Contributions to Management Science

Maria Heep-Altiner
Martin Mullins
Torsten Rohlfs *Editors*

Solvency II in the Insurance Industry

Application of a Non-Life Data Model

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Preface

The Solvency II Framework came into effect on 1st January 2016. The scope of the new Act is considerably more wide-ranging and complex than previous legal structures and is based on three distinct pillars. In this publication, the most important Solvency II applications are therefore illustrated pillar by pillar and the consistent data model of the so-called IVW Private Lines applied in order to provide a comprehensive overview of the regulatory structures and to afford stakeholders a better understanding of the framework as a whole.

The insurance industry plays a crucial role in both social and economic terms. It facilitates risk transfer for both companies and individuals, thus creating a more sustainable future for all of us. In an age marked by a high degree of unpredictability, be it global warming or emerging technologies, insurance provides a crucial set of services. Hence, a degree of oversight on the part of the political authorities at both national and, in this instance, supranational levels is required.

The regulatory regime in place for EU insurers immediately prior to Solvency II was no longer appropriate for the evolving insurance industry. This led to a major overhaul project: the design and implementation of a new comprehensive framework known as Solvency II, based on the core Solvency II Directive. This complex process began a decade ago, and in 2016, Solvency II came into effect across the EU.

This publication has been developed within a combined **teaching and publication project** wherein master students of the Institute of Insurance Studies at the Cologne University of Applied Sciences (TH Köln) produced written work on Solvency II. This project was undertaken in collaboration with academics from the TH Köln and in cooperation with researchers from the University of Limerick. The project as a whole has been supported by project teams from the TH Köln and the University of Limerick.

Our aim was both to improve the pedagogical experience of our students and provide a valuable resource for stakeholders in the insurance industry and those working in actuarial sciences. The Cologne Institute of Insurance Studies has extensive experience in book production projects, and on this occasion, this has been further enhanced by the international cooperation of our colleagues in Ireland.

We would like to thank all organisations and people that have supported us during this project, especially the Institute of Insurance Studies at the Cologne University of Applied Sciences and the Kemmy Business School Department of Accounting and Finance at the University of Limerick.

Cologne, Germany — Maria Heep-Altiner
Limerick, Ireland — Martin Mullins
2017 — Torsten Rohlfs

Preliminary Remarks

The data model of the non-life insurer "IVW Private Lines" has been created as an instructive example for a lecture series with respect to financial management as well as risk management in the insurance industry. From some simple chain ladder triangles to a complete as well as very complex EXCEL output, the model developed covers all three Solvency II pillars.

While developing this model, parts of it have been published within the publication series "Forschung am **ivw**Köln" (Research at the Cologne Institute of Insurance Studies, ISSN (online) 2192-8479) on the open access platform Cologne Open Science (COS) in German language. Those relatively technical COS publications cover particular aspects as listed in the table below.

Volume	Topic	Link
06/2015	Key elements of pillar 1, especially standard formula and partial model.	https://cos.bibl.th-koeln.de/frontdoor/index/index/docId/65
10/2015	Key elements of pillar 2, especially risk management & ORSA.	https://cos.bibl.th-koeln.de/frontdoor/index/index/docId/156
06/2016	Key elements of pillar 3, especially reporting and process requirements.	https://cos.bibl.th-koeln.de/frontdoor/index/index/docId/345
07/2016	Additional to pillar 1, required capital via internal model.	https://cos.bibl.th-koeln.de/frontdoor/index/index/docId/371
04/2017	Additional to pillar 1, available capital via market-consistent-embedded value.	https://cos.bibl.th-koeln.de/frontdoor/index/index/docId/473

The publications listed above have also been used as the basis for several monographs with respect to financial and risk management in the insurance industry. In consequence of the original authorship then, many citations with respect to the data model in this document refer to the original COS publications or to the subsequent monographs, all of which are in German language.

In this monograph, the data model is treated as a whole for the first time in order to illustrate the three pillars of Solvency II. This is achieved step by step in a consistent and not overly technical manner. Nevertheless, working with a data model necessarily affords some mathematical requirements.

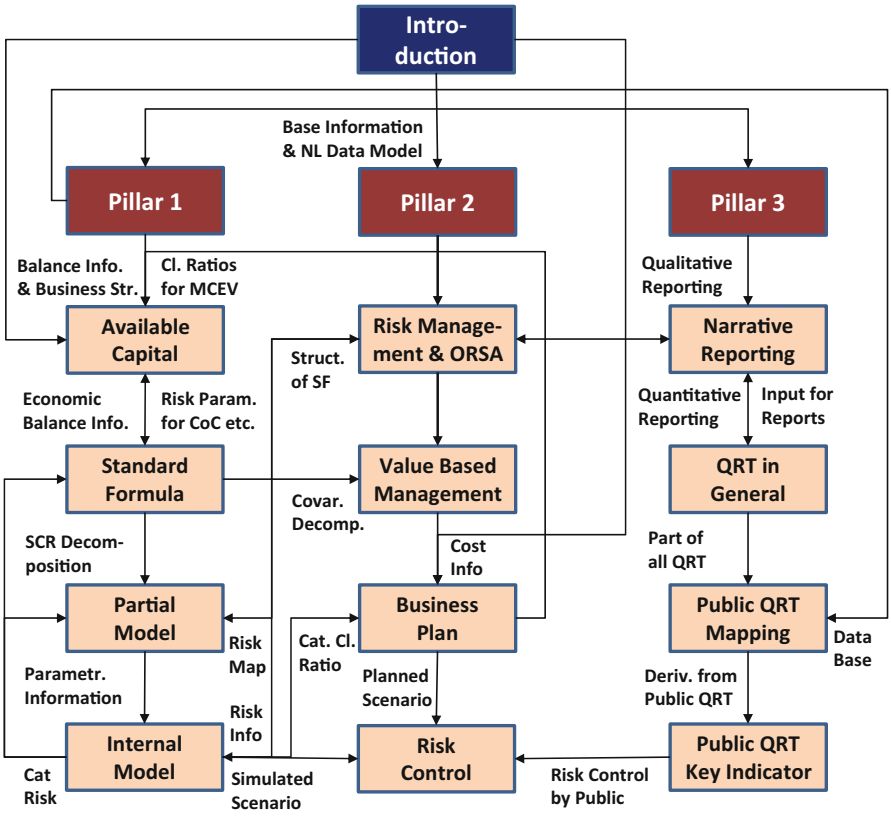

Fig. 1 Structure of the data model applications

The presentation of the data model in this publication starts with a general overview on Solvency II together with the introduction of the key elements of the non-life data model of the so-called IVW Private Lines.

This data model will be illustrated pillar by pillar where Fig. 1 highlights the interrelations between the chapters and their subsections.

In the introduction, general information with respect to the data model is presented. In each section, the individual information required will be provided. However, in some more complex cases, information needed in a section will be provided in a subsequent section.

Contents

List of Abbreviations

ABL	Assets Backing Liabilities
ABSHE	Assets Backing Shareholder's Equity
AC	Administration Costs
AC	Amortised Costs
AC	Available Capital
AD	Average Default
Adj, Adjustm	Adjustment
Admin	Administration
AL	After Loss
ALFI	Association of the Luxembourg Fund Industry
Alloc	Allocated
AMSB	Administrative, Management or Supervisory Body
AP	Accounts Payable
Art.	Article
AV	Asset Value
avail.	Available
AY	Accident Year
back.	Backing
BaFin	Bundesanstalt für Finanzdienstleistungsaufsicht (*German Surpervisory Authority*)
BC	Base Claims
BE	Best Estimate
Bef. Adj	Before Adjustment
BOF	Basic Own Funds
BoS	Board of Supervisors
BoY	Beginning of the Year
BP	Balance Year Payments
B_p	Bernoulli Distribution with Parameter p
BS	Balance Sheet
BSE	Balance Sheet Equity
BSCR	Basic Solvency Capital Requirement

BY	Balance Year
C	Coupon
CA	Claims Amount
Cat	Catastrophe
Cat-XL	Catastrophe Excess of Loss
CCF	Cumulated Cash Flow
CDF	Cumulated Development Factor
CEIOPS	Committee of European Insurance and Occupational Pensions Supervisors
CF	Cash Flow
CFO	Chief Financial Officer
CI	Concentration Index
Cl	Claims
Cl. Handl	Claims Handling
CoC	Cost of Capital
Comb	Combined
Confid	Confidence
COS	Cologne Open Science
COV	Covariance
CP	Cumulated/Cumulative Payments
CP1	First Counterparty
CP2	Second Counterparty
cr	Coupon rate
CR	Combined Ratio
CRNHR	Costs of Residual Non-Hedgeable Risks
CV	Coefficient of Variation
D	Duration
DBE	Discounted Best Estimate Provisions
DCoC	Discounted Cost of Capital
Deriv	Derived
DF	Default
DF	Development Factor
Disc, Discount	Discounted
Div, Divers, Diversif	Diversified, Diversification
DP	Default Probability
DP	Development Period
DT	Deferred Taxes
EAL	Excess of Assets over Liabilities
EC	Economic Capital
EC	European Commission
EEA	European Economic Area
e.g.	Exempli gratia (*for example*)
EIOPA	European Insurance and Occupational Pensions Authority
elig.	Eligible

EN	English
EoY	End-of-Year
EQ	Equity
ESG	Economic Scenario Generator
et al.	Et alia (*and others*)
etc.	Et cetera (*and so on*)
EU	European Union
EV	Expected Value
EVA®	Economic Value Added (*Trademark of Stern & Stewart*)
excl.	Excluding
Exp.	Expense
EXP	Exponential Function
EXP, Expos	Exposure
expect	Expected
EV	Expected value
f	Following
FaRis	Forschungsstelle finanzielles & aktuarielles Risikomangement (*Research Group Financial & Actuarial Risk Management)*
FC	Frictional Costs
FI	Fixed Income
Finite Re	Finite Reinsurance
FS	Free Surplus
FSC	Forecast Scenario
FV	Fair Value
FY	Forecasted Year
GAAP	Generally Accepted Accounting Principles
GD	Geographical Diversification
GEP	Gross Earned Premium
H	Health Risk
HC	Home Country
HFI	Herfindahl Index
IAIS	International Association of Insurance Supervisors
IBNR	Incurred but not reported
IC	Investment Costs
ICR	Initial Cover Ratio
IE	Ireland
i.e.	Id est (*that is to say*)
IFRS	International Financial Reporting Standards
IM	Internal Model
INC	Incurred Claims
incl.	Including
Info.	Information
intang.	Intangible
INV, Inv.	(Re) Investment

IR	Interest Rate
ISC	Incurred Scenario
ISSN	International Standard Serial Number
IT	Information Technology
IVW	Institut für Versicherungswesen (*Institute for Insurance Studies*)
ivwKöln	Institut für Versicherungswesen Köln (*Cologne Institute for Insurance Studies*)
K	Threshold of a Pareto Distribution
KI	Key Indicator
KPI	Key Performance Indicators
LB	Lower Bound
LCB	Level-Coupon Bond
LG	Local GAAP
LGD	Loss Given Default
Liab.	Liability
lin.	Linear
LN	Natural Logarithm
LoB	Line of Business
LR	Liquid Result
LQ	Remaining Liquidity
M	Month
MAT	Marine, Aviation, Transport
max.	Maximum
MCEV	Market Consistent Embedded Value
MCR	Minimum Capital Requirement
MCRNL	Minimum Capital Requirement Non-life
min.	Minimum
Mkt.	Market
ML	Motor Liability
MM	Man Made
Mod.	Modified
MR	Market Risk
MV	Market Value
N, n	Distribution resp. realisation of the claims number
Nat Cat	Natural Catastrophes
NAV	Net Asset Value
NB	New Business
NBE	Nominal Best Estimate
NC	Natural Catastrophes
NL	Non-life
NLR	Non-life-Risk
Nom.	Nominal
Non-techn.	Non-technical

NR	Net Ratio
NV	Nominal Value
NY	Next Year
O&G	Options and Guarantees
occur.	Occurrence
OECD	Organisation for Economic Co-operation and Development
OF	Own funds
Op., Operat.	Operational
OR	Operational Risk
ORSA	Own Risk and Solvency Assessment
oth.	Other
P	Probability p
P	Payments
P., PP.	Page(s)
para.	Paragraph
Param.	Parameter
PM	Partial Model
Pr., Prem.	Premium
Prem. & Catastr.	Premium and Catastrophe
Prob	Probability
PROP	Property
Prop	Proportional
Proj	Projection
Prov	Provisions
PVFP	Present Value of Future Profits
PY	Previous Year
P&L	Profit & Loss Account
Q	Counter probability $q = 1 - p$
Q	Quantile
QIS 5	Quantitative Impact Study No. 5
QRT	Quantitative Reporting Template
ra	Risk-Adjusted
RaRoC	Risk-Adjusted Return on Capital
RBA	Risk-Bearing Ability
RC	Required Capital
RCF	Recovery Factor
RD	Redundancies
RD	Required Dividends
Res.	Reserve
Res. & Def.	Reserve and Default
RF	Risk Factor
rf	Risk free
RG	Regular Claim
RI	Reinsurance

RM	Risk Management
RM	Risk Margin
RN	Risk Neutral
RoA	Return on Assets
RoC	Return on Capital
RoL	Return on Liquidity
RoRaC	Return on Risk-Adjusted Capital
RP	Reinsurance Provision
RSR	Regular Supervisory Report
RW	Real World
S, S_+	Distribution of the non-negative resp. strictly positive claims amount
S	Spread
S II	Solvency II
SCR	Solvency Capital Requirement
SD	Standard Deviation
SF	Standard Formula
SFCR	Solvency and Financial Condition Report
SHE	Shareholders' Equity
SLT	Similar to Life Insurance Techniques
SI	Synergy Index
SP	Surplus
SPR	Spread
SPV	Special Purpose Vehicle
Sol	Solvency
Str., Struct.	Structure
S&P	Standard & Poor's
TC	Total Cost
TD	Tax Depreciation
Techn.	Technical
TH Köln	Technische Hochschule Köln (*Cologne University of Applied Sciences*)
TL	Tax Liabilities
TP	Technical Provisions
TP	Time Period
TR	Tax Rate
TR	Technical Result
TVaR	Tail Value at Risk
TVOG	Time Value of Options and Guarantees
T1, T2, T3	Tier 1, Tier 2, Tier 3
T€	Thousands of Euros
UB	Upper Bound
Ult.	Ultimate(s)
UL	Ultimate Loss

ULIM	University of Limerick
undiv.	Undiversified
US GAAP	United States Generally Accepted Accounting Principles
USP	Undertaking-Specific Parameter
UW	Underwriting
VaR	Value at Risk
VAR	Variance
VBM	Value-Based Management
VIF	Value-in-Force
vs.	Versus
W	Weight
X, x	Distribution resp. Realisation of the Severity
XoL	Excess of Loss
Y	Distribution of the Claims Amount
YB	Beginning of the Year
YE	End of the Year
ZCB	Zero-Coupon Bond

List of Figures

Chapter 1
Introduction

Maria Heep-Altiner, Martin Mullins, Torsten Rohlfs, Svenja Hintzen, Simon Muders, Barry Sheehan, and Florian Vennemann

Since January 2016, Solvency II has been integrated as the regulatory framework for the insurance industry with the objective of harmonising European Union (EU) insurance regulation. This framework has fundamentally reformed EU insurance supervisory law and bears little resemblance to its predecessor, Solvency I. In addition, the Solvency II regulations particularly value the functionality of companies' governance and risk management systems in order to guarantee an effective and efficient control of the companies' risks.

Among other reasons, the increased complexity of the new system resulted in a long development and implementation period. Although the Solvency II Directive as the underlying reference framework was originally published in 2009, its fulfilment in EU-Member States could only be completed in January 2016 because the Solvency II framework had to be modified for several times.

There have been various reasons for the introduction of Solvency II. Besides a significant increase of risks an insurer must manage (e.g. accumulated losses through natural catastrophes and volatile capital markets), the protection of the insured is the primary objective of the new framework (Doff 2016, pp. 587–607).

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1.1 Basic Information with Respect to Solvency II

As an EU-wide regulatory framework, Solvency II must be seen within the general context of financial legislation. Hence, Solvency II has been implemented in a so-called *Lamfalussy* process[1] based on defined levels. Regarding Solvency II, for example, the German supervisory authority has clarified the levels as follows (BaFin b, p. 1):

Level 1 **Solvency II Directive**
as a fundamental basis of the Solvency II regulation

Level 2 **Delegated Act**
adopted by the Commission as directly applicable law

Level 2.5 **Binding Technical Standards**
developed by EIOPA and issued by the Commission

Level 3 **Supervisory Guidelines and Recommendations**
for efficient supervisory practices and consistent application

The concept of Solvency II is based on **three pillars**, covering specific fields of regulations on a quantitative as well as a qualitative level where this structure is illustrated in Fig. 1.1.

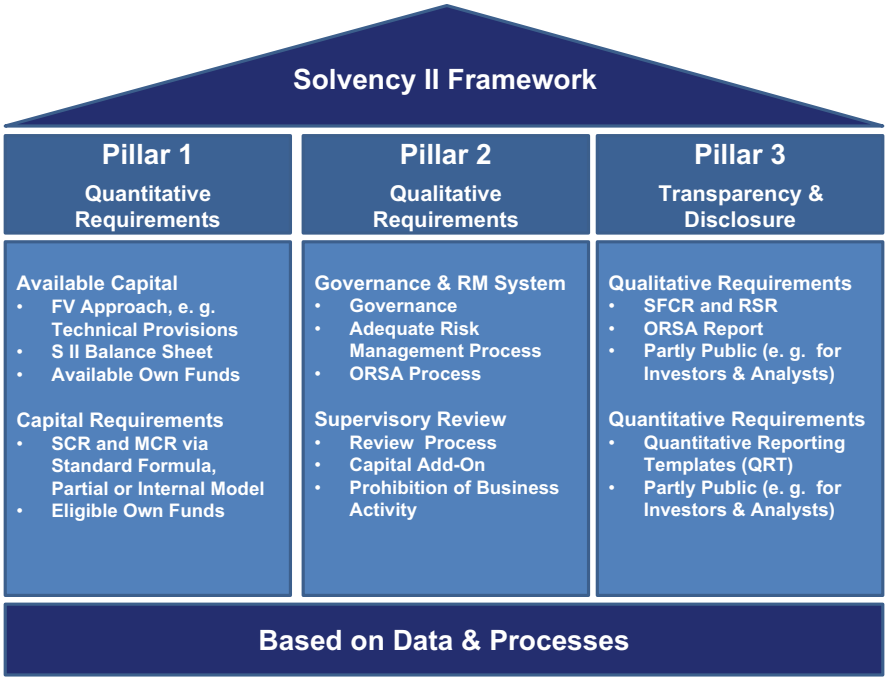

Fig. 1.1 Overview of the three Solvency II pillars

[1] Approach used to accelerate the development of EU-wide financial legislation.

In the following, the key elements of the three pillars are described with the aim to provide a basic understanding of the most important aspects of Solvency II and its requirements. Each pillar will be illustrated in more detail within the subsequent chapters using the non-life data model, introduced at the end of this chapter. Furthermore, according to the overview above, data and processes are established for the three Solvency II pillars.

1.1.1 Summary of Pillar One

The first Solvency II pillar specifies the quantitative requirements a European insurance company must meet, combining three numerical exercises; establishment of the economic balance sheet, calculation of the solvency capital requirements, and the subsequent determination of the own funds. All quantifiable risks should be covered by the **Solvency II capital requirements** and compared with the economically **available capital** (Heep-Altiner et al. 2015, p. 208).

1.1.1.1 Available Capital

Regarding the valuation of the available capital, Solvency II utilises the so-called **fair value approach** as a market price-based concept (Directive 2009/138/EC, art. 75).

Fair Value Approach

The International Financial Reporting Standards (IFRS) define the fair value (FV) as:

> The price that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date (IFRS 13.9).

In the case of *deep and liquid markets*, e.g. markets with a sufficient number of transactions and transaction volumes, fair value can be determined directly by using existing market prices. It is also possible to derive the fair value indirectly from a reference portfolio, using market prices of suitable markets (**mark-to-market**). However, if a direct or indirect derivation from existing market prices is not possible, the fair value must be determined by using an adequate model (**mark-to-model**) (Heep-Altiner et al. 2016, p. 8).

Figure 1.2 highlights the main aspects and the differences between the valuation methods within the two approaches.

In the context of Solvency II, regarding the fair value (FV) valuation, a hierarchy of input factors can be defined as follows (Heep-Altiner et al. 2017, p. 5):

- Directly observable market values (*level 1*)
- Derivable market values from reference portfolios *(level 2)*
- Estimated model values (*level 3*)