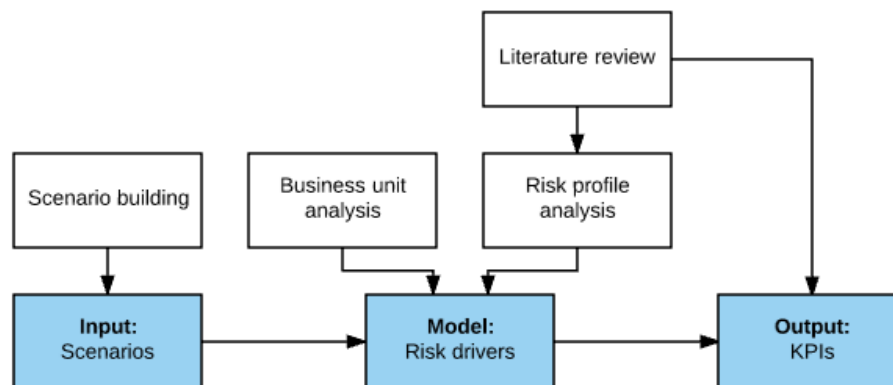


FIGURE 1.2: Conceptual design of the scenario assessment model

The first research question involves a literature review about ORSA. The aim is to find what ORSA and the financial stability KPIs entails and how these can be computed mathematically. Furthermore, a review will be done on scenario analysis in the context of the ORSA.

The second and third research question involves the analysis of APG. Since the financial stability KPIs revolves around APG's business activities, APG's business units need to be analyzed. Additionally, the risk profile of APG is examined in order to understand what risks the company is exposed to.

The fourth research question covers the model development. It consists of multiple phases. In the first phase, the scope and the constraints for the model will be determined. Subsequently, APG will be represented in a model. This is done by identifying the most important risk drivers of the financial stability KPIs by using the result of the second and third research question. The risk drivers are metrics that capture the key risks of the KPIs. By identifying the risk drivers a link between financial stability KPIs is established. Subsequently, when scenarios are assessed it should be able to adjust the values of risk drivers and therefore the financial position in terms of the financial stability metrics. In this way the impact of scenarios on the financial stability are assessed for APG. It is also important to focus on management actions. Devising these actions is the responsibility of the management, and therefore out of scope for this research, but the impact of these management actions are required and included in this research. Therefore, a hypothetical management action framework is designed and these actions should be computable in the developed model. Also, the scenarios should be defined in a predetermined structure so as to be able to automatize the scenario assessment. Thus, the last part of the model development focuses on scenario structuring.

The final research question will be answered in the last phase of the research. The quantitative impact analysis will be conducted for the finalized ORSA scenarios by applying the model and the effect will be evaluated in terms of the financial stability measures. Subsequently, a discussion will take place on whether assessing the ORSA scenarios at APG Group level is meaningful or not. Important for the assessment is also the model validation, since in this step it will become apparent if the model produced results that are credible for the organization.

1.6 Outline

Figure 1.3 depicts the outline of this report. The subsequent chapters are arranged in the following order: in chapter two a literature review will be conducted. This is followed by chapter three with the context analysis in which APG will be examined thoroughly. Chapter four and five is centered around the model development, which consist of four stages (1) determining the scope and constraints, (2) identifying KPI functions, (3) management actions and (4) scenario structuring. Chapter six will focus on the results of the scenario assessment as well as the discussion. Lastly, the report will conclude with the conclusion and recommendations.

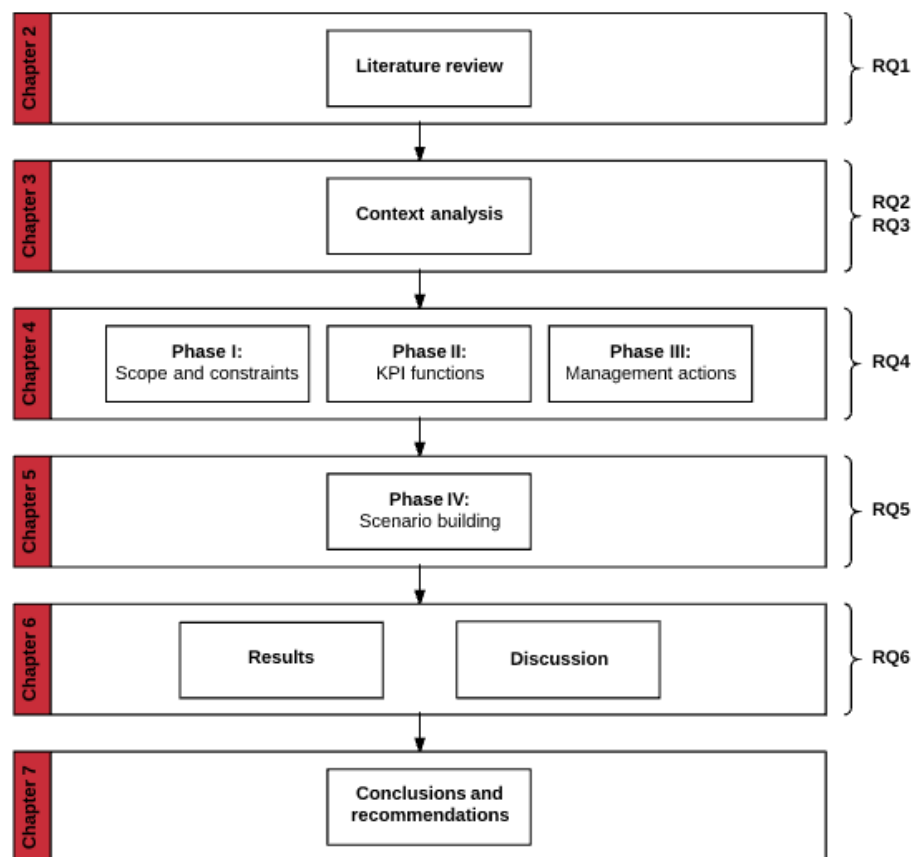


FIGURE 1.3: Research outline

Chapter 2

Literature review

The main topic of the research is the ORSA and more specifically the scenario analysis. In this chapter both topics will be elaborated on. Section 2.1 gives background on the ORSA. Next in section 2.2, a review of scenario analysis will be given in the context of ORSA. The chapter concludes with section 2.3, which will provide insight into capital requirements.

2.1 ORSA

In order to assess the risk management, the European Insurance and Occupational Pensions Authority (EIOPA), formerly known as the Committee of European Insurance and Occupational Pensions Supervisors (CEIOPS), requires all insurance companies in the European Union to conduct an annual ORSA. The ORSA, which stands for own risk and solvency assessment, is defined as follows (CEIOPS, 2008):

Definition 2.1. *ORSA is the entirety of processes and procedures employed to identify, assess, monitor, manage and report risks which a company faces or may face and determine the own funds necessary to cover the overall solvency needs at all times.*

In other words, it is a risk management tool that insurance companies in the European Union use to obtain a picture of their own risks and solvency requirements (Moormann, 2014).

2.1.1 Solvency II framework

The ORSA is part of article 45 of the Solvency Directive which stipulates Solvency II. This is a risk oriented supervisory framework for the insurance and reinsurance sector in the European Union that came into effect on 1 January 2016. In the Netherlands, the Solvency II guidelines are embedded in the Financial Supervision Act and the implementation is supervised by the DNB (DNB, 2016). The solvency framework consists of three interconnected pillars, with each pillar governing a different aspect. A general overview of the structure of the pillars can be found in Figure 2.1.

Pillar I specifies the quantitative requirements. These capital requirements are related to the risks faced by the insurer and can be seen as a buffer in terms of capital against adverse events. Two levels are specified: minimum capital requirement (MCR) and solvency capital requirement (SCR). The former is seen as the absolute minimum level of capital the firm is required to hold. The latter is intended to be approximately the value at risk measure calibrated to a 99.5% confidence level over a 1-year time horizon (Herzog, 2011). In other words, it is the loss level during a time period of one year that with a certainty of 99.5% will not be exceeded (Hull, 2015). Falling below the capital requirements will invoke regulator actions to assist the firm. Breaches to the SCR forces supervisors to take action with the goal of

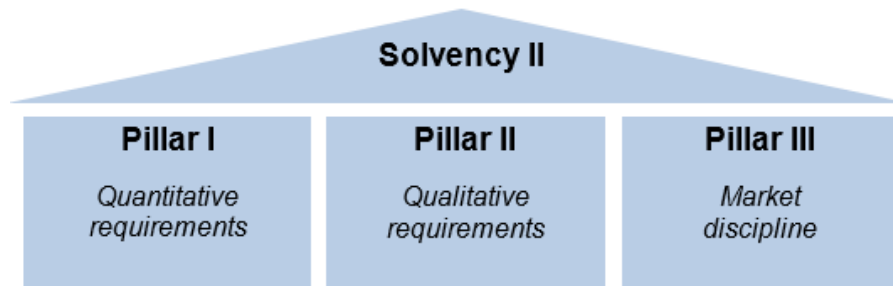


FIGURE 2.1: Three pillars of Solvency II framework

restoring the funds back to the level of the SCR. If the amount of own funds falls below the MCR, the license of the firm can be withdrawn (European Commission, 2015).

The second pillar of Solvency II focuses on the qualitative aspects of supervision (Eling, Schmeiser, and Schmit, 2007). Internal risk management practices and control are key elements. ORSA is included within this pillar. The focus of ORSA lies mainly on future risks and solvency requirements, making it complementary to pillar I which aims to assess the current quantitative requirements.

The final pillar of Solvency II is concerned with the disclosure of risk management information to the market (Hull, 2015). The disclosure enhances market discipline and transparency, which leads to a more efficient and effective insurance market.

2.1.2 Objectives

The ORSA was designed with two objectives in mind. First, it helps with the firms strategic decision making process. This is because the ORSA requires a scenario analysis which helps with the identification of potential problems, future risks and opportunities. This encourages a structured way of thinking about the future, which helps with the preparedness to handle them. Secondly, the ORSA provides regulators with a supervisory tool as the firms have to assess its future solvency requirements with a view toward their own specific risk profile (Cummins and Phillips, 2009).

2.1.3 Content

Since the ORSA represents the firms own view of its risks, the firm may decide for itself how to perform the ORSA. As a result, every ORSA is different. However, there are guidelines on how to structure the ORSA (EIOPA, 2015). The ORSA guidelines establishes what an ORSA report should contain. According to KPMG (2014), there are three major elements of importance. The first element is a forward looking assessment of both risk and solvency requirements. Solvency monitoring is another important aspect. This is the ability to report on the monitoring of solvency. The last element is the risk analysis which should include risk measurement tools such as scenario analysis and (reverse) stress testing (KPMG, 2014). The next paragraph will explore these concepts in more detail.

2.2 Scenario analysis and stress testing

Scenario analysis and stress testing are risk management tools used for the assessment of risks to the financial condition of a firm (International Actuarial Association, 2013). Both tools are quite similar in nature and are often used interchangeably in literature. However, there is a fundamental difference between both risk tools in the context of ORSA. To understand the difference between scenario analysis and stress testing, one must understand the difference between scenarios and stress scenarios. The definition of a scenario is described as follows (International Actuarial Association, 2013):

Definition 2.2. *A scenario describes a consistent future state of the world over time, resulting from a plausible and possibly adverse set of events or sequences of events.*

Thus, a scenario is a future environment over time. It results from a combination of adverse events. Scenarios are often the result of a complex set of interactions of various risk factors (i.e. interest rates and inflation), whereas a stress scenario is defined as (International Actuarial Association, 2013):

Definition 2.3. *A stress scenario is a scenario involving a single extreme event.*

A stress scenario focuses on the tail risk and are therefore likely to have a big impact on the firm. The figure presented below shows the clear distinction between both concepts and also why both concepts are often used interchangeably. The arrows pointing at scenarios and stress test provide the definition of these concepts in terms of severity and complexity (International Actuarial Association, 2013). This is in line with the definitions used in the ORSA (EIOPA, 2014):

Definition 2.4. *Scenario analysis means the analysis of the impact of a combination of adverse events.*

Definition 2.5. *Stress test is defined as the analysis of the impact of single extreme event.*

The overlap and confusion exists when scenarios are both severe and involve complex events with multiple risks and interactions.

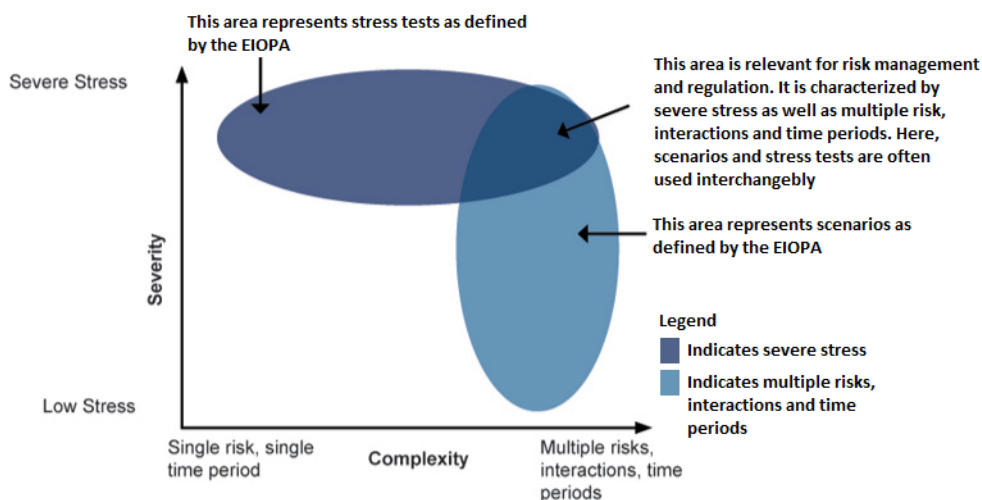


FIGURE 2.2: Scenario analysis versus stress testing, based on International Actuarial Association (2013)

Scenarios that involve many risk factors are more realistic, but this also means it is harder to assess. That is because there is dependency and correlation between different risk factors. When one variable shows a change others might do as well. Also, when stress testing is involved one should take into account that dependencies in stressed situations are different than under normal situations. For instance, under normal circumstances the financial markets are not related to the mortality rate. However, when the mortality rate suddenly increases substantially, this will likely have impact on the markets due to slight panic. To deal with the issue of dependencies one could assume that dependencies are given by a copula (International Actuarial Association, 2013).

The purpose of scenario analysis is not to predict the future but rather help the firm prepare for adverse events. The results of the analysis helps with the identification of opportunities. According to the International Actuarial Association (2013) the results of scenarios can be used to assess the financial vulnerability of both individual financial institutions as well as entire industries. Entire industries and financial systems are often assessed by regulators such as central banks by using macroeconomic stress testing models (End, Hoerberichts, and Tabbae, 2006). Moreover, scenarios can be used for solvency testing. This method examines the effect of scenarios on a firm's solvency. The latter is a form of stress testing, since it evaluates the financial strain a firm can withstand (International Actuarial Association, 2013). Finally, the results of the scenario analysis can be used as a communication tool to important stakeholders as well as enhancing the risk culture of the firm.

2.2.1 Models

Literature does not provide scenario analysis models for the ORSA. The quantification of the impact of a scenario usually requires a company-specific model developed within the firm (International Actuarial Association, 2013). That is quite logical, as each firm is different with a different risk profile and set of risk factor that behave differently.

2.2.2 Types of scenarios

There are different types of scenarios (International Actuarial Association, 2013).

Historical scenarios

These scenarios are based on an observed time period triggered by a historical event. An example of such a scenario is the collapse of Lehman Brothers in 2008. Another example is the Russian Ruble crisis in 1998.

Synthetic scenarios

These are hypothetical scenarios that are not observed before. As a result, these scenarios can be more tailored to a specific area of interest for the company. An example of such a scenario could be a scenario were there is a big loss of customers due to a new European pension system.

Company-specific scenarios

These are scenarios where scenarios are tailored specifically to a company. For example, a big loss of a company's unique product.

Single event scenarios

Scenarios that does not lead to any crippling side effect, but can be described by the effect of a single event. An example, is a hail storm.

Multiple event scenarios

In contrast to the above described single event scenarios, these scenarios lead to multiple events. An example is a global financial crisis, such as the one in 2008. Notice, that historical and synthetic scenarios could also be multiple event scenarios.

Reverse scenarios

In these scenarios one tries to identify scenarios that would threaten the company's existence. The evaluation of reverse scenarios is called reverse stress testing in the ORSA.

2.2.3 Approach

A proposed method for the tackling of both scenario analysis and stress testing is the three-stepped ISA (identify, simulate, assess) approach (Asselmann, 2014). The first step involves identifying the key performance indicators of the company as well as the underlying risk drivers of these indicators. The KPIs are the output of the model, and the risk drivers are the risk factors that can (negatively) impact the KPIs. The second step consists of simulating the scenarios. The firm needs to decide for itself the magnitude of the stress affecting the risk drivers. Since the KPIs and the risk drivers differ for each firm, the model is company-specific. The last step is to assess the overall company profile after the shock. This approach is illustrated in Figure 2.3, which is based on Asselmann (2014).

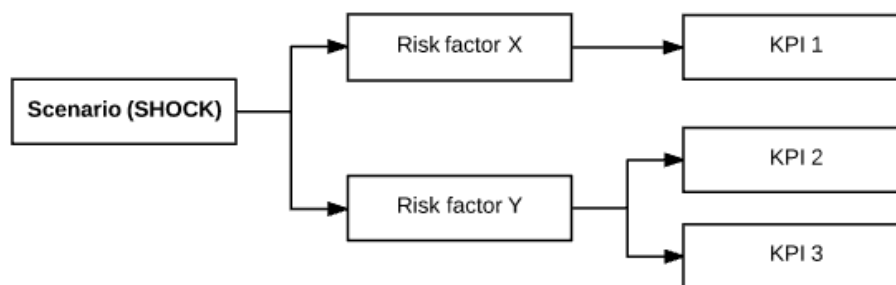


FIGURE 2.3: Relationship between scenario, risk drivers and KPIs.

2.3 Capital requirements

The capital requirements and more specifically the SCR stipulated in the first pillar are of major importance in ORSA. The SCR is defined in the binding framework for Solvency II, the directive of the European Parliament and the Council in the following way (European Parliament and Council, 2009):

Definition 2.6. *The SCR shall correspond to the Value-at-Risk of the basic own funds of an insurance or reinsurance undertaking subject to a confidence level of 99.5% over a one-year period.*

This means that the company should hold at least a certain basic own funds, which consist of the excess of assets over liabilities plus subordinated liabilities to withstand the possibility of a 1 in 200 year disastrous event happening in one year. Another way to see what SCR is about is to depict it in a balance sheet as illustrated in the figure below (EY, 2015).

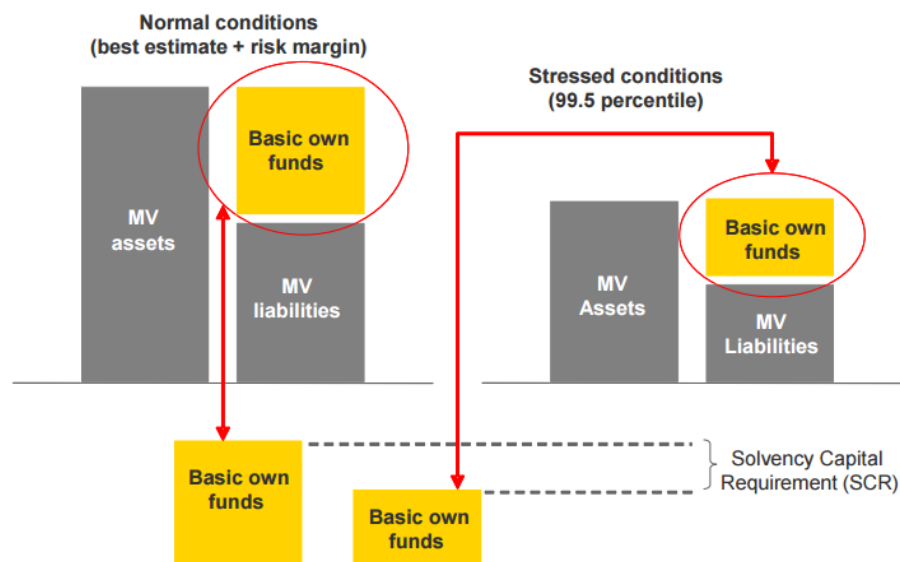


FIGURE 2.4: Representation of SCR on a balance sheet of an arbitrary company (EY, 2015). Notice that both assets and liabilities decrease in value under stress. However, this is not always the case. There are also types of stress that result in higher liabilities.

The figure shows the SCR as the difference between basic own funds in normal and stressed conditions. Notice that the balance sheet consists of assets and liabilities valued on the basis of their market value (MV). In other words, the price paid on the market to acquire these assets and liabilities. Thus, the Solvency II balance sheet is different than the corporate balance sheet in the annual reports. As shown in the figure, the Solvency II balance sheet plays a crucial role in determining the SCR as the difference between the value of the asset and liabilities determine the company's own fund. It is therefore necessary to understand the Solvency II balance sheet and in what ways the valuation of assets and liabilities are done. For an illustration of the solvency balance sheet, see Figure 2.5.

For the purpose of valuation, the balance sheet can be split in twofold: the technical provisions and the balance sheet items other than the technical provisions. The

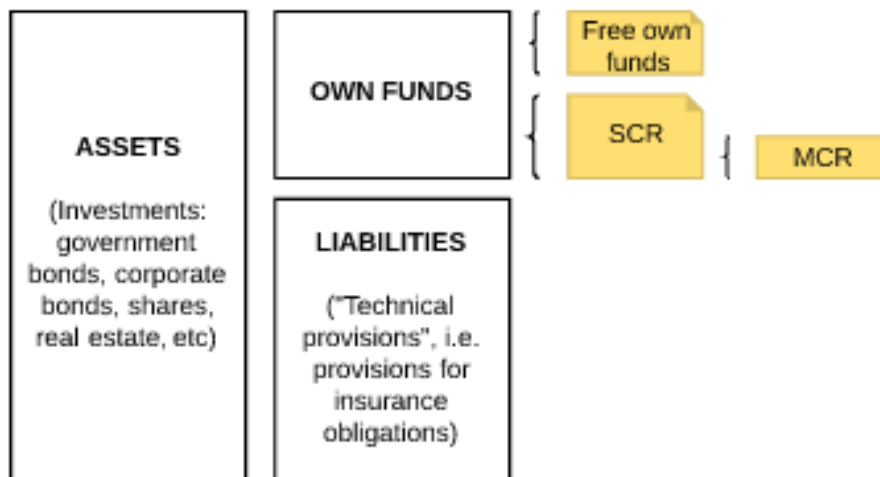


FIGURE 2.5: Schematic representation of the Solvency II balance sheet.

technical provisions are defined by the DNB as the amount held by an insurer on the balance sheet date in order to settle all existing obligations towards policyholders (DNB, 2014). The technical provisions are valued on the basis of a best estimate plus a risk margin, which is a compensation for making available the own funds that are present. The best estimate is based on cash flows and depends on whether one is a life insurance company or a non-life insurance company. Life insurers estimate it by subtracting the present value of the cash flow of all benefits to be paid minus the present value of the cash flow of the future premium inflows. Non-life insurers estimate it by the premium provision and claim provision (DNB, 2014). Because of the way technical provisions are defined, it can be concluded that one must provide insurance activities in order for it to have technical provision. The non-technical provision items on the balance sheet are valued on the basis of IFRS valuation principles, thus by either observable market prices or using other information that is available in the market. The distinction between the valuation techniques has an important implication for the risk. Those items valued using market prices are hedge-able risks which can be effectively hedged in the financial markets, whereas best estimates plus risk margin are non hedge-able risks.

2.3.1 Standard risk aggregation formula

Now that the concept of SCR is clear, it is important to understand how the SCR is computed as this is one of the output variables in this research. The SCR can be computed in two ways, either with the standard model proposed by the EIOPA (replaced CEIOPS, the Committee of European Insurance and Occupational Pensions Supervisors) or an internal model constructed by the firm itself. The standard model is a standardized approach, meaning the same design, specifications and assumptions are used regardless of the company. For this reason, the standard model is not always reliable, which may lead to a deficient computation of SCR (Bauer, Bergmann, and Reuss, 2010). The standard aggregation formula forms the basis of the standard model. Mathematically, the formula is expressed as follows:

$$SCR_{\text{total}} = SCR_{\text{basic}} + SCR_{\text{operational}} - adj \quad (2.1)$$

Where adj is the adjustment loss absorbing capacity of the technical provisions. The aggregation described above consists of integrating information from several random variables. Each SCR represents a random variable. Solvency II recognizes six types of risk: market risk, credit default risk, life underwriting risk, health underwriting risk, non-life underwriting risk and operational risk (EIOPA, 2009). Aggregation of these random variables (SCR of each risk) could be accomplished in a number of ways such as the linear aggregation or using copula-based methods (Cifuentes and Charlin, 2016). The latter involves constructing a multidimensional distribution out of one-dimensional probability distributions (Embrechts and Lindskog, 2003). In Solvency II the linear aggregation expression based on the variance-covariance matrix is used, which is expressed in the following way (CEIOPS, 2010):

$$SCR_{\text{basic}} = \sqrt{\sum_{i=1}^5 \sum_{j=1}^5 \rho_{ij} * SCR_i * SCR_j} \quad (2.2)$$

Where i and j both correspond to (1) market risk, (2) credit default risk, (3) life underwriting risk, (4) health underwriting risk and (5) non-life underwriting risk. The ρ_{ij} corresponds to the correlation between the risks i and j . These correlation factors were developed by CEIOPS and are depicted in Table 2.1:

Correlation matrix					
ρ_{ij}	SCR_{market}	SCR_{default}	SCR_{life}	SCR_{health}	SCR_{nonlife}
SCR_{market}	1	0.25	0.25	0.25	0.25
SCR_{default}	0.25	1	0.25	0.25	0.50
SCR_{life}	0.25	0.25	1	0.25	0
SCR_{health}	0.25	0.25	0.25	1	0
SCR_{nonlife}	0.25	0.50	0	0	1

TABLE 2.1: Correlation matrix for Solvency risks (CEIOPS, 2010).

The CEIOPS approach for choosing the value of the correlation parameters are described mathematically: for two random variables representing risk X and Y with $E(X) = E(Y) = 0$, the correlation parameter ρ should minimize the aggregation error depicted in the following equation (CEIOPS, 2010):

$$|VaR(X + Y)^2 - VaR(X)^2 - VaR(Y)^2 - 2\rho * VaR(X) * VaR(Y)| \quad (2.3)$$

Since there is correlation between risks, there is also diversification. Diversification benefit arises when two distinct risks are not completely dependent on each other (meaning $\rho \neq 1$), and a bad (good) outcome for one risk does not mean a bad (good) outcome for the other risk. The diversification benefit can be computed as follows:

$$Diversification = \sum_{i=1}^5 SCR_i - SCR_{\text{basic}} \quad (2.4)$$

Notice from equations 2.1, 2.2 and 2.4 that the linear aggregation is only applied for the first five risks. The capital for the sixth risk (operational risk) is simply added, implicating that there are no diversification benefits between operational risk and the other risks ($\rho = 0$). Many practitioners have conformed this implication, however Cifuentes and Charlin (2016) argues differently stating that operational risk does have diversification effects and proposes a 6*6 matrix instead.

2.3.2 Risk modules

As mentioned in the preceding paragraph, Solvency II distinguishes six types of risk for which buffers (SCR) have to be held by the insurer. These risks are themselves composed of several sub-risks. For an overview of all risks and sub-risks, see Figure 2.6.

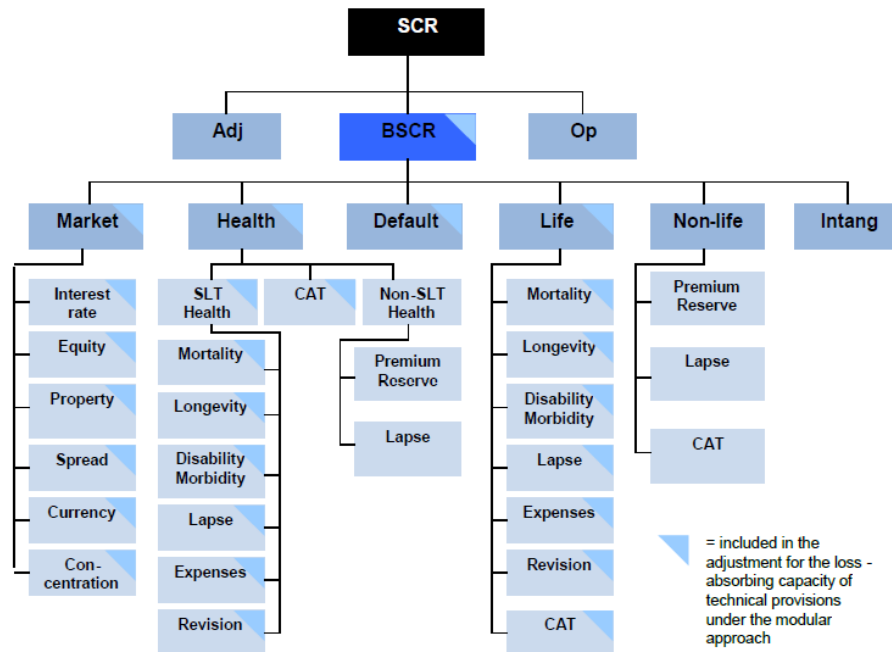


FIGURE 2.6: Overall structure of the standard formula in terms of risk modules and sub-risk modules (EIOPA, 2009).

For the computation of the SCR for the risk, the standard model follows a modular bottom up approach. It first aims to compute the capital requirement for each sub risk module by employing the method as depicted in the following equation:

$$SCR_{\text{risk}} = nav - (nav|_{\text{riskshock}}) \quad (2.5)$$

First an instantaneous shock is delivered to the risk. Subsequently the net asset value ($nav = assets - liabilities$) is determined after the shock. This amount is then subtracted from the NAV in normal conditions. The following amount is then the required capital for that specific risk (Devineau and Loisel, 2009). The shock for each risk is determined through an empirical analysis and expert judgment by the CEIOPS (Herzog, 2011). For example, the instantaneous shock of 45% for global equity (equity risk) was found after an analysis of the MSCI World Developed (Market) Price Equity Index and the MSCI World Equity Total Return Index (CEIOPS, 2010). The empirical 99.5% VaR for both indices were -44.25% and -42.12% respectively. So, CEIOPS deemed the shock of 45% reasonable enough (surprisingly this was changed to 39% in the latest update without specified reasons).

After computing the capital requirements of each sub risk module, the SCR need to be aggregated into six main risk modules. In the next step the SCR of the modules are aggregated using equation 2.1 and 2.2. The risk modules that are part of the standard model are mainly risks that insurance or reinsurance companies are exposed to. That is because the standard model was developed with these companies

in mind, meaning that a company that does not provide insurance or reinsurance related services would not be much exposed to these risks. The health, life and non-life underwriting risk modules will not affect non-insurance undertakings, since these risks arise from premium calculations and claims reserve. The operational risk module is also irrelevant from a non-insurance undertaking perspective. This is because the way the capital charge for operational risk is calculated in the standard model. For more information about the computation approach, please refer to appendix A.

The computation is centered around variables which are related to health, life and non-life insurance technical provisions and earned premiums corresponding to health, life and non-life insurance. This means that only market risk resulting from the fluctuation of market variables and credit default risk which result from debtor default are relevant for non-insurance undertakings in the context of Solvency II. An important note is that even if there is no capital charge for operational risk in the context of Solvency II, it does not mean the company does not have any operational risk. It just means that the company does not have to set aside a capital charge for operational risk in the context of Solvency II.

2.3.3 Solvency ratio

An important metric in Solvency II and in this research is the solvency ratio. This ratio is defined as follows (EIOPA, 2014):

Definition 2.7. *Solvency ratio' denotes the ratio of the eligible amount of own funds to cover the Solvency Capital Requirement using the latest available values.*

Not every own fund can be used as buffer, hence the eligible in the definition. The own fund can be categorized in three tiers. The lower the tier, the lower the quality of capital. From the definition, the following equation can be derived:

$$SolvencyRatio = \frac{Own\ funds}{SCR} \quad (2.6)$$

2.4 Conclusion

In this chapter the following research and sub research questions were answered:

RQ (1): What is an ORSA?

The ORSA is the Own Risk and Solvency Assessment. This is a risk management tool, specified in Solvency II, and used by insurance companies in the European union to obtain a picture of their own future risks and solvency requirements. The ORSA is company-specific since each company has their own risks and risk profile. However, it should contain at least three elements. This includes (1) a forward looking assessment on risk and solvency requirements, (2) solvency monitoring and (3) risk analysis using scenario analysis and or reverse stress testing.

RQ (1.1): What does scenario analysis entail in the context of ORSA?

Scenario analysis is described as the analysis of the impact of a combination of adverse events. It is characterized by multiple risk factors that may or may not be severe. This is different from stress testing, which is defined as the analysis of the impact of a single extreme severe event. There are no standardized models for the scenario analysis in ORSA. Each company is company-specific, as a result a company-specific model is necessary.

RQ (1.2): What are relevant measurements in the ORSA and how can these be evaluated?

The most important computations in the context of ORSA are the solvency requirements in general and the SCR in specific. The SCR is the economic capital that one must hold in order to withstand the possibility of a 1 in 200 year disastrous event happening in one year (99.5 % VaR). The SCR can be computed using the standard risk aggregation formula and is based on risk modules. There are six risk modules: (1) market, (2) counter-party default, (3) life underwriting, (4) non-life underwriting, (5) health underwriting and (6) operational risk. These risk modules are mainly insurance related risks. As a result, for non-insurance companies, the only risks that matters in the context of the ORSA are market and counter-party default risk. Operational risk does exist, however for non insurance related companies it does not require a capital charge due to the way the capital charge is calculated according to the Solvency II regulations.

APG AM's main source of revenue is a management fee received from its clients. The fee is negotiated with each client and therefore differs for each pension fund. For ABP the fee is a fixed lump sum amount of money, whereas the rest of the clients pay a fee based on a fixed percentage of the net asset value of the assets under management. The management fee is received on a monthly basis and is sufficient to cover the costs of internal and external investment managers as well as the own operational and non-operational costs.

From the previous discussion, the relevance of the AuM development over time can be derived. Since the fee received from pension funds (besides ABP, which has no earnings volatility) depends on the assets under management, more assets means more fee. The inflow and outflow of AuM is therefore of major importance. The AuM flow depends mainly on two factors. First, clients can add or withdraw capital. The second factor is the investment result. The investment result depends on the asset mix and market variables such as market returns and interest rates.

APG's asset mix portfolio consist broadly of [REDACTED]. It follows then that APG got a very diverse investment portfolio. Lots of diversification takes place, because the investment strategy is geared towards long term and responsible investments. Since different building blocks react differently to market variables (for example interest rates on property), the AuM development depends on the amount of assets invested in each building block. Followed by the preceding, the following construct can be established for the total assets under management for APG AM:

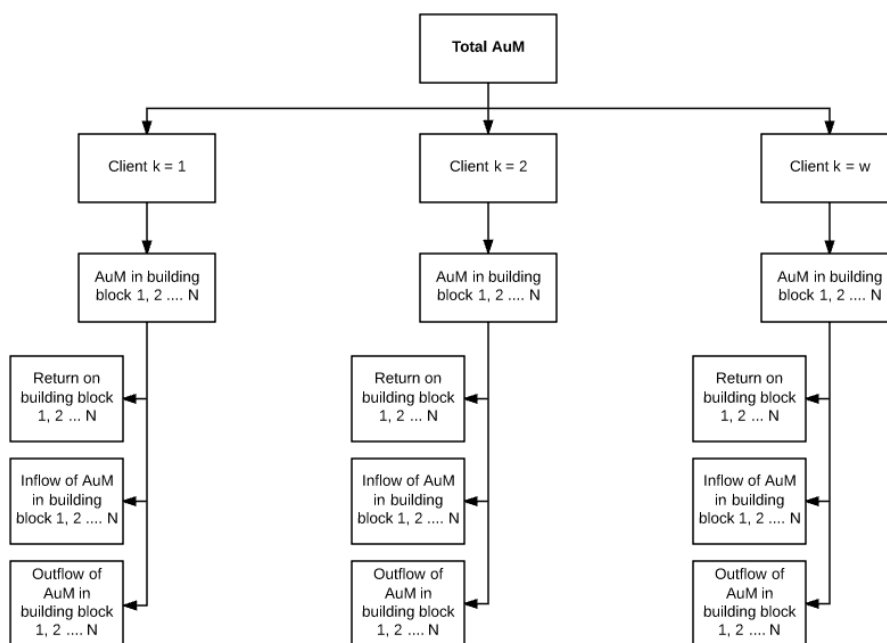


FIGURE 3.1: Assets under management construct of APG Asset Management.

Managing the asset management operations involves costs. Salaries have to be paid to internal managers as well as fees to external investment managers. The costs for external managers follows a complicated fee structure. [REDACTED]

[REDACTED]

3.1.2 APG Rechtenbeheer

APG Rechtenbeheer (in English APG Rights Management and APG RB henceforth) provides executive consultancy, marketing and communication, pension administration and risk management for several pension funds in the Netherlands. Among the clients are the pension funds ABP (government and education), bpfBOUW (construction industry), BPF Schoonmaak (cleaning industry), PWRI (pension scheme for social employment), SPW (housing cooperative), SPMS (medical specialist), PPF APG (APG's employee pension fund), ABP BRD (disabled military) and BTER (construction and infrastructure). Several clients of APG RB are also clients of APG AM, but not all of them. The most important clients in terms of revenues are shown in Table 3.2. Again, ABP is the biggest client in terms of revenue.

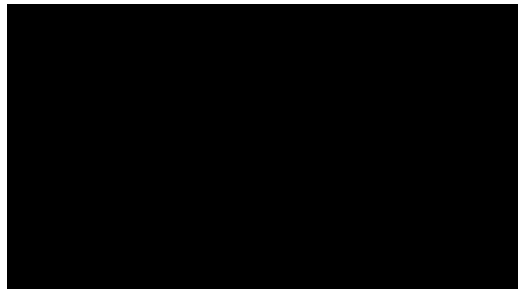


TABLE 3.2: Top clients of APG RB in terms of revenue in 2016 (source: business plan of 2016).

APG RB has broadly two ways of receiving revenue from clients. The revenue is either received per participant in the fund which is based on a certain price or a lump sum fee is discussed with the pension fund. With the former more participants means more revenue, with the latter there is not much earnings volatility since more or less participants does not mean more revenue.

The participants among pension funds are further divided in three states: active participants, deferred (or sleeping) participants and pensioners. Active participants are the individuals that are participating in the pension scheme of a pension fund. When you change a job and consequently from a pension fund, you become a sleeper. Pensioners are those individuals who are retired and receive pension benefits. Pension funds are only required to pay APG for the active participants and pensioners associated with the pension fund. Sleepers are omitted for these payments.

The states are not fixed. Transition is possible from one state to another. As shown in Figure 3.2 there are several transition possibilities: (1) new people that are participating in pension schemes (2) whenever an active participant hits the pension

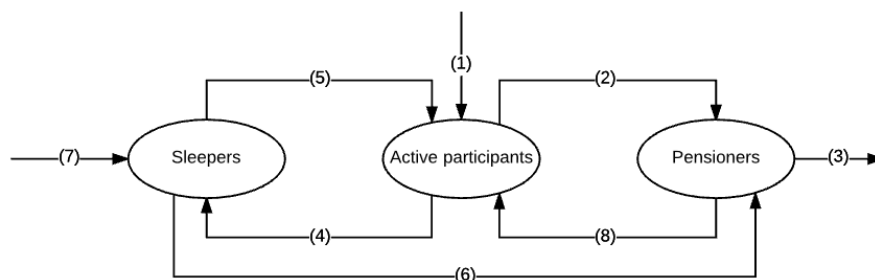


FIGURE 3.2: Transition relationships between the states.

age (3) deceasing pensioners (4) whenever participants stop participating in pension schemes (5) whenever someone decide to participate in a pension scheme (6) if sleepers hit the pension age (7) inflow of sleepers. Depending on the ORSA scenario, transition (8) may also be possible for pensioners. In the *"Lifecycle"* scenario developed by APG, pensioners are able to work and go back to pension freely (see chapter 6 for more information about this scenario).

3.1.3 APG Diensten

APG Diensten (in English APG Services) is a supporting business unit. It takes care of the main internal services, namely facilitatory services and ICT services. For this, they earn internal revenue. APG uses a fund transfer pricing method to calculate these revenues. This means that the revenue of APG Diensten is charged as costs to other business units that choses to use the facilitatory and ICT services (allocated costs). Subsequently, this also means that both total internal revenue and total allocated costs are equal.

3.1.4 APG Deelnemingen

APG Deelnemingen (in English APG Participations) focuses on innovative services for individuals and employers. The innovative services are broad in nature. For instance, algorithmic trading experiments, but also research of the application of block chain technology to pension funds. APG Deelnemingen is a relative small business unit compared with the rest of the group. In terms of revenue it is around 2.0% of total revenue in 2016 according to the business plan.

3.1.5 Other supporting units

Other supporting business units are Groep Staven and Shared Services. The former contains the board of directors and the groups that support them (i.e. group finance, group strategy). The latter consist of other facilitatory services which are not included in APG Diensten. Important is to know that there are three supporting business units in total: Groep Staven, Shared Services and APG Diensten. These are the only business units that provide supporting services. Consequently, these units are the only units where the allocated costs ("doorbelaste kosten" in Dutch) flows to. This relationship is not reciprocal. The supporting units themselves do not have allocated costs that flow to other business units. This is illustrated in Figure 3.3.

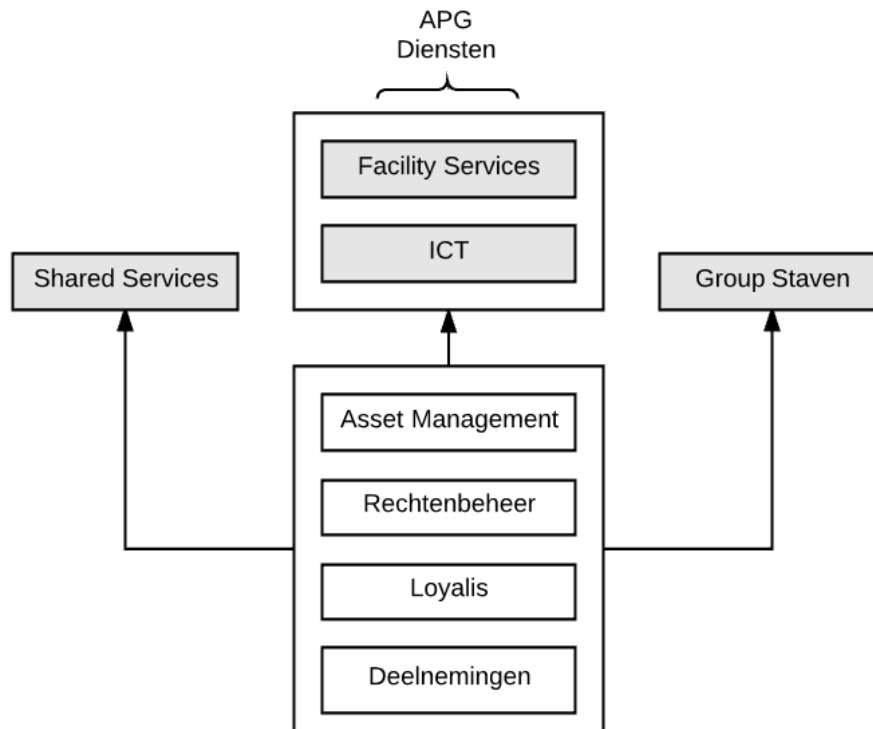


FIGURE 3.3: The gray blocks represents the supporting business units. The line shows in which direction the allocated cost cash flows move to.

3.2 Loyalis

Loyalis N.V. is the insurance company that carries out insurance activities such as offering supplementary pension and disability insurance products. It consists of two business lines: "Leven" (Life) and "Schade" (Non-life). Each business line offers different insurance products and services. The business line "Leven" provides life insurance products (i.e. life annuity), whereas "Schade" offers non-life and health insurance products (such as total permanent disability insurance). For the protection of these adverse events for policyholders, Loyalis receives provision and premium income. Besides providing products and services, Loyalis also lets APG AM invest their capital in the market to gain additional profit.

Loyalis has experience with ORSA as it already conducts an ORSA each year. This means they are familiar with both scenario development as well as assessment modeling. Since GRC also requires an assessment model, it is important to understand how the ORSA scenarios are being assessed at Loyalis and if it can be used as a foundation for the model in this research. The following paragraphs will elaborate on the ORSA process, scenario development and scenario assessment within Loyalis.

3.2.4 Example ORSA scenarios

A few examples of ORSA scenarios for Loyalis are examined in this paragraph that might also be useful for APG Group.



3.3 Risks in the context of ORSA

This section will examine the risk profile of APG in the context of the ORSA.

3.3.1 Solvency balance sheet

As stated in the literature review, Solvency II risks consist of market, counter-party default, life underwriting, non life underwriting, health underwriting and operational risk. These risks are quantified by applying shocks to either the assets or liabilities on the solvency balance sheet. This means that the Solvency balance sheet is a good starting point for the analysis of the relevant solvency risks within APG. The solvency balance sheet of APG is composed of the market value of various items reported on the balance sheet in the annual report (see appendix 2 for the balance sheet as reported in the annual report). In order to understand the Solvency balance sheet, the items on this balance sheet is examined.

Table 3.3 depicts the standalone solvency balance sheet of APG at the end of 2016. The standalone balance consist of only the parent company APG Group and is different than the consolidated balance sheet which consist of both the parent company and its subsidiaries. In the standalone balance sheet, the various business units within APG are reported as a single line financial fixed asset. As illustrated in Table 3.3, this is by far the biggest post on the asset side of the balance sheet. More specifically, a large part of the financial fixed assets consist of the insurance company Loyalis. This was approximately 75% in 2016. This points at the importance of Loyalis to APG Group in terms of Solvency II riskiness relative to the other business units in the group. The other business units expressed as a percentage of total financial fixed assets are for APG Asset Management (22.84%), APG Rechtenbeheer (2.34%), APG Diensten (1.44%) and APG Deelnemingen (0.22%).

TABLE 3.3: Market value of the standalone balance sheet of APG at the end of 2016.

Like any normal balance sheet, APG's balance sheet is split into assets and liabilities. At the asset side there are fixed and current assets. Fixed assets can be classified into intangible fixed assets, tangible fixed assets and financial fixed assets. Intangible fixed assets include software and its own insurance portfolio. In Solvency II the value of these items are omitted. The tangible fixed assets, which are quite minor in

APG case, include decoration items (paintings) and equipment such as phones. As mentioned before, the equity values of the business units are aggregated together and booked as a financial fixed asset. The financial fixed assets lead to an exposure to market risk in the form of equity risk, since the equity value of the business units may decline due to adverse events. APG also has current assets, which consist of receivables and capital at bank accounts. Not surprisingly, these assets result in an exposure to credit default risk as the counter-party may default. In the case of APG, these counter-parties are mostly banks.

The liability side of APG consist of long term liabilities, short term loans (items with duration not longer than one year) and provisions. These provisions are not insurance related, but rather related to the pensions of APG's own employees. Since 2013, employees of APG Group are either part of the pension scheme of ABP or PPF APG (stands for "Personeelspensioenfond"). Both pension funds use a different form of pension scheme. ABP uses a collective defined contribution scheme (CDC). In this scheme the amount of pension received is based on salary and the number of years a person participates in a scheme with a conditional indexation (Reichert, 2014). PPG APG on the other hand uses a defined benefit scheme (DB). The level of pension received depends on the number of years worked in combination of an average salary (Reichert, 2014). The distinction between schemes has implications for the balance sheet. Due to its nature, the DB scheme of PPF APG is reported as a liability (Defined Benefit Obligation), whereas the CDC does not. This liability is reported under provision and is subject to interest rate risk. When interest rates go down, more capital should be set aside to meet future obligations, which increases the provision.

The standalone balance sheet of APG does not involve much complexity, because items such as bonds or technical provisions are not included directly in the balance sheet. Instead, they are included indirectly through the single line item financial fixed asset, which contains all the equity values of all business units.

From the balance sheet, one can deduct that APG Group is currently solely exposed to counter party default risk and market risk in the form of equity risk and interest rate risk. The other risks in the context of Solvency II is currently not relevant for APG Group as all of those risks are related either to the trading portfolio or insurance. This means that APG as a standalone company does not have to set aside a capital charge for life underwriting, non-life underwriting, health underwriting and operational risk. This does not mean that APG is not exposed to operational risk. However, it just means that APG does not have to set aside a capital charge for operational risk in the context of Solvency II. The operational risk defined by the Basel Committee on Banking Supervision (2001) as "risk of loss resulting from inadequate or failed internal processes, people and systems or from external events" does exist within APG. Terpoorten (2013) shows a method for computing the capital charge for operational risk within APG using an expert elicitation method.

Notice that APG does not bear any financial or market risks as a result of the trading portfolio (such as changes in prices of stock and counter party default risk on bonds). This may sound surprising since APG also operates in the asset management world. However, the reason is quite straightforward. All financial risks are on account of the pension funds themselves, since APG only execute the investment decisions that the pension funds make on their own. The pension funds themselves choose the building blocks in which they want to invest in. APG only manages the investments on behalf of their clients. As a result, all risks that arise due to investments is not risk that is taken on by APG. These risks are however, managed since it is important for asset management and client reporting.

3.3.2 Computations of SCR

Now that it is clear what risks in the context of Solvency II APG Group is exposed to, this paragraph will elaborate on the computation of the SCR for each risk and subsequently the SCR of the business units and APG.

The construction of the SCR for APG is schematically depicted in Figure 3.5. The total SCR for APG is the sum of the SCR for each business unit within APG while taking into account of diversification effects. The SCR of the business units are computed by aggregating the SCR for each risk module the business unit is exposed to minus diversification effects. All computations are based on the standard model developed by EIOPA.

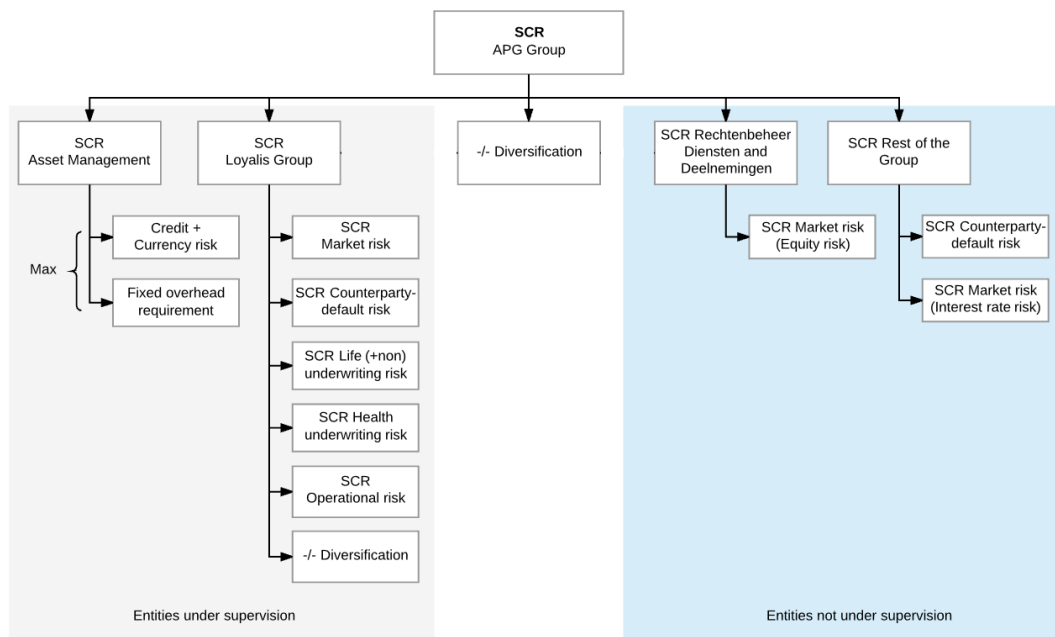


FIGURE 3.5: Construct of the Solvency II related risks for APG Group.

As mentioned before, the standard model is not always reliable due to the underlying assumptions within the formula. Nevertheless, both APG and Loyalis are using the standard formula as a basis for the computation of the SCR. An important note in the light of this research is that the purpose is not to develop an internal model for the calculation of SCR. For this research, it can be assumed that the SCR computation using the standard model is adequate. Moreover, APG already conducted a research in 2013 for the development of an integral economic capital model for allocating a capital charge for each risk the organization is exposed to. However, due to a lack of data and resources at that moment, it was deemed infeasible to design such a model. For more information about this research project, please refer to the research of Terpoorten (2013). In the following paragraphs, the SCR computation for the business units will be elaborated.

Loyalis Group

Loyalis computes its SCR separately for its business lines "Leven" and "Schade". "Leven" mainly provides life insurance, whereas "Schade" provides non-life as well as health insurance. As a result, different risk modules in the standard model are relevant for these business lines. Both SCR are then aggregated into a SCR Loyalis Group, while taking account of the correlation between the risks. For this research,

the SCR determination of Loyalis is out-of-scope. Loyalis already determines and reports their SCR to the DNB. Since the model build in this research will be like an extra layer on top of the model of Loyalis, the output of the models of Loyalis will be used as input for the model in this research. Thus, further analysis of the risk modules is not required.

APG Asset Management

Before assessing the SCR computation of APG AM, it is important to understand an important business characteristic within this business unit. The business operation of APG AM is characterized by the presence of two types of cash flows. The first type of cash flows are cash flows in the name of the pension funds. An example of such cash flows are cash flows related to the return on assets under management which flows directly to the clients of APG and not to APG. The second type of cash flows are cash flows on behalf of APG AM itself. These cash flows move to APG (also known as corporate money) and not to the pension funds. This distinction has important risk implications for APG AM. Risks incurred on behalf of the clients (due to the trading portfolio) are not relevant for APG AM. As a result, APG AM is not exposed to market and counter party default risk in the context of Solvency II. These risks are irrelevant, because it involves risks as a result of the trading portfolio, which are accountable to the pension funds. This is because pension funds make investment decisions themselves (they choose the building blocks in which they want to invest) and these are only executed by APG. Just like APG Group, it is important to mention that APG AM does have many risks (these are documented in the ICAAP: Internal Capital Adequacy Assessment Process). However, these risks are not important in the context of the Solvency II risk modules. Nonetheless, when trying to compute the SCR it would be wise to take into account all the relevant risks for APG AM.

To compute the SCR for APG AM, APG can use the method prescribed in MiFiD as a basis for the SCR computation. MiFiD, which stands for "Markets in financial instruments directive", is an European Law for investment firms (Casey and Lannoo, 2009). Similar to Solvency II, regulators requires firms under MiFiD to report capital requirements. This is based on the Capital Requirements Regulation (CRR) and the Capital Requirements Directive IV (CRD IV). Both regulations are a continuation of the Basel III accord, which is a risk oriented supervisory framework for banking (Masera, 2014). Since APG AM is subject to MiFiD and also computes a capital charge for MiFiD, which takes into account all the relevant risks for APG AM, the same method can be applied for the SCR computation. The current procedure for the measurement of the capital charge (SCR in Solvency II) for APG AM is depicted in equation 3.1.

$$SCR_{AM} = \max \left(\text{CurrencyRisk} + \text{CreditRisk}, FOR \right) + \text{SafetyCapital} \quad (3.1)$$

The method takes the maximum of the capital requirement computed by the Fixed Overhead Requirement (FOR) or the capital charge for each relevant risk within APG AM (in the case of APG AM that will be currency and credit risk) plus an additional capital for safety purposes, which is set by the board of directors. The FOR method determines a capital requirement by taking 25% of the fixed costs from the previous year and subtracting several discretionary deductibles, such as variable bonuses (European Banking Authority, 2014). These are deductible, because

the management may discard these costs at any time. Instead of taking the fixed costs, one can also take the total costs. APG AM takes the total costs.

The currency risk defined as potential effects of currency fluctuations on profit and equity also requires a capital charge. A capital charge for currency risk is required, because APG is exposed to currency risk from financing local activities at the locations in USA and Asia (called APG USA and APG Asia respectively) as well as invoices in foreign currency. The credit risk exposure for APG AM results mainly from bank and client receivables as a result of managing their assets. [REDACTED]

The described method above is currently used within APG AM. However, this method may change in the future due to an application submission for AIFMD. The AIFMD, which stands for Alternative Investment Fund Managers Directive, is a European Union regulation that applies to hedge funds, private equity funds and real estate funds (Hoekstra, 2012). Capital requirements are also required in this context. Equation 3.2 can be used for the computation of the SCR when AIFMD rules are followed instead of MiFiD rules.

$$SCR_{AM} = \max \left(\min \left(10; 0.125 + \max ((AuM - 250) * 0, 02\%; 0) \right); FOR \right) + 0.01\% * AuM \quad (3.2)$$

In short, the capital charge consist of the maximum of FOR and a minimum starting capital of 125.000 EURO (0.125 million) plus a capital that is dependent on the AuM (DNB, 2015). The latter is capped at 10 million, meaning that if $FOR > 10million$ the FOR is leading for the SCR. However, notice that there is still additional capital above the FOR that is dependent on the AuM. This addition is only required if APG does not insure their profession related liability.

APG Rechtenbeheer, APG Diensten and APG Deelnemingen

Unlike Loyalis with Solvency II and APG AM with MiFiD, the business units APG RB, APG Diensten and APG Deelnemingen are not subject to any individual supervision. As mentioned before, these business units result into an exposure to equity risk for APG since the equity value may negatively change due to adverse events. To determine the capital charge for equity value, one applies a standard shock of 22% to the equity (own funds) of the business unit (DNB, 2017). This is depicted in the following set of equations:

$$SCREquity_{RB} = OwnFunds_{RB} * 22\% \quad (3.3)$$

$$SCREquity_{Diensten} = OwnFunds_{Diensten} * 22\% \quad (3.4)$$

$$SCREquity_{Deelnemingen} = OwnFunds_{Deelnemingen} * 22\% \quad (3.5)$$

This approach is possible, because the business units are a single line item ("strategische deelneming" in Dutch) on the balance sheet. If this was not the case, a shock of 39% for equity risk type I (equity in regulated markets in the European Economic Area or the "Organisation for Economic Co-operation and Development countries") or a shock of 49% for equity risk type II (equity in emerging countries, unlisted

shares and any other similar equities not related to equity type I) must be applied (DNB, 2017). The more risky the equity, the higher the applied shock and the higher the capital charge. All percentages are standard shocks determined by the supervisor and are calibrated using historical data.

Rest of the group

The final SCR required to be computed is the counter party default risk for the rest of the group. This exposure is a result of receivables still needed to be collected as well as bank deposits. The counter party default risk can be grouped in several categories. As in equity, the more risky the counter party, the higher the applied shock. The following equation can be used to determine the counter party default risk:

$$SCR_{CounterpartyAPG} = \sum_{i=1}^k \left(Claim_i * Shock_i \right) \quad (3.6)$$

With $i = 1, 2, \dots, k$ the type of claim as shown in Table 3.4.

Type of counter party	Shock
Claims third parties (normal debtors)	15%
Claims third parties (longer than 3 months)	90%
Claims type I (banks)	5%
Claims type II (claims on customers)	15%
Claims on related parties	0%

TABLE 3.4: The shock in percentage for each type of claim.

At the moment, APG Group is only exposed to type I and claims of third parties (normal debtors). Both are depicted in the balance sheet in Table 3.3 in the *current assets*. According to the notes in the annual report of 2016, the *receivables and prepayments* mainly consist of receivables from group companies with a duration of less than 1 year and the *cash* item contains bank balances in current account and deposits (APG, 2016). The former are claims of normal debtors and the latter are claims of banks (type I).

3.4 Conclusion

In this chapter the following two research questions were answered:

RQ (2): What are the most important characteristics of the business units within APG Group?

APG AM's most important business characteristic is the AuM in general and how this AuM develops over time in specific. Key aspects are the return on AuM, the inflow and the outflow of AuM. The most important client both in terms of revenue and assets under management of APG is ABP. It will be financial disastrous when ABP decides to leave as customer. However, it is not to be expected that this scenario may occur, since ABP is also 92.16% shareholder of APG. [REDACTED]

The key characteristic for APG RB are the participants. These participants consist of active participants, sleepers and pensioners. APG RB receives revenue based on the active participants and pensioners. APG Diensten is solely for supporting the other business units. Other business units within APG pay revenue to APG Diensten for the supporting ICT and facility services. APG Deelnemingen is focused on innovation. APG RB, APG Diensten and APG Deelnemingen are relative small compared to Loyalis and APG AM in terms of solvency balance value. This points at the importance of both Loyalis and APG AM with regard to Solvency II riskiness.

RQ (3): What risks are APG Group susceptible to in the context of ORSA?

To understand the risks that APG is susceptible to, one should examine each individual business unit of the group. For the assessment of the business units, one can make the distinction between business units that are under supervision of regulators and those business units that or not. The former consists of Loyalis and APG AM which are subject to respectively Solvency II and MiFiD. The same risk assessments and capital requirement computations in those regulations can be applied for the examination of the risks for these business units in the ORSA. In a nutshell, Loyalis determines their capital requirement per risk module for (1) market, (2) counter-party default, (3) life underwriting, (4) non-life underwriting, (5) health underwriting and (6) operational risk. These risk modules are then aggregated using the standard aggregation formula of Solvency II. APG AM determines their capital requirement by the higher amount of (1) the fixed overhead requirement (25% of the total cost over the past year) or (2) the identified risks using CRR / CRD IV (which is credit risk and currency risk). In practice, the fixed overhead requirement results in a substantially higher amount [REDACTED].

As a group APG is susceptible to equity risk, interest rate risk and counter-party default risk. APG is exposed to equity risk, since the equity value of the strategic participations (APG RB, Diensten and Deelnemingen) may decline due to adverse events. Interest rate risk is also relevant since APG has provision related to the pensions of APG's own employees. When interest rates go down, more capital should be set aside to meet these future obligations (the pensions for the employees), which increases the provision. Last but not least, APG is exposed to counter-party default risk as a result of receivables and capital at bank accounts.

Chapter 4

Model outline

The chapter starts with an introduction of the requirements, scope, constraints and the required data input of the model. This is followed by a discussion about the chosen KPIs for the model. Afterwards, the model design will be elaborated in more detail starting with the KPI functions. The final part of this chapter is dedicated to the management actions.

4.1 Requirements

The goal of the research is to develop a model that can satisfy the following three requirements:

1. The model should be able to evaluate the impact of an ORSA scenario on the financial stability KPIs of APG Group.
2. The model should take management actions into account. If a management action is taken, it should be possible to implement this into the model so that the effect can be measured in terms of the KPIs.
3. The model should be flexible both in terms of assessing a broad range of possible scenarios as well as being flexible to use since the scenario assessment is required every year for the ORSA.

4.2 Scope and constraints

It is important to determine to what extent APG will be modeled, since it will not be feasible to model the entire company. Therefore, the following scope and constraints were determined:

Scope

- The aim is to assess the financial impact of the scenarios on APG at group level. Impact on non-financial aspects of the company are included in the ORSA of APG but not in the model.
- Loyalis will not be modeled from scratch, since Loyalis has its own tools for the computation of the SCR, solvency ratio and results. Instead, the model developed in this research will be complementary to the existing model of Loyalis. It will be like an extra layer on top of the model of Loyalis. This means that the developed model uses the output of the model of Loyalis as input for its own model.

- Management actions will be defined by the management and not by the author of this research. However, to test the model for requirement (2) hypothetical management actions will be taken into consideration.
- When macro economic variables are deemed relevant, only the impact resulting from the change with respect to that variable will be considered. The modeling of the variable itself will not be examined.
- The model will not look at the effect of scenario's on pension funds. Obviously, interest rates may have a negative impact on coverage ratio's of a pension fund. However, this risk is purely accountable to pension funds, because APG is merely executing the decisions made by the pension funds.

Constraints

- The model should follow the business plans as closely as possible. APG's business plan is envisioned in the base case scenario.
- According to the guidelines, the ORSA time period should be at least three years but not more than five years. In this research a time period of five years will be considered, because with a longer time horizon there is a higher probability of an event happening that can damage the company substantially.

4.3 Data input

For the model developed in this research (from heron referred to as APG model) itself three datasets are required. The first dataset required is the business plans of APG Group and the individual business units. These business plans gives a forecast of APG's most important financial data such as profit, costs and FTE's for a time period of three years. The business plan cycle always starts before conducting the ORSA. Therefore, the data of the business plans is always available for the ORSA. Secondly, the market value balance sheet of APG Group is required in order to start the solvency computations. This data is readily available since APG regularly report their solvency requirement to supervisors. The final set of data comes from Loyalis. More specifically, one requires the result before taxes, total operational costs, capital charge for each risk module and own funds. These data can be found either in the business plan or ORSA of Loyalis. The latter is done before the ORSA of APG Group.

4.4 Chosen KPIs

The KPIs that are deemed relevant for APG's risk profile and subsequently suitable as output for the model are as follows:

- **Profit and loss**

APG does not aim for profit maximization. Its main objective is to generate returns so that pension funds can provide sufficient pensions for people in the Netherlands. Nevertheless, operating with a negative bottom line is never a sustainable business practice and financially not healthy. This is also reflected by the strategy of APG, namely to maximize pension value for participants in the pension scheme of pension funds under the condition of financial health. Thus, a negative bottom line should be avoided. With the KPI profit and loss,

APG will be able to monitor the financial health. With an overview of both revenues and costs, APG will know if their business practice is sustainable for a particular scenario. Moreover, by showing the profit and loss statement of the business units, one can also see a more specified indication as to where the financial problem lies when an adverse scenario materializes.

- **Pension funds under management**

The pension funds under management are the clientele of APG. The clientele is of utmost importance for APG. Firstly, without pension funds there are no participants, meaning that APG cannot apply their strategy to maximize the pension value for the participants. Secondly, the customers are the main source of income for APG and thus necessary if one requires to maintain its financial health.

- **Assets under management**

As mentioned, the goal of APG is to maximize pension value for participants under the condition of financial health. To maximize pension value, APG requires a high net return on investments. The amount of investments is called the assets under management. The higher this metric, the more pension could be disbursed to participants. Also, APG receives a fee based on this metric, thus a higher assets under management is also beneficial for APG from a financial standpoint.

- **Participants**

The foregoing discussion shows that participants are at the heart of the strategy of APG. Thus, it is not surprising that the number of participants is relevant as a KPI for APG.

- **Full time equivalent**

The personnel costs are by far the largest cost item of APG. This cost item is largely driven by the FTEs. It is therefore important to understand how these FTEs develop as it will largely determine the operational costs of APG

- **SCR, own funds and solvency ratio**

These solvency KPIs are mandatory by the DNB. The importance of these KPIs were already elaborated in detail in chapter 2 and 3. In summary, the SCR shows how much capital is required to protect itself against (1) market, (2) counter-party, (3) life underwriting, (4) non-life underwriting, (5) health underwriting and (6) operational risk. The own funds is the actual capital buffer within the company. The solvency ratio is the ratio between own funds and SCR. When this metric falls below the 100% threshold, it means that APG does not have a sufficient buffer to protect itself against adverse events.

4.5 Strategic KPI functions

To satisfy the first requirement of the APG model, the KPI's will be expressed as a function of the risk drivers. These risk drivers are the variables that are going to be shocked by a scenario. When the risk drivers change in value, the KPI will also change in value. In this way the KPI's can be calculated for each scenario. In the APG model, the model users themselves are required to estimate the risk drivers.

4.5.1 Assets under management

The AuM is driven by the investment performance and the inflow and outflow of AuM of each client of APG. The inflow increases with the premiums received and also when new clients or new assets are acquired, whereas the outflow increases when clients leave or if there are any withdrawals of capital. The investment performance depends on the macro-economic environment as well as the portfolio mix making it very difficult, even impossible, to predict accurately. The following function expresses the total assets under management for a particular year:

$$TotalAuM_T = \sum_{k=1}^w \left((AuM_{(T-1),k}) * (1 + r_{a,T}) + \Delta AuM_{(T,k)} * (1 + \frac{1}{2}r_{a,T}) \right) \quad (4.1)$$

Where:

- $r_{a,T}$ = average return on AuM during year T
- $\Delta AuM_{(T,k)}$ = change in AuM for a customer k during year T (where client k = 1,2... w)

The first risk driver $r_{a,T}$ is the return on the AuM. The return could be positive (higher return) or negative (lower return) depending on the scenario. No distinction is made between different asset classes and one single return for all asset classes and customers is assumed. Otherwise, lots of assumptions are required. For instance, each building block has a different return, which requires an estimation of the return per building block and this applies for every client. For 5 clients and 12 building blocks, 60 estimations are required, which is quite inefficient to do. Furthermore, it is questionable whether model users can predict these return accurately. Of course, for simplification purposes the building blocks could also be categorized in equity, fixed income and cash. However, it is still difficult to estimate the return for this portfolio mix, since each category consist of multiple subcategories (fixed income: has index linked debt, treasuries etc). Additionally, correlation effects also need to be taken into account between the portfolio building blocks, which complicates the estimations even more. That is why the preference is given to a single guesstimate of the AuM return, rather than a complicated computation of AuM return. One can estimate the AuM return on the basis of historical AuM return, which are depicted in the annual reports of APG. For an overview of the average return, please refer to appendix C.

The second risk driver is the change of AuM in a particular year, which accounts for the adding or withdrawal of capital by pension funds by either new pension funds or the departure of old pension funds. The inflow and outflow also includes received premiums from participant in the pension funds and the payments to the pensioners. The reason a distinction is made between customers, is so that one can easily see the effect of a removal of a (important) customer, such as ABP.

4.5.2 Participants

The total number of participants in a year is the sum of the participants for each client i. The participants for each client i consists of active participants, sleepers and pensioners. During each year there could be inflow and outflow of participants as shown in chapter 3 paragraph 3.1.2. This is mathematically depicted in the following expression:

$$\begin{aligned}
TotalParticipants_T &= \sum_{i=1}^n (Active_{(T-1,i)} + \Delta Active_{(T,i)}) + \\
&\sum_{i=1}^n (Sleepers_{(T-1,i)} + \Delta Sleepers_{(T,i)}) + \sum_{i=1}^n (Pensioners_{(T-1,i)} + \Delta Pensioners_{(T,i)})
\end{aligned} \tag{4.2}$$

Where:

- $Active_{(T,i)}$ = active participants in a pension fund i during year T (where pension fund $i = 1, 2, \dots, n$).
- $\Delta Active_{(T,i)}$ = change in active participants in a pension fund i during year T (where pension fund $i = 1, 2, \dots, n$).
- $Sleepers_{(T,i)}$ = deferred (or sleeping) participants in a pension fund i during year T (where pension fund $i = 1, 2, \dots, n$).
- $\Delta Sleepers_{(T,i)}$ = change in deferred (or sleeping) participants in a pension fund i during year T (where pension fund $i = 1, 2, \dots, n$).
- $Pensioners_{(T,i)}$ = pensioners in a pension fund i during year T (where pension fund $i = 1, 2, \dots, n$).
- $\Delta Pensioners_{(T,i)}$ = change in pensioners in a pension fund i during year T (where pension fund $i = 1, 2, \dots, n$).

The participants for each pension funds consists of active and deferred participants as well as pensioners. For the participant KPI the distinction is not necessary. However, the distinction is made because the revenue of APG Rechtenbeheer depends on the number of active participants and pensioners. A pension fund is only required to pay to APG for these types of participants. Also, for APG it does not matter if one is an active participant or a pensioner since both pays the same amount.

The risk drivers for the participants KPI are the change of active participants, sleepers and pensioners during a year T as a result of inflow and outflow.

4.5.3 Employees

The total number of FTE is driven by the number of FTE's and the inflow and outflow of FTE for each business unit within APG:

$$TotalFTE_T = \sum_{j=1}^m \left(FTE_{T-1,j} + \Delta FTE_{(T,j)} \right) \tag{4.3}$$

Where:

- $FTE_{T,j}$ = the full time equivalents of business unit j during year T (where business unit $j = 1, 2, \dots, m$).
- $\Delta FTE_{(T,j)}$ = change of full time equivalents of business unit j during year T (where business unit $j = 1, 2, \dots, m$).

4.5.4 Profit and loss statement

The (P&L) KPI, also referred as the income statement, provides an overview of the profit earned over a specific period of time. Two aspects are relevant for the APG model: the revenues and costs KPI. This is shown in equation 4.4:

$$Result_T = \sum_{j=1}^m \left(Revenue_{T,j} - Costs_{T,j} \right) \quad (4.4)$$

Where:

- $Revenue_{T,j}$ = the revenue of business unit j at time T (where business unit $j = 1, 2, \dots, m$).
- $Costs_{T,j}$ = the costs of business unit j at time T (where business unit $j = 1, 2, \dots, m$).

APG is interested in the total revenue and costs for the group as a whole. However, for this research the revenues and costs will also be split per business unit. The reason is twofold. Firstly, it gives a more specified indication as to where the problem lies when a scenario materializes. Secondly, the ORSA and the business plan should be aligned with each other. Since the business plans of APG follows the business unit structure, the same structure will be used. The revenue and cost structure will follow the business plans of APG as closely as possible. However, an important note should be mentioned regarding one revenue (internal revenue) and one cost (allocated costs) component. Internal revenue of one business unit is the allocated cost (called "doorbelaste kosten" in Dutch) for another business unit. This means that the following equation must be satisfied in the APG model:

$$TotalInternalRevenue_T = TotalAllocatedCosts_T \quad (4.5)$$

Therefore, when total internal revenue increases by $X\%$ amount, total allocated costs will also increase by the same amount and vice versa. This means that both components can be omitted from the model without a change in the total profit of APG. However, in this model this will not be omitted. The reason pertains to the computation of the own fund of APG Rechtenbeheer, APG Diensten and APG Deelnemingen as well as the capital requirement for APG AM, which will be elaborated in the next section. For now it is important to know that an estimation of the current assets are required in order to estimate the own funds. This estimation is done through the total profit cash flow of the business unit, and requires both the total revenue and costs cash flows with the allocated costs. If one omits these costs, the profit gets artificially inflated resulting in an erroneous view of the "real" profit. As a result, the own funds estimations will be in discord. In the next sub paragraphs the revenue and costs for each business unit will be elaborated.

4.5.5 Revenue APG Asset Management

Equation 4.6 computes the revenue of APG Asset Management. This revenue is earned as a result of managing investments on behalf of their clients.

$$RevenueAM_T = Lump_{T,abp} + \left(\sum_{k=1}^w (AuM_{T,k}) - AuM_{T,abp} \right) * Fee_{T,k} \quad (4.6)$$

Where:

- $Lump_{T,abp}$ = lump sum fee of client ABP during year T
- $AuM_{T,k}$ = assets under management for a client k during year T (where client $k = 1, 2, \dots, w$)
- $AuM_{T,abp}$ = assets under management for client ABP during year T
- $Fee_{T,k}$ = the fee for any other client minus ABP during year T (where client $k = 1, 2, \dots, w$)

The revenue of APG Asset Management consist of a fixed lump sum fee of the client ABP and a fixed fee as a basis point of the AuM for the rest of the clients. For the latter the same fixed fee is assumed. The revenue that comes from ABP does not depend on the assets under management. As a result, there is not much earning volatility, which is a good case for APG, since ABP is the biggest customer in terms of revenue (around 70% in 2017). Thus, there are two risk drivers relevant for computing the revenue, the fixed lump sum fee as well as the fixed fee as a percentage of the AuM.

4.5.6 Revenue APG Rechtenbeheer

The following equation computes the revenue earned for APG Rechtenbeheer as a result of pension administration, pension communication and other services:

$$Revenue_{RB_T} = \sum_{k=1}^m \left(Active_{T,k} + Pensioners_{T,k} \right) * \left(\frac{Tariff}{Participant} \right)_{T,k} \quad (4.7)$$

Where:

- $Active_{T,k}$ = active participants in pension fund k during year T (where pension fund $k = 1, 2, \dots, m$).
- $Pensioners_{T,k}$ = pensioners in pension fund k during year T (where pension fund $k = 1, 2, \dots, m$).
- $\frac{Tariff}{Participant}_{T,k}$ = tariff per participant for pension fund k during year T (where pension fund $k = 1, 2, \dots, m$).

Pension funds are required to pay a fee to APG only for the active participants and pensioners within the pension fund.

4.5.7 Revenue APG Deelnemingen

The business unit APG Deelnemingen is quite small relative to the rest of the company. In terms of revenue and solvency balance sheet value in 2017 it was respectively merely 3,6% and 0.22%. Therefore, no risk drivers are identified and the assumption is made that the revenue grows with X% depending on a scenario:

$$Revenue_{Deelnemingen_T} = Revenue_{Deelnemingen_{T-1}} * (1 + X_T) \quad (4.8)$$

4.5.8 Revenue APG Diensten

The revenue of APG Diensten consists of the sum of the allocated costs that APG AM, APG RB, APG Deelnemingen expenses for ICT and Facility services:

$$RevenueDiensten_T = \sum_{j=1}^m \left(AllocatedCostsICT_{T,j} + AllocatedCostsFS_{T,j} \right) \quad (4.9)$$

Where:

- $AllocatedCostsICT_{T,j}$ = allocated costs to ICT for business unit j during year T (where business unit j = 1,2... m).
- $AllocatedCostsFS_{T,j}$ = allocated costs to Facility Services for business unit j during year T (where business unit j = 1,2... m).

4.5.9 Costs

The costs are also an important KPI for APG. The costs throughout the organization of APG are categorized by Group Finance into several categories. Each of these categories are grouped into several other sub categories. This is illustrated in appendix B. The same cost categories can be used for this research. In the same way as the revenues, the costs will also be split per business unit.

This research will use risk drivers to determine how the costs develop per scenario. One risk driver will be identified per cost category. When a scenario materializes the risk factor will get shocked, and this changes the value of the costs. The risk drivers that were chosen are depicted in Table 4.1. The risk drivers are based on the theory of traditional volume-based costing systems (Balakrishnan, Labro, and Sivaramakrishnan, 2011), meaning the costs are linear dependent on the volume of the driver.

Costs	Risk driver
Staff	Internal FTE & average salary/FTE
Automation	Estimated directly
Outsourced primary process	External FTE
Housing	FTE and fixed
Allocated	FTE
Non-operational	None (fixed Y% growth)

TABLE 4.1: Risk drivers for the cost KPI.

There is a distinction between the internal FTE, the workers of APG itself and external FTE, which are employees from outside of APG. For the staff costs the internal FTE is used as a risk driver. More FTE means more staff costs. More specifically, the staff costs are determined by an average salary costs per FTE and the FTE. The reason an average salary cost is used is because an average salary cost is straightforward to relate to a scenario. For example, a scenario with a scarcity of knowledgeable employees results in a higher salary when these knowledgeable employees are being employed.

The automation costs does not have a risk driver. These costs are directly estimated in the APG model per scenario, since there is no driver that can predict how many ICT related investments one must do. For the outsourced primary process, it is assumed that the external FTE drives these costs. Housing costs are business-unit specific. Each business unit has a different type of housing costs. The housing costs for APG AM depends solely on catering costs which depend on the cost driver FTE, whereas the housing costs of APG Diensten consist of mainly rent costs which are fixed in nature. Allocated costs are driven by FTE. This is also the way Group Finance is allocating costs to business units. Finally, non-operational costs are assumed to follow a fixed Y% growth. That is because non-operational costs are not related to operational activities.

4.6 Solvency KPI functions

The SCR of APG Group will be computed using the following formula:

$$SCR_{Group_T} = (SCR_{Loyalis_T} + SCR_{AM_T} + SCR_{Market_T} + SCR_{Counterparty_T}) - Diversification \quad (4.10)$$

Equation 4.10 consist of several components. The first component is *SCR_{Loyalis}*. This component will not be estimated in the APG model. Instead, the SCR will be computed by Loyalis using their existing models and the result will be used as input for the APG model. The second component corresponds to the capital requirement of APG AM and is computed using equation 4.11:

$$SCR_{AM_T} = (TotalCosts_{AM_{T-1}} * 0.25\%) - DiscretionaryDeductibles_{T-1} \quad (4.11)$$

The equation follows the FOR method, since in practice this capital charge is much bigger than the combined capital charge of credit risk and currency risk (see chapter 3). The FOR method requires the estimation of the total costs of APG AM of the previous year. Since the costs will change depending on a scenario, the link between scenarios and the SCR of APG AM is established. Notice, that the total costs are required. This shows that estimating the allocated costs was imperative, otherwise the estimation of total costs for APG AM would be artificially lower resulting in an erroneous capital charge. Another important note is that *SCR_{AM}* is equal to the MiFiD value, which is equal to the market value of the own funds of APG AM. The importance of this will be elaborated later on.

The third component in equation 4.10 is market risk and is computed in the APG model using equation 4.12.

$$SCR_{Market_T} = SCR_{Equity_T} + SCR_{InterestRate_T} \quad (4.12)$$

To estimate the equity risk, one should estimate and sum the own funds of the strategic participations APG RB, Diensten and Deelnemingen and multiply this with the strategic participation shock as outlined in Solvency II (see equation 4.13).

$$SCR_{Equity_T} = (OwnFund_{RB_T} + OwnFund_{Diensten_T} + OwnFund_{Deelnemingen_T}) * 22\% \quad (4.13)$$

The strategic participation shock of 22% is lower than the shock of equity risk type I or type II (see paragraph 3.3.2), meaning that strategic participations are not deemed as risky in the Solvency regime. This is quite intuitive and in accordance with the analysis in the previous chapter. The pension administration services that APG RB provide, is not that risky in the context of the insurance focused Solvency regime. APG Diensten is a supporting unit and APG Deelnemingen is a relative small business unit compared with the rest, so both are also not risky in Solvency II.

To compute the market value of the own funds (equity) of these participation, one can use accounting principles, namely subtracting the market value of liabilities from the market value of the assets. This means that for the business units APG RB, Diensten and Deelnemingen both assets and liabilities needs to be estimated for the computation of the equity risk for these strategic participations. Notice, that three individual balance sheets are required, and not the standalone balance sheet of APG discussed in chapter 3. Also, notice that the market value of the balance sheets are required. For APG, the latter is accounting related. There are various rules in Solvency II with respect to the transformation of non-market value balance sheet items to the market value items. For example, goodwill and software are both omitted from the market value. The own fund can then be estimated using equation 4.14 for APG RB, APG Diensten and APG Deelnemingen:

$$Ownfunds_T = TotalAssets_T - TotalLiabilities_T \quad (4.14)$$

The link between the P&L and the balance sheet comes mainly from the *Profit* or *Loss* item. This item will increase (decrease) depending on the ORSA scenario with the profit (loss) of respectively APG RB, Diensten or Deelnemingen. This is shown in equation 4.15.

$$Ownfunds_T = Ownfunds_{T-1} + ProfitOrLoss_T \quad (4.15)$$

Next, to equity risk, interest rate risk is also a relevant risk for APG. This is because APG got provisions for the pensions of APG's own employees, which is exposed to changes in the interest rate. Therefore a capital requirement is needed, albeit the capital charge for this risk is quite low. APG itself finds the interest rate risk negligible, therefore it omits it from the calculation. However for completeness sake, the interest rate risk will be computed. To determine the interest rate risk of APG, the set of equations 4.16 and 4.17 are used. The capital requirement for interest rate risk is determined by calculating the impact on the available capital (assets minus liabilities) in the event of changes in the interest rate curve. The largest loss of capital after an upward shock or a downward shock of the yield curve determines the interest rate risk. The cash flows for the unshocked and shocked scenarios are the same, only the curve for discounting changes. The upward and downward shocks are fixed percentage changes to the unshocked yield curve and specified by EIOPA.

$$SCRInterestRate_T = \max \left(UpwardShock_T - Unshocked_T; DownwardShock_T - Unshocked_T \right) \quad (4.16)$$

$$\begin{aligned}
Unshocked_T &= \sum_{t=1}^{90} \left(\frac{CF_{(A,t)} - CF_{(L,t)}}{(1 + r_t)^t} \right) \\
UpwardShock_T &= \sum_{t=1}^{90} \left(\frac{CF_{(A,t)} - CF_{(L,t)}}{((1 + (1 + S_{up,t})r_t)^t)} \right) \\
DownwardShock_T &= \sum_{t=1}^{90} \left(\frac{CF_{(A,t)} - CF_{(L,t)}}{((1 + (1 + S_{down,t})r_t)^t)} \right)
\end{aligned} \tag{4.17}$$

Where:

- $CF_{(A,t)}$ = cash flow resulting from interest rate sensitive assets in year t .
- $CF_{(L,t)}$ = cash flow resulting from interest rate sensitive liabilities in year t .
- r_t = interest rate with maturity t . The interest rate follows from the interest rate term structure or yield curve.
- $S_{up,t}$ = upward shock as determined by Solvency II. Where $S_{up,t} > 0$
- $S_{down,t}$ = downward shock as determined by Solvency II. Where $S_{down,t} < 0$

Here, it is important to take into account the standalone balance sheet of APG Group, because it involves the provision of the whole group. Since, APG does not have any risk sensitive assets as a group (see chapter 3), all cash flows from assets can be omitted. Also, notice from the equation that the interest rates are required for a time period of $t = 1$ to $t = 90$. This means a yield curve is required. For the yield curve of a scenario, the assumption is made that the yield curve in the scenario is the same as the one from the current day multiplied with a certain shock of $X\%$ on the curve depending on the scenario. The current interest rate curve can be built by merging the Euribor short term rates and the long term swap rates, and fit the rates in between by linear interpolating while taking into account the day count convention.

The discounting of the cash flows can actually be done with more precision by making use of a zero coupon yield curve instead of the yield curve derived from Euribor and the swap rates. To illustrate this with an example, let's suppose one discounts the cash flows in year four with the interest rate in year four derived from the Euribor and swap rates yield curve. As a consequence, one is not actually discounting with an interest rate in year four, but actually with an interest rate for an interest rate instrument with a duration of four years. Thus, using a zero coupon yield curve is preferred. Since, the market for zero coupons are highly illiquid, one must perform bootstrapping in order to derive a zero coupon yield curve. However, in this research this will not be performed and instead the yield curve derived from the Euribor and swap rates will be used.

Another risk that may arise is credit default risk. To determine which type of credit default risk APG is exposed to, one should consult both the standalone balance sheet in Table 3.3 and the type of counter party in Table 3.4. From the tables, one can see that APG is exposed to credit default risk type I (banks) due to *cash* and credit default risk claims on normal debtors due to *receivables and prepayments*. It is assumed that *cash* changes with the total profit (loss) of APG Group, for *receivables*

and prepayments an assumption is made that it will grow with a certain $X\%$ depending on the ORSA scenario. The counter party default risk can then be calculated using the following formula:

$$SCR_{CounterpartyAPG} = \sum_{i=1}^k \left(Claim_i * Shock_i \right) = Claim_{typeI} * 5\% + Claim_{normal} * 15\% \quad (4.18)$$

To have consistency in the balance sheet it is important that the balance sheet item *FinancialFixedAsset* of APG Group consist of the sum of own funds for all business units. Therefore the following equation needs to be satisfied:

$$\begin{aligned} FinancialFixedAsset_T &= OwnFundsAM_T + OwnFundsRB_T \\ &+ OwnFundsDiensten_T + OwnFundsDeelnemingen_T + OwnFundsLoyalis_T \end{aligned} \quad (4.19)$$

The own funds of APG RB, Diensten and Deelnemingen were already estimated using equation 4.14. Thus, only the own funds of APG AM and Loyalis are required. The former is straightforward to compute. Recall that the SCR AM is equal to the MiFiD value. The MiFiD value is equal to the market value of the own funds therefore it also equal to the SCR AM (see equation 4.20. Thus, it is not necessary to estimate the whole balance sheet of APG AM. The own fund of Loyalis is one of the output of the models of Loyalis itself.

$$OwnFundsAM_T = MiFiDValue_T = SCRAM_T \quad (4.20)$$

Finally, there is also a diversification benefit component in equation 4.10. Diversification advantages arise due to the addition of APG Group to the supervisory Solvency II regime of the DNB. This addition changes the proportions of the different risks within the group, resulting in less overall risk and capital charge. Through equation 4.21 the total diversification benefits can be estimated.

$$\begin{aligned} Diversification &= \left(\sum_{i=1}^5 SCR_{i,(APG+L)} - \sqrt{\sum_{i=1}^5 \sum_{j=1}^5 \rho_{ij} * SCR_{i,(APG+L)} * SCR_{j,(APG+L)}} \right) \\ &- \left(\sum_{i=1}^5 SCR_{i,L} - \sqrt{\sum_{i=1}^5 \sum_{j=1}^5 \rho_{ij} * SCR_{i,L} * SCR_{j,L}} \right) \end{aligned} \quad (4.21)$$

Where i and j are respectively (1) market risk, (2) credit default risk, (3) life underwriting risk, (4) health underwriting risk and (5) non-life underwriting risk. Moreover APG and L stands for APG Group and Loyalis respectively. To determine the diversification, one requires the SCR of the risk modules of both Loyalis and APG Group. From here, the diversification effect of Loyalis is computed as well as the diversification effect of Loyalis plus APG Group. Now the diversification benefit is computed by subtracting the diversification effect from Loyalis from the diversification effect of Loyalis plus APG Group.

4.8 Conclusion

The following research question was answered in this chapter:

RQ (4): What are the risk drivers for the financial stability KPIs?

In this chapter the strategic and solvency KPI functions were derived and discussed thoroughly in terms of risk drivers. Moreover, the interrelationships between risk drivers and KPIs were elaborated. The resulting risk drivers are summarized in Table 4.2. These risk drivers are used to depict APG in a model. Whenever the risk drivers change in value, the KPIs will change in value and subsequently the financial stability of APG can be assessed. Now the question to be asked, is how the risk drivers are changing in value, and if they change to what particular value will it change? These questions and more will be answered in the next chapter, which will focus on the scenario building.

Risk drivers per KPI
Assets under management
r_a
ΔAuM
Participants
$\Delta Active$
$\Delta Sleepers$
$\Delta Pensioners$
FTE
ΔFTE
Revenue
$Lump$
Fee
$Tariff/Participant$
Costs
$AverageSalary/FTE$
$AutomationCosts$
$InvestmentCosts$
$InternalFTE$
$ExternalFTE$
SCR, own funds and solvency ratio
$TotalCostsAM$
$DiscretionaryDeductibles$
$YieldCurve$
$Claim$
$ProfitOrLoss$

TABLE 4.2: Summary of all the risk drivers per KPI for APG identified in this research.

Chapter 5

Scenario building

This chapter focuses on scenario building. The first section will elaborate on why scenario building is imperative. Afterwards, the approach for scenario building will be discussed. In section 5.2 driving forces will be identified. These driving forces act as the first building block for the scenarios. This is followed by section 5.3 which will cover the second building block of the scenarios. Section 5.4 describes a method for bundling these building blocks. This is followed by section 5.5 which examines the quantification method of a scenario. The chapter will conclude with a discussion about the finalized APG scenarios.

5.1 Standardized approach

In the ORSA an examination should take place on a sufficiently wide range of scenarios addressing the most material risks. The ORSA guidelines do not specify how a scenario should be. This gives enormous flexibility to the scenario development of a firm. Given that the risk is material, the scenarios could be anything, ranging from a harmonic European pension system to an explosion of a nuclear power plant. There is virtually an unlimited number of scenarios that could have a major impact on APG. Thus, to make the research more feasible, the scenarios need to be structured in a standardized way. The approach for structuring the scenarios so that it can be assessed in the model is described as follows:

1. Identify driving forces. These are future developments that may impact APG. The driving forces will be the first building block for the scenarios.
2. Determine which risks in APG's key risk framework is addressed. The risks are the second building block for the scenarios.
3. Bundle building block I and II in a specific scenario.
4. Quantify the scenarios by mapping the scenarios to the risk drivers.

The next paragraphs will elaborate on these steps in more detail.

5.2 Building block I: driving forces

The first step in the scenario building process is to identify the factors that fundamentally determine future developments. These factors are called driving forces (Schwartz, 1991). A large number of driving forces were identified during the scenario development process conducted by APG's strategic team in collaboration with Group Risk and Compliance (from heron GRC). However, it is not advisable to stop

with this list of driving forces. New potential driving forces should be determined each year. To illustrate that this is necessary: one would most likely not think of block-chain technology 30 years ago. It would not be a driving force back then as it did not even exist, but it is a driving force at the moment of writing this research. Thus, it is paramount to identify driving forces each year. To identify driving forces, the same method applied by APG's strategic team and GRC could be used. This method was inspired by the SHELL scenario planning method (Schoemaker and Heijden, 1993).

- 1. Organize a brainstorming session**

The brainstorming session should consist of several participants in distinct field areas, such as persons knowledgeable in IT, risk, finance, asset management etc as they might know the relevant developments in their field of work. There were eight participants for the brainstorming session in 2017.

- 2. Together with the participants, determine an initial long list of possible driving forces**

The PESTEL framework is used as the starting point for the identification of possible driving forces (Gillespie, 2007). The framework is often used in strategic management to provide an overview of the macro-environmental factors that need to be taken into consideration when doing an environmental analysis. The PESTEL framework consist of the following areas: **(P)**olitical, **(E)**conomical, **(S)**ociocultural, **(T)**echnological, **(E)**nvironmental and **(L)**egal (Gillespie, 2007). Driving forces are identified for each area. For instance, for the technological area, one could think of block-chain technology, predictive market places, ripple, robotics etc. To stimulate the brainstorming session one can make use of big white boards, flip charts and post-it-notes and just write down on it whatever comes to mind.

- 3. After compiling the initial long list of driving forces, the list should be shortened using a simple scoring system**

Usually, when brainstorming one considers the most unimaginable factors. To make sure that the driving forces are relevant for APG, a simple scoring system can be used. The scoring should be done by the brainstorming group. Each participant scores the driving force using a scale from 0 (not relevant) till 5 (relevant) with only integers. The maximum score of the driving force is 8 ($participants$) $\times 5 = 40$. The driving force will be included in the final list when the score is more than half of the maximum score (>20), otherwise the driving force will be omitted. When scoring one should think about the driving force in terms of possible impact on APG's target group, product, services, business model.

- 4. Determine the driving forces with the most impact on APG using a survey**

After the brainstorming session has ended, all driving forces should be scored in terms of both importance and predictability. To do this one could apply the same survey as used by APG's strategic team and GRC. The survey should be sent to several key stakeholders within APG. There were 37 people for the survey in 2017. The selection criteria is that they need to be key persons in the organization, such as directors of the business units. Essentially, two survey questions need to be answered for each driving force X:

(Q1): Indicate per driving force X how you expect this trend to develop fifteen years in the future.

Driving force X will:

- (a) *Decrease strongly*
- (b) *Decrease limitedly*
- (c) *Stay the same*
- (d) *Increase limitedly*
- (e) *Increase strongly*

(Q2): Determine per driving force X the importance of this trend for APG's business model fifteen years in the future. Think about APG's business model, the role of the value chain, products and services, earnings model and the extent to which APG can remain sustainable. Driving force X is (very) important as soon as driving force X is (very) important in relation to one of the aforementioned areas.

Driving force X will be:

- (a) *Unimportant*
- (b) *Neutral*
- (c) *Important*
- (d) *Very important*

5. The survey results are plotted in an importance versus predictability matrix

The matrix depicted in 5.1 was developed by APG's strategic team. The y-axis relates to the importance of the driving force relative to APG and the x-axis relates to the standard deviation of the survey results of **Q1**. The latter is used as a proxy of the predictability of the driving force. The more people fill in different results for **Q1**, the more unpredictable the driving force is, since there is no general consensus of the development direction.

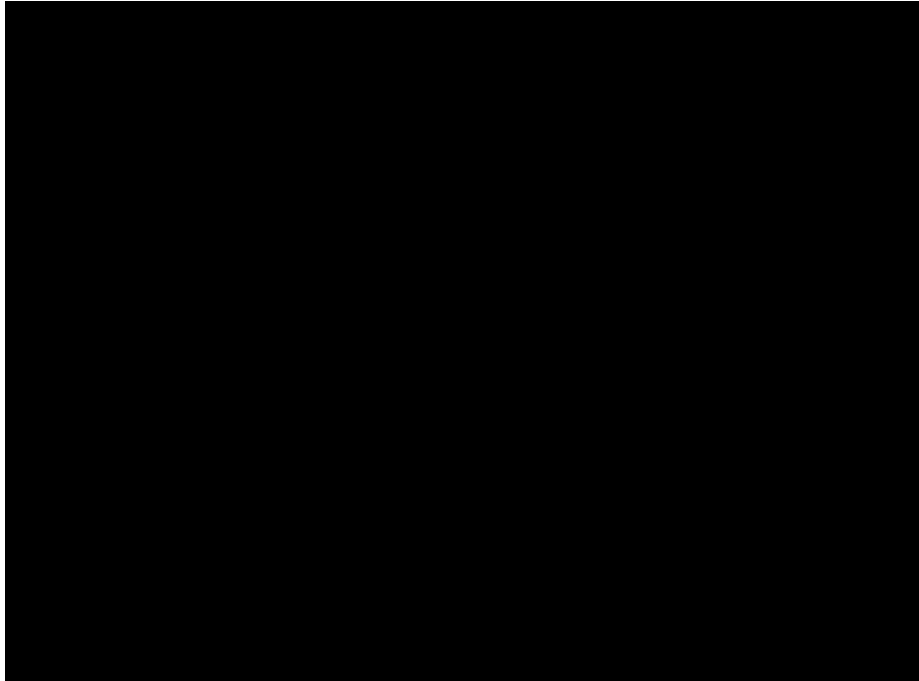


FIGURE 5.1: Mapping driving forces in terms of importance versus deviation (source: APG's strategic team)

6. Choose the final driving forces that are going to be used as building blocks for the scenarios

Driving forces that are in the upper-right quadrant are always included. These driving forces are (very) important for APG according to the participants of the survey. The unimportant driving forces are omitted (the fourth row in the entirety). The choice of including driving forces that are neutral depends on the predictability. The predictable forces (small deviation) are omitted as building blocks.

Finally, the resulting list of driving forces can be used as building blocks for the scenarios of APG. The scenario development conducted by APG's strategic team and GRC actually involved even more steps.

7. Creating scenario framework

In this step a scenario framework is created. The scenario framework is the template depicted in Figure 5.2. The aim is to think about the driving forces and risks in terms of what will happen to the contextual and transactional environment of APG. The former consists of developments in areas that are not influenced by the organization, but which may affect the organization. In other words, it consist of the areas in the PESTEL framework described previously. The transactional environment of APG consists of the parties with which APG maintains contact, which affects APG and which APG can influence themselves. The scenario framework can be created either as an individual or in a group. The latter choice is preferred, especially if the group consist of key stakeholders. In APG's scenario development, the sketches of the scenario framework were actually created in a workshop with several key persons within APG, including the board of directors. To summarize this process, four preliminary drafts of scenarios were created by the strategic team using the

template in Figure 5.2. The participants of the workshops were then able to enrich these frameworks by discussing and writing in them. There was also a blank template in which participants could freely compose anything. The result of the workshop were five completed scenario frameworks (one scenario was omitted by the strategic team in the end, because it had too many overlap with other scenarios).

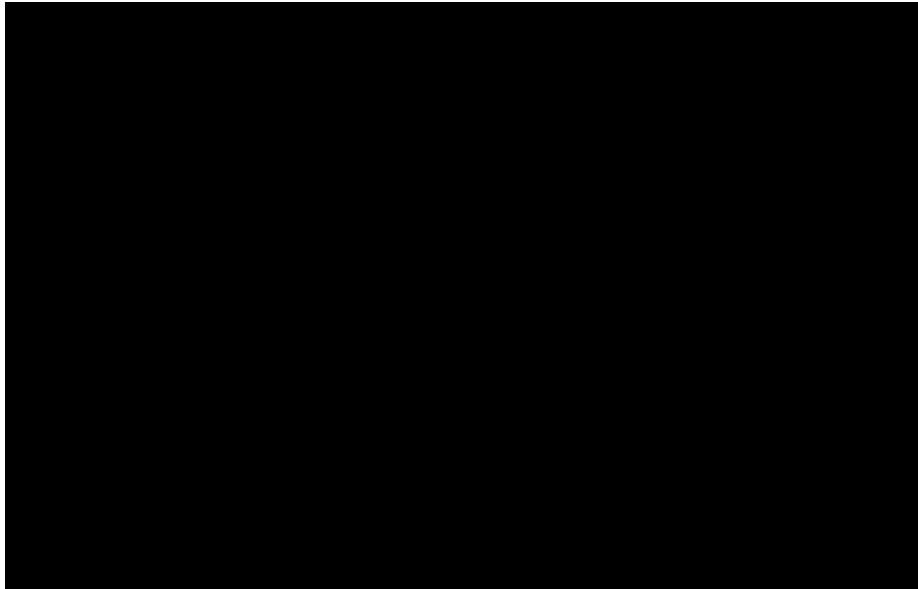


FIGURE 5.2: Scenario framework template consisting of the contextual and transactional environment for each scenario X (source: APG's strategic team)

8. Writing the scenario story

The last step in the scenario development process is to write the scenario framework in story form. Important is to take into consideration all the factors determined in the framework.

For this research, step (6) and (7) will not be used. The reason is that the scenario development conducted by the strategic team is developed from a strategic perspective, whereas the ORSA scenarios should be developed with a more risk oriented mind. Thus in the next paragraph, this risk oriented view will be explored.

5.3 Building block II: key risks

The common theme for all scenarios is that it should address the most important risks for the company. This means that risk is an another perspective for building scenarios. APG has already identified several key risks within the organization. These risks are encapsulated in a framework. This framework is depicted in appendix E. The risks in this framework can be used as the starting point for the scenarios. This means that one decides first which risks need to be addressed and then think about what driving forces will make these risks materialize.

5.4 Bundling building blocks to scenarios

After deriving all the driving forces and risks, scenarios can be created by bundling both building blocks. This approach can be summarized as follows:

1. **Determine which risk in APG's risk framework are addressed for a particular scenario. Try to address multiple risks in one scenario.**

It is important that the scenarios should cover a wide variety of events and risks. The scenario analysis would not be interesting if scenarios addresses the same risks for each scenario. This is because identical risks will probably result in the same financial outcome. For the ORSA, it would be recommended to address multiple risks per scenario.

2. **Decide which driving forces are used to address the risks in the previous step. Try to use multiple driving forces for each scenario**

Deciding which building blocks to use, is just a matter of preference. For example, if one wants to address business model risk, the driving forces (building blocks) "digital innovation" could be relevant but also "block-chain technology" etcetera since all of these driving forces could potentially address business model risk. Just like in the previous step, it is important not to use the same driving forces for a scenario. In particular, one should not assume the same direction in which the driving force develops, as it will most likely result in identical scenarios.

3. **Determine in which direction the driving force develops**

The driving forces could develop in the following ways: (1) strong decrease, (2) limited decrease, (3) stay the same, (4) limited increase and (5) strong increase. Notice that this development direction is also **Q1** in the survey discussed previously. An important difference, however, is that the survey question was more to test how predictable the driving force is according to the survey respondents.

An example of a scenario is:

Example 5.1: Rise of the robotics

Driving forces: digital innovation (*strong increase*), amount of cyber attacks (*limited increase*), impact robotics on labor market (*strong increase*) and growth of number of fintechs (*strong increase*).

Addressed risk: business model risk due to rise of fintechs and adjustment risk as a result of a changing environment with respect to new concepts, automation and big layoffs.

With some creativity, one is then able to design a story around the developed scenario. It is at this point that the scenario design is complete. After determining the scenario, the next step is to assess it quantitatively using the model developed in this research. Therefore, the scenario should be translated into quantifiable units. More specifically, it means that it should be translated in terms of the risk drivers identified in the previous chapter.

5.5 Quantifying scenarios

This is the most challenging step in the scenario building process, since a considerable amount of assumptions is required. For instance, it is difficult to deduce exactly what happens to the return on AuM when X happens and X could be anything ranging from digital innovation to an exponential growth of health technology or both. Thus, ideally the assumptions are based on a consensus of a group. In this section, three approaches will be elaborated for the quantification of the scenarios.

1. The model user does the quantification itself based on intuition

This is the most straightforward solution and is solely based on best guesstimates. For example, the model user can guesstimate by itself that a particular cyber-crime scenario will result in an one-time investment cost of 50 million EURO and subsequently 5 million EURO automation cost each following year to strengthen the ICT infrastructure. All numbers are based on the intuition of the model user. Essentially, the model user only alters the risk drivers in the model.

2. Expert elicitation methods

The opinion of experts are used to decide what the quantification of risk drivers per scenario will be. In specific, expert elicitation methods can be used to determine a general group consensus.

3. Human swarming

The final quantification method is a concept employed in artificial intelligence (A.I.). This method aims to create an artificial swarm that connect groups of networked humans with the objective of getting a general consensus opinion of a group (Rosenberg, 2015).

In the following subsections the approaches will be described more thoroughly. Approach (1) is omitted from the discussion, since it is so straightforward that it does not require any additional explanation.

5.5.1 Expert elicitation methods

The KPIs heavily depend on the values of the risk drivers. Changing the value of the risk drivers differently leads to different results. Every person has a different degree of belief in the occurrence of an event. Due to the subjective nature of scenario analysis, different individuals may assign different values to the risk drivers of the same event. For example, what could happen to the FTE in a robotics scenario? The FTE could reduce to any percentage ranging from 0% to 100%. It is almost impossible to predict this percentage accurately.

In order to get a better result it is therefore paramount to elicit expert opinions on the matter and this eliciting should be done within a group. In literature there is abundant information about expert elicitation methods. A large part of those methods are for inducing probability distributions or success chances of projects. For scenario analysis probabilities are irrelevant. Nevertheless, those methods are largely based on obtaining the most reliable consensus of the opinions of a group of experts. Thus, those methods should be applicable to the quantification of risk drivers as well. For the expert elicitation methods considered in this research, the focus will be on three methods that were distinguished by Ven and Delbecq (1974): interacting groups, nominal group technique and the Delphi method.

Method (1): Interacting groups

The first method is an unstructured process for eliciting expert opinions in a group. At the start of the group discussion, a problem statement is posed by the group discussion leader. Afterwards, an unstructured discussion takes place. The discussion ends with a majority voting. The advantage of this method is that it does not require much planning and time. The method is completed whenever the group discussion meeting is ended.

Method (2): Nominal group technique

The Nominal Group Technique (NGT) is a structured process for eliciting expert opinions (Delp et al., 1977). At the beginning of the group discussion, the problem statement is posed by the group discussion leader. The participants are then required to write its response to the question on a paper together with a short explanation. Afterwards, all the responses are presented in the group on a medium, i.e. a flip chart. Duplicate responses are eliminated. Each response is then discussed in the group interactively. Finally, the items on the flip chart are ranked *1st, 2nd, 3rd, 4th* and so on by each participant. The scores are then aggregated to see the preferences of the whole group. This is known as the rank and vote procedure. Just like the method of *interacting groups*, the advantage of this technique is that it usually does not require much time. The method is completed whenever the group discussion meeting is finished.

Method (3): Delphi method

The Delphi method is an expert elicitation method that can be used to obtain a group consensus of experts (Dalkey, Brown, and Cochran, 1969). By use of either a questionnaire or interview one elicits an opinion of each participant in the group concerning some central problem. The questions should be designed in such a way to bring out the participants reasoning that went into his or her answer, like the factors that he or she considers relevant. After giving the answers, each participant gets feedback concerning the answers of the other participants. There are two kinds of feedback: (1) available data requested by some of the experts in the group (2) factors that are considered to be relevant by other participants. With this new information, the participant can revise his or her belief and response to the question again. This process is repeated as long as desired.

While answering the questions, the participants should avoid any contact with the other participants. Thus, an advantage of this method is that it does not require face-to-face meetings. This is helpful when meetings cannot be planned. The disadvantage of this method is that it is time consuming in relation to the preparation time as well as the time of obtaining the results. It is estimated that an average conducted Delphi method requires 45 days to five months (Delbecq, Ven, and Gustafson, 1975).

5.5.2 Human swarming

Human swarming is a technique that is modeled after biological swarms. In nature, insects such as honey bees, amplify their intelligence by forming collective swarms enabling them to enhance problem solving and decision making as a group. This is known as swarm intelligence. In human swarming applied in many A.I. areas, one tries to create an artificial swarm by combining human insights in real-time and A.I.

algorithms into an unified intelligence system. This artificial swarm can then converge on solutions in synchrony, providing a general consensus of the group (Rosenberg, Baltaxe, and Pescetelli, 2016). Notice that this method harnesses the wisdom of the crowd. Thus, at first glance it has overlap with techniques such as polls and surveys. However, the main difference is that such techniques treat the crowd as isolated individuals that provide input independently with another, whereas swarms think collectively. Another difference is that the wisdom of the crowd techniques mainly emphasize the difference in opinions of the crowd while providing no mechanism for bridging the opinions (Rosenberg, 2015). Human swarming on the other hand, enables individuals to negotiate real-time, adapting as the opinions of the crowd evolve. Rosenberg (2016) has shown that human swarming outperforms individuals, polls and votes in prediction, including predicting who wins sporting events and political events. A collective swarm system can be created synthetically. In the following sub paragraphs, two approaches will be discussed.

Predictive market places

A method for creating human swarms is to use predictive market places, such as AUGUR. A prediction market is a market where individuals can bet on the outcome of future events. When people forecast correctly, they win money, whereas if they forecast incorrectly, money will be lost. Thus, when participating in a prediction market, people will try to be as accurately as possible with their predictions, making the price a good proxy of how likely an event is to occur (Peterson and Krug, 2015). The difference between a prediction market and a betting hub, such as Unibet or Ladbrokes, is that a betting site works centralized. The one who decide the outcome of an event and the payoff are centralized (the odds-maker), whereas in prediction markets such as AUGUR everything is decentralized. The decentralization is possible, since AUGUR is built on a block chain.

Example 5.2: AUGUR

Question: What will happen to the AuM return of APG in 2018 in "Scenario X"?

- (a) Decreases with more than 10%
- (b) Decreases between 1% and 10%
- (c) Stays between -1% and 1%
- (d) Increases between 1% and 10%
- (e) Increases with more than 10%

The odds for each answer should be $20\% = 0.20$ meaning that all possibilities have equal probability of occurring at the start of experiment. The odds add up to $100\% = 1.00$. As someone who participates in the market, if you buy a share it will cost you 20 cent. If you are right, you will receive a dollar on that share. If you are wrong you lose 20 cent. Depending on the answers of the participants, the odds will move, and the one with the greatest odds are the most likely to occur. For example, when the odds for *c* becomes 0.70, than that means that *stays the same* is the most likely to occur, according to all the participants participating in this market place with ($P(c) = 70\%$).

The advantage of a predictive market place is that one can see an estimated probability of an outcome, since the market price is an indication of the probability. The main disadvantage of using predictive market places is that it requires money, since one needs to bet on outcomes. Another disadvantage is that the predictive market place ends only when the answer of the question is known, so the prediction market settlement day may be very far in the future depending on the event that is predicted.

UNU platform

Another method for inducing human swarming is to use the UNU platform created by the company *Unanimous A.I.* This computer platform allows the creation of swarming by letting a group of participants that are connected online answer questions. The questions are answered by moving a magnet. The movement of the magnet induces a movement to the graphical puck. The puck reflects the position of the weighted responses of all participants up to that moment. Each participant may move the magnet toward any answer in real-time and may change direction at any given moment. The closer the magnet is to the puck, the stronger the pull. An answer becomes definite when the puck stays at the answer for more than a threshold amount of time, which the user may specify themselves. Figure 5.3 shows the UNU in action.

An advantage of the UNU platform is that it is highly dynamic. Participants have to decide together in real time what the best possible answer of a question is. Another advantage is that it does not require any monetary capital to set up the swarming.

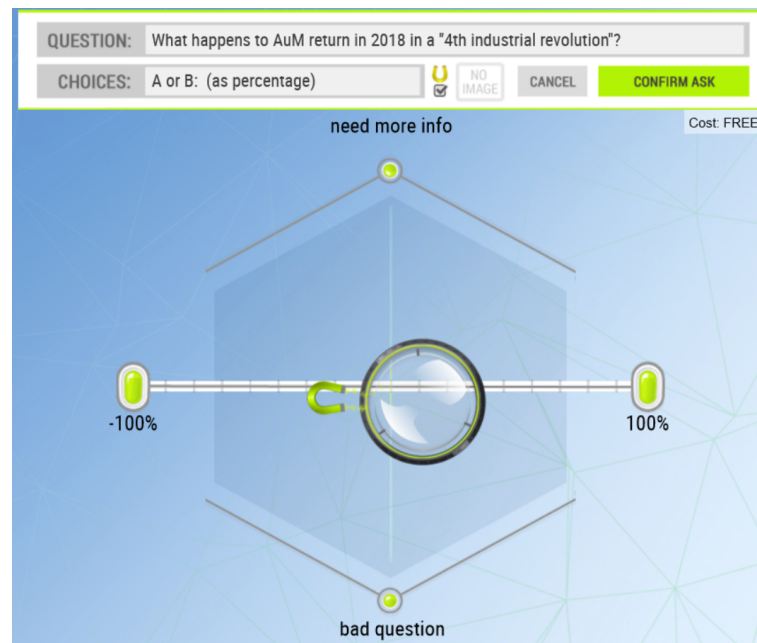


FIGURE 5.3: Human swarming method for eliciting an opinion out of a group of participants. Here only one user is depicted. By moving the magnet with the mouse, the graphical puck will be moved. The position of the graphical puck reflects the position of the weighted responses of all participants up to that moment

5.6 Finalized APG scenarios

The foregoing scenario building process can be applied in order to derive ORSA scenarios. However, for the current year (2017) it is not necessary to build scenarios. APG's strategic team already finalized four scenarios for the scenario analysis.

5.6.1 Difference in approach

This section will elaborate on the difference between the scenario building approach used by APG and the one formulated in the previous sections. The difference between both approaches is summarized in Table 5.1.

Steps (in chronological order)	APG's approach	Author's approach
Derive driving forces		
<i>Organize brainstorming session</i>	✓	✓
<i>Determine initial long list of DF</i>	✓	✓
<i>Shorten the DF list using a score system</i>	✓	✓
<i>Send survey to key persons</i>	✓	✓
<i>Plot an importance vs deviation matrix</i>	✓	✓
<i>Choose DF to be used as BB</i>	✓	✓
<i>Create a scenario framework</i>	✓	
<i>Write a scenario story</i>	✓	
Derive key risk	✓	✓
Bundling BB to scenarios		
<i>Determine which key risks to address</i>		✓
<i>Decide which DF addresses the key risks</i>		✓
<i>Determine driving force direction</i>	✓	✓
<i>Write a scenario story</i>		✓
Quantifying scenarios		
<i>Best guesstimates model user</i>		✓
<i>Expert elicitation methods</i>		✓
<i>Human swarming</i>		✓

TABLE 5.1: The difference between the used and ideal scenario building approach (with *DF* = *driving forces* and *BB* = *building blocks*)

The table shows that the approach used by APG did not address risk adequately. APG did look at the risks, but only after the scenarios were developed. This is shown by the *write a scenario story* step, which is put deliberately in the table twice to emphasize the order of this step. In APG's case the step was performed before addressing the risks. This means that scenarios could have been created that addresses none of the key risks within APG or multiple scenarios could have been created that addresses the same risks. From a risk management perspective both are not ideal.

The scenario building approach used by APG emphasizes the strategic perspective. More specifically, it is meant to test whether the current strategy is robust with respect to different scenarios. Risks are less of a concern. That is why the scenario building approach as formulated in this research is preferred for the development of ORSA, since both risks and strategy are highlighted. Notice also that APG did not quantify the scenarios specifically. This should also be done, otherwise no financial assessment can be done.

5.6.2 APG Scenarios

The four scenarios that APG finalized are called *life-cycle 3.0*, *4th industrial revolution*, *battle for the individual* and *collectivity for the own country*. This subsection depicts the scenario story as well as highlighting the addressed driving forces and risks. The scenarios will be quantified in the next chapter.

Scenario 1: Lifecycle 3.0.

Life-cycle 3.0 (in Dutch Levensloop 3.0) is characterized by a low market return and interest rate setting as well as a very high life expectancy due to a rapid increase in health technology. This environment leads to big pension cut plans by pension funds in the Netherlands, since pension providers such as ABP cannot provide a good yield for their participants. As a result the current Dutch pension system becomes unsustainable and steadily transitions to a more individual pension system is taking place. The high life expectancy also creates additional challenges including attaining a sustainable employability since people's life are getting longer and longer and people's life are changing. Study, work and leisure time are increasingly becoming interchangeable.

Driving forces: market return (strong decrease), interest rate (strong decrease), growth of health technology (strong increase), competition in illiquid markets (strong increase), individualization (strong increase), restriction collective pension (strong increase), competition in future income (strong increase).

Addressed risk: adjustment risk, publicity risk (due to long-term low return), program and project risk, longevity risk

Scenario 2: 4th industrial revolution

The fourth industrial revolution is characterized by an exponential growth in digital innovation and robotics. As a result, many jobs are replaced by robots and many processes that were once done by humans are substituted by machines and automatic algorithms. Unemployment over the whole world is rising fast. This major shift in the world, creates a sharp division in society. At the one hand, there are people with work and capital, on the other hand there are people without work and without capital. This creates a certain tension in the world. Moreover, the labor market becomes more flexible in this scenario. The number of self-employed people and employees with flexible contracts increases leading to a more competitive labor market.

Driving forces: market return (strong increase), flexibility in labor market (strong increase), growth of digital innovation (strong increase), number of fin-techs in the field of future income (strong increase), impact robotics on labor market (strong increase).

Addressed risk: business model risk, adjustment risk, composition of staff, product development risk, information strategy, information security, program and project risk.

5.7 Conclusion

This chapter focused on the scenario building. The structuring is necessary, because every year new ORSA scenarios should be developed and assessed financially. However, since APG already finalized scenarios for this year (2017), there is no need to build any scenarios this year.

RQ (5): How can the scenarios be structured as input for the model?

There are two building blocks required for building scenarios: driving forces and risks. The former are the factors that fundamentally determine future developments. The latter are the key risks within APG. Since ORSA scenarios should address the most material risks, both building blocks are chosen to be the starting point for ORSA scenarios. After bundling the building blocks into scenarios, the scenarios should be quantified in terms of the risk drivers. Several approaches were described in order to tackle the quantification, including self assessment, expert elicitation methods and human swarming.

The result of the scenario building are scenarios that can be characterized by driving forces, the direction in which the driving force develops, the addressed risk and the input values for the risk drivers and the course of these values over the year of the scenario horizon. The approach described in this chapter can be applied each year for determining ORSA scenarios.

Chapter 6

Results and discussion

The ORSA scenarios are assessed using the model developed in this research. For the documentation of the model, please refer to appendix D. The model input are the *risk drivers*. These drivers, written as a function of the KPIs, are the variables that are shocked for each scenario, *ceteris paribus* for the model assumptions made in the model. The values of the risk drivers in this research are based on two methods: guesstimates of a risk manager and researcher and an expert elicitation method. The guesstimates are based on best judgment on the effect of the risks per scenario that materialize due to the driving forces and translated to shocks (in %) applied on particular risk drivers in the base case scenario that were deemed relevant.

6.1 Base case scenario

██████████

6.2 Life-cycle 3.0

██████████

6.3 4th industrial revolution

██████████

6.4 Battle for the individual

██████████

6.5 Collectivity for the own country

██████████

6.6 Expert elicitation method

An experiment was set-up with key-stakeholders within APG for the quantification of the risk drivers. Due to time constraints, it was not possible to set-up a complete human swarming experiment by using the *unu.ai* tool as described in this research (see appendix H to see how this could be set up). Instead, an expert elicitation

method was performed based on the *nominal group technique* as mentioned in paragraph 5.5.1.

The complete method went as follows: seven key-stakeholders within APG participated in the experiment, including the CFRO of APG AM, COO of APG AM, director of strategy and director of group risk and compliance. A risk manager elaborated on the goal of the ORSA as well as the scenarios to be assessed. The scenarios were also send beforehand so that the stakeholders could prepare in advance. Afterwards, the voting procedure started. Unlike the *nominal group technique*, no ranking method was used. An online tool was used called the *mentimeter*. With this voting tool one can elicit the opinion of the crowd using the mobile phone and the result is projected directly in real-time in the *mentimeter* tool. The participants can see the result at any time on the *mentimeter* screen. Each participant has to drag the pointer to the score they want to assign to a statement as depicted in Figure 6.1. Several statements were presented. Each statement was discussed 10 minutes interactively with the group and then the group could vote on the statement. There was no possibility to change answers after voting.

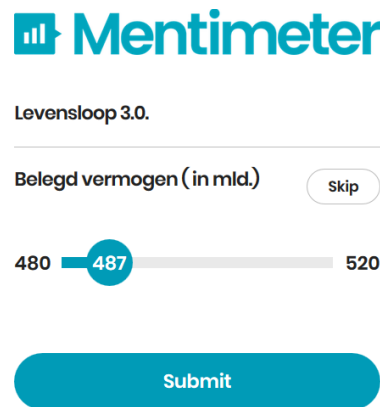


FIGURE 6.1: Participants can drag the pointer to the score they want to assign to a statement.

Ideally, all risk drivers are quantified for each year in the scenario horizon. However, due to time constraints that was not possible to set-up. Thus, only the most important risk drivers were estimated for each scenario and only for the final year of the scenario. The following statements were presented in the *mentimeter*:

Lifecycle 3.0

1. What is r_a when this scenario materializes?
2. What effect does r_a have on ΔAuM ?
3. What is the effect of the higher life expectancy on ΔFTE ?
4. What is the effect of the higher life expectancy on ΔAuM ?
5. What is Δ participants when this scenario materializes?
6. What happens to ΔAuM when the participants leave?

4th industrial revolution

1. What is r_a when this scenario materializes?
2. What effect does r_a have on ΔAuM ?
3. What will be the effect on employment when this scenario materializes?
4. What is the effect of higher unemployment on Δ participants?
5. What is the effect of higher unemployment on ΔFTE ?
6. What is Δ participants when this scenario materializes?
7. What happens to ΔAuM when the participants leave?

Battle for the individual

1. What is Δ participants when this scenario materializes?
2. What happens to ΔAuM when the participants leave?

Collectivity for the own country

1. What is r_a when this scenario materializes?
2. What effect does r_a have on ΔAuM ?

The mean of the answers of the stakeholders are summarized in Table 6.1. The Δ represent the difference between the variable in the base case scenario and the particular scenario.

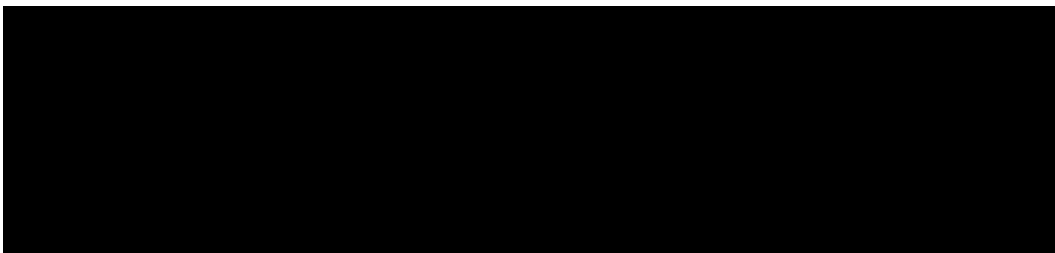


TABLE 6.1: The average results according to the stakeholders

Now let's compare the result of the quantification by the risk manager and researcher, which is summarized in Table 6.2.

created, making it possible for stakeholders to collaborate in real-time over the answer, which improves group consensus. Voting will result in an average, but not a consensus.

6.7.2 Model discussion

The model created for APG Group is simplistic in nature. No stochastic simulations are performed, nor is there a high degree of granularity. However, this model design is chosen intentionally.

At the first place scenario analysis is not about probability. The essence is to judge what happens to the organization when a scenario materializes. Thus, at the input side of the model it is not important to perform probabilistic computations (i.e. the probability of a scenario materializing). Then, one could argue that the output could be stochastic (i.e. a range of most probable output), but here the lack of data arises. Provided the scenario is satisfying the condition of addressing the most material risks, the scenarios developed in the ORSA could be anything ranging from a harmonic European pension system to advanced robotics that may take over most of the jobs. The challenge is that it is difficult to determine a probability distribution of the outcome for each scenario (and the μ and σ), since it never (or to that extent) materialized in the real world. Also, even if a scenario materialized historically, for example when APG decides to assess historical scenarios, it can be argued that it does not practically make sense to do stochastic simulation for the KPI's that are required as output for the model (i.e. for employees or profit). Better is to use expert judgment, for example with the costs for technological investments.

Another reason why a simplistic model is developed is because most of the KPI's are straightforward to compute. For the reader, it may sound surprising that the computations for Solvency II are simplistic in nature. The main reason for this is the essence of Solvency II. In Solvency II the insurance related risks and the capital requirements thereof take center stage. However, since APG does not conduct independent insurance activities at group level, the solvency requirements is to a large extent only based on the requirement of the insurance company. In the standard model for Solvency II, the premise is that financial and non-financial risks lead to a capital charge. In the case of APG it accounts only for equity risk (a little bit interest rate risk) and counter party default risk. Both risks are limited as shown in Table 6.3.

Business unit	SRC (in million)	% of Total
Group	8	1.84 %
APG AM	130	29.89 %
Loyalis	297	68.28 %
Total	435	100 %

TABLE 6.3: The capital charge for APG Group is relative small compared to Loyalis and APG Asset Management (example from September 2016).

APG does not bear any other financial or market risks. The financial risk or market risk of the investments that APG manages on behalf of their clients is not risk that is taken on by APG. All market risks are on account of the pension funds themselves. This is due to the legal set up of APG, but also regulations that are applicable for pension funds in the Netherlands. Moreover, the pension funds make

the investment decisions themselves (they choose the building blocks in which they want to invest) and these are only executed by APG.

From a capital management perspective, one could argue that it is not so useful to determine a capital charge for the group. As shown in Table 6.3, the SCR of APG Group excluding APG AM and Loyalis accounts only for 1.84% of the total SCR. Effectively, this means that Loyalis and APG AM are by far the most risky business units according to Solvency II. Intuitively it also makes sense, since asset management and insurance related activities are riskier than pension administration and communication. Since both fields are risky, it is not surprising that both entities are already under close supervision and both are required to submit risk reports to the supervisor. Key reports are the ORSA and ICAAP for Loyalis and APG AM respectively. Both reports includes the reporting of risks within the business unit and the quantification of these risks in the form of a capital charge. Given that the riskiest business units of APG are already under close supervision, it then naturally becomes questionable why APG Group also requires to do so.

6.7.3 ORSA discussion

It can be argued that the ORSA is quite useful for APG Group even though there are already risk reporting controls in place for the riskiest business units. The reason is because the ORSA enhances the planning and control cycle within APG by integrating risk, strategy and the business planning. Moreover, the ORSA is also complementary to many existing processes.

Recall that the ORSA, helps with the firms strategic decision making process by performing a scenario analysis. The scenario analysis provide a good picture of future challenges. It is at this point that strategy is also linked with risk management. That is because the ORSA requires the firm to identify future material risks irrespective of whether the risks are quantifiable or not and subject these risks to a wide range of scenario analysis. Thus, scenario analysis in the ORSA enhances the firms ability to react to future risks, which makes the firms strategy more resilient. Moreover, scenario analysis can assess the robustness of the current strategy by testing whether or not the firms strategy can be maintained when there are unforeseen changes in the environment. The business planning is imperative for this robustness testing since the strategy of APG is translated to the business planning in concrete values. The model developed in this research can help as a tool for this strategy robustness testing by estimating its financial well being for each scenario versus the financial health when the current business strategy is implemented.

From purely a risk perspective, the ORSA can also be useful. As mentioned, the ORSA requires the firm to identify every current and future material risks. Notice though, that only for the Solvency II related risks a capital buffer is required to be maintained. The risk identification is already done within APG by means of risk reports. However, the risk reporting is more on current risks and not the future risks that APG may be exposed to. In that way, the ORSA's forward-looking perspective is complementary with current risk control. Moreover, the ORSA also brings those future risks that may affect the company back to executive attention. As argued by Ruijter (2015), this forward-looking perspective may help the company with providing unique opportunities for growth and innovation.

The scenario analysis is also conducted as part of the ORSA of Loyalis and the ICAAP of APG AM. However, the scenario analysis that was carried out for those business units were focused especially on those business units and were more specific in nature. For example, with the ORSA scenarios of Loyalis the focus was

mainly on the financial and insurance related risks such as a low interest rate environment, sudden high life expectancy and spread risk (which were discussed shortly in chapter 3 paragraph 3.2.4). For APG AM the scenarios were related to the risks resulting from loss of fee due to a loss of AuM and departure of key clients. In other words, the scenarios that were assessed were more stress testing related with only one variable changing at a time and thus less broad in nature. The scenario analysis for APG can then easily be complementary to those scenarios by assessing scenarios that are more broad in nature and assessing risks that are more specific to the group that could be less relevant at individual level. An example of the latter could be a changing pension system. It would definitely impact the business model of APG Group, whereas the effect on asset management or insurance will be relative small compared with APG Group.

Since ORSA is so company-specific, there are not many guidelines on ORSA. This was also mentioned in the literature review. ORSA mainly depends on the nature, scale and complexity of the risks inherent in its business. The more complex the risk the more complex ORSA should be. Thus it can be expected that the ORSA of Loyalis is much more complex and quantitative in nature than the one from APG Group, since APG as a group is not exposed to financial risk as a result of the asset management and insurance related risks.

6.8 Conclusion

In this chapter the following research question was answered:

RQ (6): Is the modeling of ORSA scenarios at APG Group level, meaningful or not?

The modeling of ORSA scenarios at APG Group level enhances both strategic and risk management. Scenario analysis can assess the robustness of the current strategy by testing whether or not the firms strategy can be maintained when there are unforeseen changes in the environment. From a risk perspective modeling ORSA scenarios is useful because it enhances the firms ability to react to future risks, which makes the firms strategy more resilient. This is also complementary to APG's current risk control, as ORSA emphasizes a forward looking perspective to risk. The modeling of ORSA scenarios at APG Group level is also complementary to the ORSA of Loyalis and the ICAAP of APG AM, since it focuses on scenarios that are more broad in nature and assessing risks that are more specific to the group that could be less relevant at individual level. Thus, even though the solvency monitoring of APG Group is somewhat irrelevant due to APG's Group small contribution to the overall SCR level, the ORSA modeling is meaningful for the above reasons.

Chapter 7

Conclusion and recommendations

This chapter deals with the conclusions and recommendations that have been drawn up using the results of the research. The first paragraph will be devoted to the conclusions, afterwards the recommendations are discussed. The last paragraph lists some suggestions for future research.

7.1 Conclusion

The goal of this research was to answer the main research question in order to solve the main problem. The problem definition can be summarized as follows:

GRC does not have a tool to assess the impact of the scenarios on APG's financial stability.

In order to tackle this problem, the following main research question was defined:

What model can be developed for the assessment of the financial stability KPIs of APG Group with respect to different ORSA scenarios?

The answer to this main research question was obtained by answering the following sub research questions.

1. What is an ORSA?
 - 1.1. What does scenario analysis entail in the context of ORSA?
 - 1.2. What are relevant measurements in the ORSA and how can these be evaluated?
2. What are the most important characteristics of the business units within APG Group?
3. What risks are APG Group susceptible to in the context of ORSA?
4. What are the risk drivers for the financial stability KPIs?
5. How can the scenarios be structured as input for the model?
6. Is the modeling of ORSA scenarios at APG Group level, meaningful or not?

RQ1 was answered in the *literature review* chapter. **RQ2** and **RQ3** in *context analysis*. **RQ4** in *model outline*. **RQ5** in the *scenario building* chapter. Finally, **RQ6** was answered in chapter *results and discussion*.

The research process can be summarized as follows. Firstly, a literature review was conducted in order to answer **RQ1**. The ORSA is a risk management tool used by insurance companies in order to obtain a picture of their own future risks and solvency requirements. At the heart of ORSA, lies the scenario analysis. Important computations in the ORSA and scenario analysis are the SCR computations. In summary, the SCR shows how much capital is required to protect itself against (1) market, (2) counter-party, (3) life underwriting, (4) non-life underwriting, (5) health underwriting and (6) operational risk.

An important take-away in the literature review is that there are no standardized models for the scenario analysis. Each company is specific. As a result a company-specific model needs to be developed. Thus, the answering of **RQ2** and **RQ3** were necessary. This provided more insight into APG and its risk profile in the context of Solvency II. More specifically, risk drivers were found for each business unit, with the exception of Loyalis, that could represent APG in a model. The analysis also resulted in a specific risk profile of APG. For the assessment of the business units, one can make the distinction between business units that are under supervision of regulators and those business units that or not. The former consists of Loyalis and APG AM which are subject to respectively Solvency II and MiFiD. The same risk assessments and capital requirement computations in those regulations can be applied for the examination of the risks for these business units in the ORSA. The other business units are susceptible to equity risk, (minor) interest rate risk and counter-party default risk.

From this analysis, **RQ4** was answered. The scenario assessment model was developed by identifying risk drivers that resulted from the context analysis and writing these drivers as a function of the financial stability KPIs. The scenarios to be assessed in the model can be designed by means of the scenario building process described in this research. Thus, **RQ5** was answered. This approach emphasizes both strategic and risk management. The former by identifying driving forces, the latter by addressing the most important risks within APG. The result of the scenario building are scenarios that can be characterized by driving forces, the direction in which the driving force develops, the addressed risk and the input values for the risk drivers and the course of these values over the year of the scenario horizon. The value of the risk drivers can be determined by best guesstimates of the model user itself, expert elicitation methods are human swarming. The latter method is preferred, since human swarming has proven to be better for getting a group consensus.

Finally, **RQ6** was answered. The modeling of ORSA scenarios at APG Group level enhances both strategic and risk management. Scenario analysis can assess the robustness of the current strategy by testing whether or not the firms strategy can be maintained when there are unforeseen changes in the environment. From a risk perspective, modeling ORSA scenarios is useful because it enhances the firms ability to react to future risks, which makes the firms strategy more resilient. Thus, even though the solvency capital requirement of APG Group is somewhat irrelevant to compute due to APG's Group small contribution to the overall SCR level, the ORSA modeling is meaningful for the above reasons.

To conclude, the result of the research is a scenario assessment model that acts as a layer on top of the models within Loyalis. By using this model, APG is able to financially estimate the consequences of the ORSA scenarios.

7.2 Recommendations

There are several recommendations proposed in this research:

1. The first recommendation is to use the model for strategy robustness testing. That is to see if the current strategy envisaged in the business plan is resilient to different circumstances. By putting the complete data of the business plans, and shocking this business plan with scenario assumptions, the testing can be performed.
2. The model developed in this research acts as a layer on top of the models within Loyalis. It therefore requires output of Loyalis, namely the SCR of the different risk modules as well as result before taxes and non-operational costs. These metrics are the output of the ALM model of Loyalis. The advice is to collaborate with Loyalis in order to derive these values. Discuss with the ALM modeler or someone who is knowledgeable with scenario assessment in the context of ORSA.
3. It is recommended to follow the entire scenario building approach as formulated in this research. The reasons are two-fold. Firstly, by sending surveys and organizing meetings with key stakeholders such as board of directors, one actively involves key stakeholders with the ORSA process. This is important in the ORSA. Secondly, by discussing the potential driving forces and the risks that need to be addressed in the key risk framework, APG will intertwine risk management and strategy in the ORSA. This is also paramount for the ORSA.
4. Another recommendation is to use human swarming or a group of experts, preferably the board of directors, to come up with the value of the risk drivers. Moreover, the board of directors should also discuss about potential management actions and assess this in the same model. This also makes sure that the board of directors plays an active role in the ORSA process.
5. The current solvency capital requirement computation for APG Group is peculiar and somewhat meaningless for risk management. Due to the computation methods, it seems that with the exceptions of APG AM and Loyalis, APG Group does not bear any risk at all. The biggest question mark however, is on operational risk. APG is not exposed to operational risk in the context of Solvency II meaning that the capital buffer for operational risk is set to nil. However, APG does have operational risk as specified in the research of Terpoorten (2013). More specifically, the author argued that operational risk is the most important risk category within APG Group. It is therefore strange that the capital buffer is set to zero. Thus, it is recommended to follow the approach of Terpoorten (2013) to set aside a true capital buffer for operational risk that better reflect the risk profile of the company. The capital buffer for operational risk can then be added up to the group SCR. This is possible, because in Solvency II there are no diversification benefits between operational risk and the other risks ($\rho=0$). The advantage of using this method is that APG will show to regulators that they think about operational risk in its true form.
6. It is recommended to add a reverse stress test scenario. A reverse stress test is also mentioned in the ORSA guidelines. A straightforward reverse stress test scenario could be to assess how many clients need to leave in order for the company to break in terms of losses or SCR.

7.3 Future research

Human swarming is a very interesting method for amplifying prediction accuracy, eliciting opinions and also as a decision making tool. This method is useful in any situation that requires human input. APG could do future research on application of human swarming within the business. For example, human swarming could be applicable for scenario monitoring. Scenario monitoring is useful since the ORSA requires the constantly monitoring of current and future risks. As the ORSA scenarios are potentially risky, it would be helpful to monitor which scenario will most likely materialize so that one can prepare for the risks on time. By eliciting the opinions of employees of APG, one can try to predict which scenario will most likely materialize. This could be done by unwinding a scenario into several variables and predicting these scenario variables using human swarming.

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Appendix A

Operational Risk in Solvency II

The computation approach for the SCR of operational risk in Solvency II is as follows (CEIOPS, 2009):

$$SCR_{op} = \min \left((SCR_{BasicCap} * SCR_{basic}), \max \left(Op_{premiums}; Op_{provisions} \right) \right) + UL_f * Exp_{ul} \quad (A.1)$$

Where:

- SCR_{basic} = basic solvency capital requirement.
- $SCR_{BasicCap}$ = cap at 30 percent.
- $Op_{premiums}$ = operational risk charge over the earned life premiums.
- $Op_{provisions}$ = operational risk charge over the earned provision.
- UL_f = A factor charge to be applied to the amount of annual expenses (gross of reinsurance) incurred by the unit-linked business. This factor charge is 25%.
- Exp_{ul} = amount of annual expenses (gross of reinsurance) incurred by the unit-linked business.

The operational risk formula above was designed in such a way that it addresses operational risks to the extent that these have not been explicitly covered in other risk modules in the standard model of Solvency II.

Appendix B

Cost structure

The costs at APG are classified in several categories. These categories and sub categories are all depicted in the following construct on the next page:

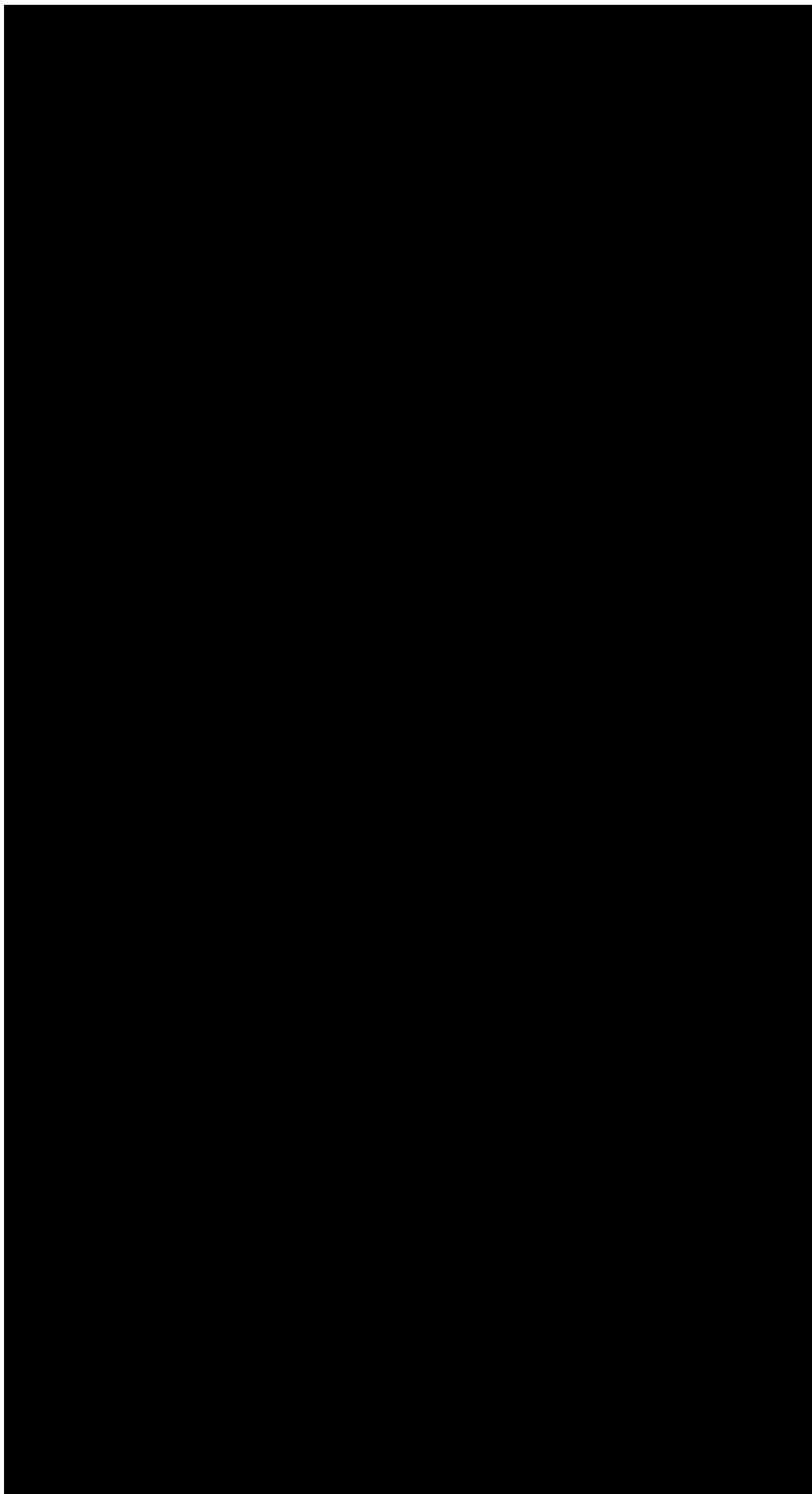


FIGURE B.1: Total costs construct

Appendix C

Useful information

Annual report balance sheet

Assets	Value (x1000)	Liabilities	Value (x1000)
Fixed assets	1.085.545	Provision	64.636
Intangible fixed assets	21.310	Short-term loans	194.453
Tangible fixed assets	1.189	Long-term loans	23.767
Financial fixed assets	1.063.046	Own funds	1.229.953
Current assets	427.264		
Receivables & prepayments	185.691		
Cash	241.573		
Total Assets	1.512.809	Total Liabilities	1.512.809

TABLE C.1: Standalone balance sheet of APG in 2016 (APG, 2016)

Key data

Year	AuM	Return on AuM	Participants	Net result
2010	€272.000.000	Unknown	4.440.000	€47.000.000
2011	€284.000.000	Unknown	4.249.000	€33.000.000
2012	€324.000.000	Unknown	4.443.000	€32.000.000
2013	€343.000.000	6.2% - 7.2%	4.478.645	€9.000.000
2014	€398.800.000	8.4% - 10.7%	4.467.654	€36.000.000
2015	€406.413.000	1.6% - 3.2%	4.449.077	€44.000.000
2016	€440.005.000	8.2% - 9.6%	4.455.522	€65.000.000

TABLE C.2: Key data based on annual reports of the past seven years.

Appendix D

Model documentation

The model constructed for the assessment of the financial stability of APG Group is documented in this appendix. The model is built in Excel and consists of several spread sheets. The next paragraphs will explore the spread sheets in more detail. In principle the model can be seen as an extra layer on top of the models of the insurance company Loyalis. The model uses input of Loyalis, but it does not make any detailed computations for Loyalis. Of course, Loyalis can also be omitted if required by the model user.

Dashboard

The dashboard is the main sheet of the model. In this file the model user can alter the input of the model in order to assess the financial stability of APG Group. The input required is highlighted in yellow. The input consist of the risk drivers for each business unit. The risk drivers are the parameters that are shocked per scenario. In other words, when the model user alters the value of these parameters a shock will be applied to the risk driver. In this way different scenarios can be evaluated.

The scenarios are assessed in terms of the financial stability KPI's. The output consist of total assets under management, total number of participants, total number of FTE's, total revenue, total costs, net result, solvency capital requirement, own funds and solvency ratio. These KPI's are visualized in both tables and graphs.

In addition to the input and output presented, there is also two macros that can be used in this sheet. The first macro concerns the danger zone and is designed for risk assessment purposes. The model user can specify a danger zone for the KPI's and this will be illustrated in a traffic light model. A green traffic light means no risk, orange means medium risk and a red depicted traffic light means high risk. For example, the model user can specify that the danger zone of the solvency ratio is 130%. If the solvency ratio falls below this specified danger level, there will be a red light and some sort of management action should be taken.

The second macro used in the model is a save function. The purpose of this macro is to save the KPIs in another table. This makes it easier for the model user to compare scenarios with each other. One can for example alter the input of the model, save the result, alter input of the model again, and then compare both results. The comparison is also visualized in graphs.

Table of contents

This is the table of contents. The model user can easily jump to different sheets in the Excel file. It is also possible to jump back from each sheet to the table of contents by clicking on the table of contents macro button.

Fact Sheet

The fact sheet is where the model user inputs the model data. The data required is highlighted in yellow. This data can be found either in the business plan of APG group or the individual business plans for each business unit. If one wishes to take Loyalis into consideration, then it is also necessary to look at the ORSA (or ALM study) to get their forecast of the result before taxes, own funds and SCR.

Business units

This sheet is a calculation sheet. In principle, no input is required of the model user. The model uses its own set of assumptions for the computation of revenue and costs. These assumptions are described in chapter 4. To align the model with the values of the business plan one can make use of the correction macro.

Balance sheets

This spread sheet depicts the development of the balance sheet of APG Group and its business units. This is relevant for the solvency requirement computations described later on. As the starting point, the model requires the market value of the balance sheet of APG Group, APG Rechtenbeheer, APG Diensten and APG Deelnemingen. The balance sheet of APG Asset Management is unnecessary because only the MiFiD value is relevant and this value can be derived from the profit loss sheet described in the next paragraph. Since the balance sheet values of APG Diensten and APG Deelnemingen is minor, both can be taken together.

Profit Loss

This sheet gives an overview of all the computed revenues and costs in profit and loss statement format. There is also a table to show that the model is consistent so that internal revenue is equal to the allocated costs.

Solvency

This sheet gives an overview of the solvency risks computations for APG Group as well as the diversification. Here, the SCR of Loyalis its risk modules can be used as input to the model.

Interest rate risk

One can use this sheet to estimate the interest rate risk. To determine the interest rate risk one requires a yield curve, interest rate risk sensitive assets and liabilities.

Management actions

Most management actions can be done in the other sheets. For example, if one wants to reorganize and remove FTE's one can simply go to the dashboard and alter the FTE values for a particular business unit.

Driving forces

Information about the driving forces are depicted in this spread sheet.

Appendix E

Risk framework of APG

The risk department within APG identified several key risks within APG. These risks, which are encapsulated in a general framework, are depicted in the table below. These risks are monitored by risk owners within the organization and reported regularly using reports.



Appendix F

List of driving forces



Appendix G

Experiment

This is an experiment that was set-up by the author of this research for the scenario assessment.

G.1 Frequently asked questions

(1) What is the goal of this experiment?

The goal of the experiment is to use human swarming for predicting the value of KPIs for each ORSA scenario. The KPIs include total assets under management, total participants, total revenue, total costs and total employees. The result of this experiment will be used for the scenario assessment in required by the ORSA.

(2) What is this human swarming technique?

Human swarming is a technique that is modeled after biological swarms. In nature, insects such as honey bees, amplify their intelligence by forming collective swarms enabling them to enhance problem solving and decision making as a group. This is known as swarm intelligence. In human swarming an artificial swarm is created by combining real-time human insights and A.I. algorithms into an unified intelligence system. This artificial swarm can then converge on solutions in synchrony, providing a general consensus of the group (Rosenberg, Baltaxe, and Pescetelli, 2016).

(3) Why not just use polls, surveys or voting methods?

Human swarming harnesses the wisdom of the crowd. Thus, at first glance it has overlap with techniques such as polls and surveys. However, the main difference is that such techniques treat the crowd as isolated individuals that provide input independently with another, whereas swarms think collectively. Another difference is that the wisdom of the crowd techniques does not provide mechanism for bridging the opinions, which is not beneficial when trying to get a group consensus (Rosenberg, 2015) Human swarming on the other hand, enables individuals to negotiate real-time, adapting as the opinions of the crowd evolve. Research has shown that human swarming outperforms individuals, polls and votes in prediction, including predicting who wins sporting events and political events (Rosenberg, 2016).

(5) Which human swarming platform do we use?

We can use the UNU platform created by the company *Unanimous A.I.* This computer platform allows the creation of swarming by letting a group of participants that are connected online answer questions by moving a graphical puck to select among the provided answers. Each participant may move the magnet toward any answer in real-time and may change direction at any given moment. The closer the magnet is to the puck, the stronger the pull. An answer becomes definite when the puck stays at the answer for more than a threshold amount of time (three seconds).

(6) Instructions for the participants

Participants require either *Google Chrome* or *Mozilla Firefox* browser which is installed at each employee laptop or tablet.

1. Go to <https://unu.ai/>
2. Click **Sign in**
3. Log-in using the provided user name and password
4. In find the swarm, click **GRCExperiment**
5. Type provided password for this swarm.

Instructies

- You have a magnet at your disposal.
- The magnet can be moved either by your finger (in case of tablet) or your mouse(pad) (in case of laptop).
- Look at the question and move the puck towards the answer which you think is correct. The magnet pulls, it does not push! The closer to the puck, the stronger the pulling effect. If you think the answer is correct, make sure to stay close to the puck.
- You can change the direction of your magnet at any time during the question.
- Each question lasts 60 seconds.

G.2 Experiment set-up guide for APG

